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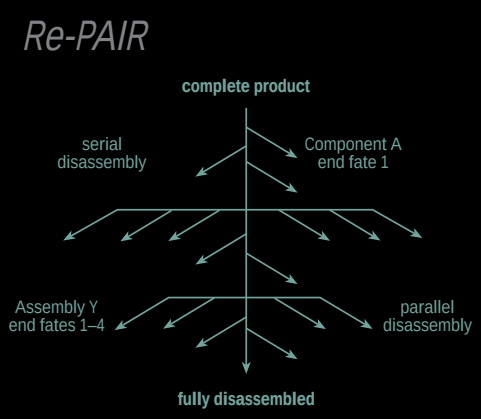
The Journal of Sustainable Product Design



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GENERAL INFORMATION

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

Martin Charter

Joint Editor, The Journal of Sustainable Product Design

The practicalities of a holistic view of sustainable product development and design (SPDD) – incorporating economic, environmental, ethical and social considerations – are poorly understood. At present eco-efficiency is the dominant paradigm and its application at the product level is now starting to generate new solutions. However, a landmine can be produced in an eco-efficient manner, whilst creating jobs in the process!

SPDD that ignores social and ethical issues, falls short on the broader sustainability agenda. As a result, it is important to explore the value creation process and understand and take a position on the issues. The production of footballs using child labour in Pakistan or India, may delivery high quality products and profitability, whilst securing direct and indirect employment in the North and South. However, some of the children may lose out on education, and suffer health problems through dirty stitching needles. But, if the children do not work, their extended families may suffer continued and increased poverty. There is no easy answer, but we need a clearer understanding of the whole picture.

The sustainability landscape is dotted with problems and opportunities. For example, changing producer responsibility legislation in the electronics sector will produce opportunities for those providing specialist recycling services and those who start to design smart for dismantlability. These new designs with require increased individual creativity and innovative approaches to involvement from customers, suppliers and recyclers if new solutions are to be generated that are easier to recycle, use less hazardous materials and use more recyclate.

Whether one takes a holistic or environmentally-driven view on sustainability, we are still in a learning phase in relation to product and service development. Understanding of the eco-design process is improving, and this is being driven by the development of strategic approaches incorporating measurement metrics. However, there is still a lot to achieve. For eco-design to progress within the firm there will need to more effective learning strategies to collect project experience, this will require a learning organisation approach.

There are a number of organisations that are progressing

Sustainable product development and design

Sustainable product development design (SPDD) is concerned with balancing economic, environmental, ethical and social aspects in the creation of products and services. SPDD looks to minimise adverse sustainability impacts and maximise sustainability value throughout the life-cycle of the product or service. To create sustainable products and services that increase stakeholders' 'quality of life', whilst at the same time achieving major reductions in resource and energy use, will require a significant emphasis on stimulating new ideas through higher levels of creativity and innovation.

Martin Charter in 'Design for Environmental Sustainability', Foresight, Office of Science and Technology, UK, May 1998

eco-design projects in different parts of their businesses and in different parts of the world. However, often there does not appear to be any form of systematic knowledge collection mechanism and little internal and external networking, with big dangers of 're-inventing the wheel' arising. A mechanism needs to be put into place to improve knowledge management of eco-design processes and content. Process management knowledge being how to run eco-design projects and content knowledge being the micro-management of the operationalisation of environmentally-considered product design. Some companies have started to experiment with intranet-driven systems for employees interested and involved in the green product development process, however what is clear is that if eco-design is to be successful, the approach needs to be systemic, involving both customers, suppliers and recyclers. Therefore there should be opportunities for the development of extranet services with different levels of accessibility, for example, in relation to materials use and impact. The involvement and level of participation of other stakeholders in the eco-design process, will be dependent on the level of knowledge outside of the firm, and the degree of commercial confidentiality and sensitivity attached to the product development process. Involvement will also be a function of the corporate culture relating to trust issues and the degree of application of the 'not invented here' syndrome!

The fifth issue of the Journal of Sustainable Product Design highlights the need to consider the needs and concerns of the external stakeholders in the eco-design process. Michael Jay Polonsky, Senior Lecturer, School of Management, University of Newcastle, Australia, Philip J Rosenberger, Lecturer, University of Western Sydney, Australia, and Jacquelyn Ottman, President of J Ottman Consulting Inc, US, discuss the issue of stakeholder involvement in the green product development process based on research conducted in the US and Australia. The research indicates that interaction with stakeholders outside the normal system is poorly evolved. Frank Boons, Lecturer in Policy Sciences and Organisational Sociology, Tilburg University, Netherlands, analyses the roles that individual stakeholders play in the product chain, drawing on three cases from the Netherlands. The conclusion is that it may be necessary to create links and also to break links in the product chain, for new and existing eco-design projects to be successful. Burton H Lee, Doctoral Candidate, Department of Mechanical Engineering, Design Division, Stanford University, US, and Kosuke Ishii, Associate Professor, Department of Mechanical Engineering, Design Division, Stanford University, US, present a series of practical issues surrounding design for dismantling, and highlight a new tool, the 'Recyclability Map'. The paper highlights the need for better communication between designers and recyclers. An interview with Joseph Fiksel, Senior Director of Battelle's Life Cycle Management group focuses on the practicalities and challenges of increasing the involvement of product designers in the eco-design process. In the Innovation section, Jacquelyn Ottman, President of J Ottman Consulting Inc, US, and Virginia Terry, Researcher in Sustainable Design at The Surrey Institute of Art & Design, UK, provide a series of examples of greener products and the opportunities and threats associated with greener marketing. Finally, the O2 pages provide an overview of useful eco-design websites worldwide.

The Journal for Sustainable Design is always interested in papers that can give examples of sustainable product development and design. Articles can be highly practical or theoretical focusing on real product or service design problems, as well as on management or policy level perspectives. Of particular interest are articles that challenge conventional thinking and take a more systemic view incorporating social and ethical, as well as environmental and economic considerations.

As always we welcome your views and comments. •

Developing green products: learning from stakeholders

Michael Jay Polonsky, Philip J Rosenberger III, and Jacquelyn A Ottman

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The complexities of environmental issues require that when developing new green products marketers should seek out, involve and learn from stakeholders with environmental expertise. These stakeholders often have information that lies outside the organisation's main area of expertise and can assist the firm in developing less environmentally harmful products. This paper examines US and Australian marketers' perceptions of stakeholders' potential to influence the green new product development (NPD) process and what strategies can be used to involve stakeholders in this process. The findings suggest that marketers believe some stakeholders with 'high' influencing abilities should be involved in the green NPD process, although it appears that in practice, firms use very basic methods to involve these stakeholders. There also appears to be limited formal interaction between the firm and its stakeholders and that marketers are not engaging and learning from others with green product expertise.

Introduction

Environmental concern has increased in the 1990s. This has resulted in consumers going green, and environmental issues becoming high on the list of management's priorities. For example, 78% of CEOs of the top 50 UK firms reported that green issues were important to their firm's present activities and 82% felt they would be more important in the future (Peattie and Ring 1993). Greening the firm minimises environmental harm and provides an important competitive advantage (Porter and van der Linde 1995). Thus, greening business has important ramifications for all organisational activities, but it may require that the firm substantially changes its culture to include green issues into all business decisions and activities (McDaniel and Rylander 1993). However, firms which have not involved key environmental stakeholders or which have not adopted a learning-organisation approach to business (eg. risk taking and outward looking), will find that adopting a green mindset is difficult.

Marketers were quick to jump on the green band wagon. The number of US 'green products' more than doubled in the early

'90s (Hartman and Stafford 1997). Unfortunately, for the environment and marketers, many of these products were not as 'green' as they claimed to be, and many of these supposedly 'green' products have disappeared almost as quickly as they appeared. On the surface, these failures may suggest that firms were 'right' not to listen to these 'outside' influences. However, this inference would be incorrect. It is only by making 'mistakes' that these firms can learn how to make more effective and less environmentally harmful products in the future. Learning firms adopt a risk-taking approach.

Some green products are truly environmentally superior to the alternatives and are financially successful. That is, they perform at least as well as competing products and are less harmful to the environment. Firms making these goods are incorporating environmental product attributes into the overall product mix and not simply 'tacking them on' to existing products as an afterthought. In this way, they are making environmental objectives as important as 'other' financial objectives (ie. profitability, market share, etc.). Firms are finding that 'going green' makes good business sense as well as good environmental sense (Menon and Menon 1997, Porter and van der Linde 1995).

For products to become less environmentally harmful, *all* operational areas need to consider the full environmental impact of corporate activities (McDaniel and Rylander 1993). However, marketers are rarely environmental experts and are likely to be unfamiliar with all of the environmental intricacies of their firm's activities. In some situations, the relevant environmental information may not be available anywhere within the firm. If this is the case, firms must turn to outside experts for this information. However, when faced with a new or unknown situation there is a tendency for firms to only look inward for answers and, thus, they may overlook valuable information sources. It is, therefore, important for firms committed to greening their activities to be outward looking and obtain environmental input from a broad range of environmentally-knowledgeable stakeholders. This means that the firm should not simply focus on feedback from the usual customers and suppliers (Fineman and Clarke 1996, McDaniel and Rylander 1993, Polonsky 1996). To maximise this opportunity, firms must shift to an organisational-learning approach, ie. outward-looking and risk-taking.

There is some evidence that some firms have already adopted innovative learning-organisation initiatives and are including wider environmental input in strategy development by involving environmental groups in their new product development (NPD) processes (Fineman and Clarke 1996, Hartman and Stafford 1997). For example, the Danish Railway worked with O2 – a non-profit, international network of theoretically and practically experienced ecological design professionals (see pages 58–59) – to design a new generation of more environmentally-friendly, cost-effective S-trains. In another case, the German company, Foron, partnered with Greenpeace to produce the Greenfreeze line of refrigerators, giving it a competitive advantage in the European marketplace, as well as opening up other world markets. A potential drawback of including more external stakeholders in the green NPD processes, however, is that the processes may become more complex.

Using US and Australian samples, this paper examines which stakeholders marketers believe should be involved in the greening of products, what strategies can be used to involve these stakeholders and how firms can learn from these interactions. The results will hopefully provide some insights into strategies and approaches that can be used by others to develop less environmentally harmful green products.

Greening new products

Product development processes generally include a number of different steps, for example:

- opportunity identification
- design
- testing
- introduction
- life cycle management (Urban and Hauser 1993).

While not explicitly discussed by Urban and Hauser (1993), learning initiatives and stakeholder participation are involved in all five steps (see Figure 1). However, in the green NPD process, it is

assumed that environmental issues and performance objectives are equally included alongside other NPD objectives and issues. For example, the Danish Railway required that all materials purchased for the new S-train had to consist of re-used materials (preferably mono-materials) that could be re-used later and that there was reduced energy consumption over the life of the train. Greening the NPD process means that firms consider green issues and objectives to be as important as other issues. This also means that there is a change in the firm's organisational culture, with the firm becoming more outward-looking, as well as having systems in place that formally include firm-environmental stakeholder interactions. Figure 1 shows how green stakeholders and learning can be included in the NPD process.

Firms typically involve buyers, customers, R&D departments, company executives, competitors, investors, government, suppliers, and universities/ scientific community in the NPD process. These internal and external groups could be called 'traditional' stakeholders. The greening process requires that firms include other non-traditional groups eg. environmental special interest groups (SIGs) and, possibly even the natural environment itself. There are a range of approaches that can be used to address internal stakeholders and these could also be used to deal with external stakeholders, although this has not been examined in the NPD literature. However, the stakeholder literature has discussed the role of external groups and while the strategies used to interact with these groups have not been discussed in detail, it could be suggested that a learning organisation approach is an additional way that firms can involve these external groups (to be discussed later).

Within the green NPD process, learning from, understanding and 'managing' firm-stakeholder interactions is extremely important. In particular, developing strategic green alliances may be one effective way to develop innovative environmental solutions to business problems as well as develop less environmentally-harmful products (Fineman and Clarke 1996, Harrison and St. John 1996, Hartman and Stafford 1997, Mendleson and Polonsky 1995). It is apparent that getting and keeping key green stakeholders on-side is vital to the firm's green success, even when the stakeholders involved do not generate new green-product ideas. Unfortunately, firms traditionally seek solutions internally and shy away from external assistance, despite the fact they often have limited internal environmental information.

Green alliances with external stakeholders can be effectively used in the development and marketing of green products by both small and large firms (Mendleson and Polonsky 1995, Hartman and Stafford 1996). In these green alliances, stakeholders have played many roles, including the formation of formal strategic alliances, serving as informal advisers or being hired as paid consultants (Mendleson and Polonsky 1995, Ottman 1996b).

Environmental groups bring vast amounts of cutting-edge environmental expertise. However, firms must have a learning culture in place such that they can cooperate with external groups, trial new ideas and disseminate the information gained throughout the firm. Environmental objectives are achieved by enhancing in-house know-how with external environmental expertise. Incorporating external environmental stakeholders in the green NPD process is, therefore, one effective method of overcoming firms' limited environmental knowledge and enables them to produce more 'environmentally friendly' products. In addition, external expert green stakeholders have a strong desire to minimise the firms' environmental harm. In doing so, they do not focus solely on satisfying profit objectives and may bring alternative perspectives to solving a specific environmental product or process problem that would otherwise not have been considered. For example, the ozone-free Greenfreeze concept refrigerators may have never been developed without Greenpeace's input.

While there are extensive benefits of developing a learning organisation approach and involving external stakeholders, firms have not generally gone down this route. In many cases, there have been external pressures, such as regulation or increased competition, that have forced firms to form

NPD activity	Stakeholder group(s) involved	Stakeholder examples	Learning organisations examples
Opportunity	Customers, employees, special interest groups (SIGs), competitors, suppliers	Complying with regulators before mandatory enforcement, eg. electric cars in California	Active scanning of the external environment; thinking 'outside the box' to consider totally new or foreign products eg. a power company identifies the building industry (wallboard) as a customer for the gypsum produced from its exhaust-scrubbing processes.
Design	Customers, suppliers, government, SIGs	Involve stakeholders with green experiences, eg. Greenpeace and Foron's development of Greenfreeze refrigerators.	Starting from scratch (ie. not feeling constrained to use existing approaches/ techniques); incorporating new knowledge from other units of groups into existing designs and practices, eg. O2's designing of Copenhagen's S-trains so that they used one axle instead of the traditional two axles.
Testing	Customers, SIGs	SIGs evaluation of products, eg. the US Green Cross labelling scheme	Working stakeholder groups in a lead-user approach to identify problems and make improvements before the final product goes to market, eg. testing of an O2 design for a gas-fired absorption fridges resulted in a design change to better meet product operational requirements.
Introduction	Customers, competitors, suppliers	Endorsement by green groups of a product, eg. ACF's endorsement of the Kyocera's Ecosys laser printer	Monitoring product introduction, where managers are empowered to act and the information obtained is incorporated into the firm's planning process, eg. a product manager modifies the packaging of a new product to minimise excess waste, with the changes made operational policy.
Life cycle management	Competitors, SIGS government, customers, owners/stockholders	Defining the least environmentally harmful alternatives, eg. Environmental Defence Fund's (EDF) evaluation of least harmful alternative to McDonald's Clamshell package	Active, monitoring of the product over its life cycle, with managers making changes to strategy and deviation from short and long-term plans to address needs in the market eg. DuPont using a new production technique to minimise pollution and decrease production costs as the product comes off patent protection, with the changes made operational policy.

Figure 1: Stakeholder involvement in greening the NPD process (adapted from Polonsky and Ottman 1997)

firm-external group alliances. Reactive behaviour is not consistent with innovation, which is usually as a result of a proactive, market-oriented culture coupled with entrepreneurial values. In these cases firms do not really have a willingness to take risks and learn from mistakes (Slater 1997, p. 165), which are hallmarks of learning organisations. For green NPD, there is a strong need for an entrepreneurial approach to merge ecological concerns and marketing strategy objectives, which has been called enviropreneurial marketing (Menon and Menon 1997). Thus, effective green alliances need to have an organisational culture that is outward looking, rewarding (ie. does not punish risk taking), proactive (not reactive) and involves stakeholders.

The learning organisation

Having a superior learning capability contributes to a firm's competitive advantage, enhancing customer satisfaction, new product success, and, thus, sales growth and profitability. The essence of the learning organisation leads to the development of new capacities and also fundamental shifts of individual and collective mindsets, where people continually expand their capacity to create the results they desire, through nurturing new and expansive patterns of thinking, and where people are continually learning how to learn together (Senge 1992). A learning firm developing new green products needs to be willing to challenge the accepted view, to be cooperative, risk taking, and able to share the information gained across the organisation and able to incorporate it into the firm's 'organisational memory'. A green market-oriented firm is one in which the culture '(1) places the highest priority on the profitable creation and maintenance of superior customer value while considering the interests of other key stakeholders; and (2) provides norms for behaviour regarding the organisational development of and responsiveness to market information' (Slater 1997, pp. 164–165), while minimising the environmental impact of its product offering. A green-oriented learning organisation, therefore, actively engages its stakeholders and looks for beneficial ways to incorporate them into the green NPD process.

Unfortunately, one major barrier to developing a learning organisation is developing an open corporate culture that is willing to listen to new ideas, especially from external stakeholders. Organisations often have difficulty including external stakeholders in their processes, which results in the so-called 'not invented here' syndrome. Firms suffering from the 'not invented here' syndrome tend to belittle, discount or totally ignore ideas from outside the firm, presupposing the superiority of all ideas from within the firm. This was typically the case in the early days of the environmental movement, where environmental groups' call for change were often viewed by firms as coming from 'crazy hippies'. To overcome this inward-looking view of organisational decision-making, firms must not only open their collective minds, but they must also develop the ability to listen and translate the environmental information they collect into appropriate organisational action. Nowadays, firms have come to understand that being green usually results in improved production efficiency (and thus lower costs) and are now much more willing to listen to and work with environmental groups in becoming 'greener' organisations.

However, as with much organisational change, the fight against the 'not invented here' syndrome and the development of a learning perspective, needs to be driven by top management. Top management must 'practice what they preach' through policy and their own behaviour, since to publicly state that the firm is 'going green' and then continue to use wasteful, environmentally unfriendly practices will only engender mistrust, suspicion and cynicism amongst the workforce, as well as minimise the willingness of external environmental experts to work with the firm.

Moving to open structures will help instil commitment from all individuals within the firm and will ensure that maximum gains are achieved in any stakeholder interactions. This may also result in more formal structures to specifically enable the organisation to learn from its green stakeholders. Given that a learning orientation is now widely recognised as being an

Shell and Greenpeace have traditionally adopted aggressive approaches suggesting that each other has 'got it wrong'. However, in other situations, Greenpeace has adopted a cooperative approach to work with organisations to solve environmental problems.

important asset to the firm, it would be expected that firms would now seek to formally incorporate green stakeholders in the strategy and green NPD processes.

Involving stakeholders in the strategy process

To ensure that firms address all environmental concerns and broaden their perspective to evaluating environmental issues, they must include a wider set of individuals and groups. According to stakeholder theory, organisations should readjust their priorities – including environmental ones – to bring them in line with their stakeholders' interests (Atkinson et al. 1997, Freeman 1984). Stakeholder theory suggests, that in order to develop effective organisational strategies and outcomes, a firm must consider all its stakeholders' interests and design strategies that minimise stakeholders' potential to disrupt marketing activities and maximise stakeholders' potential to assist organisational activities (Atkinson et al. 1997, Freeman 1984, Harrison and St. John 1996, Polonsky 1996). Including the interests of a wider set of stakeholder groups in strategy development can increase organisational value, but there must be specific procedures that enable this to occur.

Several different types of broad strategies have been suggested. For example, Polonsky (1996) suggested four approaches could be used, including:

- an **isolationist** approach, where the firm attempts to minimise the impact of given stakeholders, without directly interacting with stakeholders;
- an **aggressive** approach, where the firm attempts to directly change the stakeholders views or ability to influence organisational outcomes;
- an **adapting** approach, where the firm modifies its behaviour according to the stakeholder's interests; and
- a **cooperative** approach, where the firm attempts to work with the stakeholder to achieve a desired set of outcomes.

While the specific approaches vary depending on the author(s), all agree that firms can work directly with their stakeholders to achieve common objectives.

In practice, firms have used all of these approaches in relation to green marketing issues. For example, Shell and Greenpeace have traditionally adopted *aggressive* approaches suggesting that each other has 'got it wrong'. However, in other situations, Greenpeace has adopted a *cooperative* approach to work with organisations to solve environmental problems. For example, Greenpeace worked with the Sydney Olympic-bid committee to ensure that the 2000 Olympics would be as green as possible. Firms have also undertaken extensive lobbying activities in an attempt to isolate the impact of their stakeholders on their environmental activities, an approach which has been used in the wider public policy area as well. In a wider policy example, many Australian governmental officials pressured international

stakeholders (ie. leaders of other countries) to have mandatory greenhouse gas reduction targets taken off the international agenda. The rationale used is that countries need to be treated differently depending on their circumstances. In Australia's case, it has been suggested that setting such limits would result in a substantial slowing of the economy without resulting in any major improvement in the world environment, given Australia is such a relatively small producer of greenhouse gases. While there is debate over the environmental appropriateness of such an approach, it has been to some extent adopted.

From the stakeholder perspective, Polonsky (1996) suggested that each stakeholder has the ability to affect the firm in three ways: a) directly threaten; b) directly cooperate; and c) indirectly influence organisational activities. The stakeholders' influencing abilities determine the strategy to be used to address a stakeholder's interests. Given these approaches, stakeholders may facilitate organisational learning and firm-stakeholder cooperation in NPD processes.

For example, a stakeholder with a high level of all three influencing abilities might want to be more actively included in organisational processes, or the firm might adopt behaviours consistent with the stakeholder's concerns, thus getting and/or retaining stakeholders interest. Looking at the examples mentioned above, the Australian government was keen to gain US and CHOG (Commonwealth Heads of Government) support for the Australian greenhouse gas position, as these stakeholder groups not only have extensive direct power in the international environmental process, but could influence other stakeholder groups as well.

Methodology

Two separate samples were collected to examine managers' perceptions of stakeholders' ability to influence green NPD activities and to determine what specific strategies and/or tactics were used to address these stakeholders' interests. In the first sample, Australian marketers were asked to evaluate eight stakeholders' influence in the development of a hypothetical green product. In the second sample, US marketers, who had been involved in the development of green products, were asked to evaluate the influence of thirteen stakeholders in that process and to specify what strategies they had used to involve these stakeholders.

The Australian sample consisted of all members of the New South Wales (NSW) Branch of the Australian Marketing Institute (AMI), and the data discussed in this paper was collected from the first part of a larger survey. Respondents were given a hypothetical setting and then asked to evaluate a set of stakeholders, including:

- competitors
- customers
- employees
- government
- owners/shareholders
- special interest groups
- suppliers
- top management.

Respondents were then asked to rate stakeholders on each influencing ability (direct threatening ability, direct cooperating ability, and their ability to indirectly influence others to act) using a seven-point scale (1 = very high ability, 7 = very low ability). The scenario and list of stakeholders were developed with and pretested on a small representative sample, which agreed that the eight stakeholders examined had the most influence on the green NPD process.

The second sample involved US marketing managers involved in the development of green products that had won the American Marketing Association's (AMA) Environmental Edison Award (Ottman 1996a). Using the same scales, the US marketers were asked to evaluate the potential influence of a broader list of 13 stakeholders in the development and marketing of the products that had won the award. The stakeholders included:

- academics/scientific community
- competitors, employees/unions
- end customers
- federal government
- local community
- media, retailers/trade
- shareholders/owners
- special interest groups
- state and local government
- suppliers
- top management.

As these marketers had been involved with the green NPD process, it was interesting that they included this expanded group of stakeholders. A US-based, green-marketing expert also indicated that the Australian list of stakeholders needed to be expanded to reflect the US business environment.

In addition to the three influencing questions, US marketers were also asked to rate stakeholders in terms of their importance to the green NPD process and to 'Briefly describe how you included/considered each stakeholder or their interest when developing your product.' The question was related to actual behaviour and determined what specific strategies marketers had used to include stakeholders when developing award-winning green products. Given the hypothetical nature of the scenario used for the Australian sample, a question relating to the approaches used, was not appropriate.

The samples

For the Australian sample, there were 119 useable responses received from the 1370 questionnaires sent out (an 8.8% response rate). The sample distribution, in terms of respondents' industry, was not statistically different to the AMI membership for NSW, and a statistical examination of differences between early and late respondents suggested there was no non-respondent bias.

The US sample was obtained from six of the fifteen US marketing managers whose products had won environmental Edison awards in 1993–1996 (a 40% response rate). One respondent did not complete the section dealing with specific strategies used to address stakeholders. Another company, which had won two awards, indicated that it could not respond to the survey as the information sought was confidential. This might suggest that some US firms do have detailed processes for dealing with their stakeholders and, thus, there is a possibility that some non-response bias may indeed exist within the US sample. However, due to the small sample size, a quantitative non-response analysis was not undertaken.

Results

The results are divided into two sections: 1) examines the two samples' attitudes towards the stakeholders' influencing abilities and briefly compares the two samples; and 2) examines the strategies that the US marketers used to include these stakeholders in the green NPD process.

Stakeholders' influence

Based on the earlier learning organisation and stakeholder discussion, it would be expected that respondents would perceive stakeholders to be influential in the green NPD process and that some (key) stakeholders would be considered more influential than others. A statistical comparison of the mean values of all three influencing criteria for each stakeholder within the Australian sample indicated that the influencing ability was dependent on the stakeholder group. That is, there were statistically significant differences between the stakeholder groups in terms of *each* of their three influencing abilities and that, on the *whole*, the groups were perceived to be statistically different to one another. While respondents were given the opportunity to provide additional stakeholders to this list, no one group was suggested by more than five respondents.

Table 1 shows that the Australian marketers' believe all stakeholders rated high (a mean of less than 3.5) on at least one of the three influencing abilities. Only 'Suppliers' were evaluated as low on two influencing abilities (low on threat and indirect influence) and four stakeholders were perceived to rate highly on all three influencing abilities. (Items marked N/A were not examined for the Australian sample.) On the whole, it appears that Australian marketers believe that all stakeholders examined have an extensive ability to influence the development and marketing of green products, suggesting a more outward-looking learning-organisation view. As such, it would be expected that these stakeholders' interests would be addressed in the green NPD process and that these groups would be actively involved in the green NPD process. However, this hypothetical response might potentially differ from US marketers, who had previously been involved in the green NPD process.

The US marketers were asked to evaluate thirteen stakeholder groups. They were also asked to

Stakeholder group	Direct threatening ability 1		Direct cooperating ability 2		Indirect influencing ability 3		Importance ability 4	
	USA	AUS	USA	AUS	USA	AUS	USA	AUS
Competitors	Low*	High*	Low	Low	High*	High*	Low	N/A
(End) consumers	High	High	High	High	High	High	High	N/A
Employees/unions	Low*	High*	Low*	High*	Low*	High*	Low	N/A
Government (state/local)	Low	High	Low*	Low*	Low*	High*	Low	N/A
Owners/shareholders	Low	High	Low*	Low*	Low	Low	Low	N/A
Special interest groups	Low*	High*	Low*	High*	Low*	High*	Low	N/A
Suppliers	High	Low	Low	High	Low	Low	High	N/A
Top management	High	High	High	High	High*	Low*	High	N/A
Academics/scientific community	Low	N/A	Low	N/A	Low	N/A	Low	N/A
Federal government	High	N/A	Low	N/A	Low	N/A	Low	N/A
Local community	Low	N/A	Low	N/A	Low	N/A	Low	N/A
Media	Low	N/A	High	N/A	High	N/A	Low	N/A
Retailers/trade	High	N/A	High	N/A	High	N/A	High	N/A

Table 1: US and Australian managers' perceptions of stakeholders' importance and influence

Notes (US terminology differences set off in brackets)
High = less than 3.5; Low = 3.5 or more

1 In your opinion to what extent can (US: On a scale from 1–7 to what extent can) the actions of each group directly disrupt the operation of marketing plans for this product? (1 = high and 7 = low)

2 In your opinion to what extent can (US: On a scale from 1–7 to what extent can) the actions of each group directly assist in the operation of marketing plans for this (USA: your) product? (1 = high and 7 = low)

3 In your opinion to what extent can (US: On a scale from 1–7 to what extent can) this group influence the behaviour/attitudes of others in such a way as to modify other's behaviour towards the (US: your) product? (1 = high and 7 = low)

4 On a scale from 1–7 how important was this group to the development of your product? (1 = high and 7 = low)

* Mean values of given influencing value for the specific stakeholder are significantly different at the .05 level.

US respondents believed that employees, owners, government and competitors had low influencing abilities in regard to the green NPD process, even though they are traditionally considered to be able to greatly affect organisational outcomes.

rate each stakeholder's 'importance' to the overall process and respond to an open-ended question identifying the specific approaches that they had used to address each stakeholder's interests. Having had successful green NPD experiences, expectations were that the US sample would perceive certain stakeholders to have a greater influence than the Australian sample. A statistical comparison of the mean values identified that the stakeholder group considered, significantly affected the influencing criteria and importance value. That is, there were statistical differences between the stakeholder groups in terms of *each* of their three influencing abilities and importance level, and that on the *whole*, the thirteen groups were perceived to be statistically different to one another.

In terms of evaluating the importance of stakeholders in the development of green products (see Table 1, column 4), US managers felt that four of the thirteen stakeholders were important (end consumers, retailers, suppliers, top management). This might be expected as these four groups are often considered 'internal' to the green NPD process and would traditionally be expected to be heavily involved in strategy development. However, it appears that US marketers who *had actually been involved* in the green NPD process, did not extensively believe that 'external' groups were overly important for their green NPD activities, which is inconsistent with a stakeholder and learning-oriented theory.

Table 1 shows that for the most part, US marketers believed stakeholders had low influencing abilities. Six of the thirteen stakeholders were rated low on all three influencing criteria (academics, employees, local community, owners, SIGs, local government). Of the remaining seven stakeholders, three were rated high on only one influencing ability (competitors, federal government, suppliers), two were rated high on two influencing abilities (media, top management) and two were rated as high on all three influencing abilities (consumers, retailers).

The results suggest that US marketers believe that external groups – academics/scientific community, SIGs and government groups (who often have extensive environmental information) – were not considered to have a high influencing ability in terms of the development of new green products. If these external groups are not considered in the green NPD process, their environmental knowledge cannot be shared with the firm and the environmental integrity of products may suffer.

US respondents also believed that employees, owners, government, and competitors had low influencing abilities in regard to the green NPD process, even though they are traditionally considered to be able to greatly affect organisational outcomes. This finding is consistent with Fineman and Clarke (1996), who found that these groups did not influence the greening of the UK supermarket, power, chemical and automobile industries.

For the purposes of comparisons between the samples, only the eight 'common' stakeholders will be examined (see the shaded area in Table 1). In all but two cases, US marketers perceive that individual stakeholders have a lower influencing ability than their Australian counterparts (ie. for suppliers: threat US greater than Australia, top management: indirect influence US greater than Australia). It is clear from Table 1 that Australian marketers perceive stakeholders to be more influential (17 out of 24 possible cases) than US marketers (7 out of 24 possible cases).

The fact that US marketers perceived stakeholders to have overall lower influencing abilities is important, because it was based on their experience of being involved in the green NPD process. Therefore, it is possible that Australian marketers might be attributing more influence to stakeholders than they actually deserve. If this were correct, US marketers would, therefore, not be expected to involve 'less' important stakeholders in the green NPD process. However, it could be that US marketers are in the initial (relatively costless and easy) stages of greening their products and, thus, might not need extensive external assistance to make improvements that require more difficult environmental changes (Porter and van der Linde 1995).

One alternative explanation might be that the stakeholders in the two countries have different influencing abilities. This suggestion is plausible, for stakeholder theory suggests that the range of stakeholders and their individual stakes is extremely context-specific and thus green issues might have more of a priority amongst Australian firms compared to US firms. For example, in Australia breaches of environmental regulations in some states can result in individuals within firms being fined and even jailed. Historically, there has also been a greater willingness in Australia for at least some external stakeholder groups to be involved in various aspects of the business process. Whereas, the US has historically seen a more antagonistic environment in this respect. Both these factors could explain the higher importance placed on stakeholders by the Australian sample. Another alternative explanation could be that Australian firms have had the opportunity to gain experience of what works from early US efforts, as well as having had the opportunity to pick up on the learning-organisation trend before formulating specific green NPD approaches. Lastly, it might be that the US and Australian business environments are significantly different and this restricts comprehensive cross-cultural comparisons.

Strategies to include stakeholders

Given that US firms in the sample have been successful in developing award-winning products it would be expected that they would have specific, proactive strategies to involve stakeholders in the green NPD process. In this way firms would truly have a learning philosophy, as they would gain knowledge and experience from internal and external sources. It would, therefore, have been expected that the firms in the US sample would have illustrated open, proactive, learning approaches to interacting with stakeholder groups and then incorporating that knowledge into the organisation's 'memory' to address present and future environmental problems. This would improve the firm's capacity to take *effective* action, which is how Kim (1993, p. 38) defines learning. For example, we could have anticipated a firm would develop a working party or task force, with representatives from suppliers, employees and other relevant stakeholder groups. This committee would try to identify ways to improve the firm's green product performance and would provide suggestions that could be implemented across the firm. However, this consultative process did not appear to be used. In fact, there were few detailed suggestions about stakeholders' interaction, eg. most were extremely general and primarily related to monitoring the wider business environment. Some representative statements are:

Federal Government: 'FTC (Federal Trade Commission) marketing and advertising guidelines are the only place we pay attention.'

Academic/scientific community: 'Only considered to extent [they] provided background information for our work.'

Media: 'Want to focus on issues that can get free publicity.'

Supplier: 'Supplier support is crucial.'

Only two of the six respondents suggested that they actively worked with the scientific/ academic community and none suggested that they worked with environmental experts (ie. green groups or governmental agencies) in developing products.

Only two of the six respondents suggested that they actively worked with the scientific/ academic community and none suggested that they worked with environmental experts (ie. green groups or governmental agencies) in developing products. From this study, it appears that the involvement of external environmental experts in the green NPD process is limited. As was suggested earlier, this lack of involvement might reflect the fact that it is relatively 'easy' to make environmental improvements in the initial stages of corporate greening through capitalising on internal technical advances, which obviates the firm from having to open up and start interacting and learning from external stakeholders.

This is not to suggest that none of the respondents in the US sample involved any stakeholders in the green NPD process. All respondents indicated that their firms tried to identify customers' needs and work with them whenever possible. Two respondents even suggested that their organisation needed to ensure that customers understood the product's environmental benefits, indicating that firms believe they must interact with customers in order to educate them or change their expectations of organisational behaviour. In these situations, marketers are not simply reacting to their stakeholders' interests, but are proactively modifying activities and working with stakeholders to obtain the desired outcomes, just as the market-orientation and learning-orientation literature would suggest they should.

Several marketers in the study also identified that employees could be important in the green NPD process. However, from the perspective of greening activities, it is questionable whether employees would have the necessary environmental expertise to assist the firm in making 'real' or 'substantial' environmental improvements.

In practice, there are many green marketing examples of a stakeholder-involvement processes. For example, a number of firms actively petitioned the US Federal Trade Commission (FTC) to develop, continue and even strengthen the Environmental Marketing Guidelines. Similarly, Greenpeace used its resources to generate tens of thousands of pre-production orders for Foron's new Greenfreeze refrigerators, which Greenpeace had helped to develop. As was mentioned earlier, O2 worked with the Danish Railways on its newest version of the Copenhagen S-train to improve energy efficiency and performance, and reduce the overall product-lifetime costs and environmental impacts of the trains. McDonalds also applied a stakeholder involvement process when they worked with the Environmental Defence Fund (EDF) to identify the least environmentally harmful alternative to polystyrene 'clamshell' packages.

There is some evidence that respondents do, to a limited extent, involve some stakeholders in their green NPD process. However, it does not appear that this involvement occurs in an integrated fashion and, therefore, it is not as regular a feature of green NPD processes as might have been expected. The processes that were used, were very loosely structured and did not necessarily include external environmental stakeholders. One possible interpretation is that the average firm is at the early stages of this transformation process, where they are 'stumbling around in the dark', unsure of what to do exactly, trying these new approaches hesitantly and on an 'as needed' basis. Alternatively, in Kim's (1993) terms, these actions could be seen as being *superstitious learning* or *learning under ambiguity*, where changes in actions take place, but there is ultimately no true connection between the events. Thus, there is no true learning in regard to adding to the firm's green organisational capabilities.

Implications

This study appears to suggest that marketers believe some stakeholders with high influencing abilities should be involved in the green NPD process. While this makes intuitive sense, it does not appear that marketers are implementing this approach, or they are doing so but in an unstructured fashion. From the qualitative part of the study, it seems that the approaches used to involve stakeholders are simplistic in nature. That is, marketers are adopting behaviours to address stakeholders' interests and, in general, are not working *with* external stakeholders to solve specific green product problems – as would be expected from learning-oriented firms. While they were becoming greener, it could be suggested that they were not truly becoming learning organisations but were reacting to pressures in the business environment.

While on the surface the results seem to suggest that firms are adopting a 'market-orientated' learning approach, it seems that, in fact, they are actually applying an adapting-type strategy (Polonsky 1996), where they modify their behaviour, whether it is environmentally right or wrong. From the results, it is unclear if firms that are designing green products can or are truly addressing all their stakeholders' interests. Although, it does appear that the firms are developing less environmentally harmful solutions than the traditional alternatives. However, we cannot say that they have actually modified their firm's culture to make it truly greener and more stakeholder-involved and learning-oriented in nature.

Overall, it appears that there is limited learning occurring as a result of the firm-stakeholder interaction, though it might be more appropriate to refer to this as *superstitious learning* or *learning under ambiguity* as discussed earlier. Adopting a cooperative, learning-oriented approach should ensure that the objectives of both the stakeholders and the firm are met. Such an integrated, proactive green NPD process requires extensive communication between the firm and its green stakeholders.

No respondents suggested that they used innovative, cooperative arrangements to include expert stakeholders. In practice, such activities include firms working with environmental groups, the scientific community or other external stakeholders to solve specific business problems. There are many anecdotal examples of these types of relationships in the wider business press, however. For example, General Motors worked with the National Resources Defence Council to reduce its pollution output. In other cases, environmental groups have actually proactively identified alternative product uses, such as the Foron Greenpeace example referred to earlier.

The literature has suggested that these types of cooperative green arrangements have additional benefits for firms, such as increasing the perceived credibility of activities or generating positive publicity (not to mention the financial benefits). The relationships also benefit environmental groups, who achieve their own wider objectives. For example, Greenfreeze enabled Foron to become competitive in the European refrigerator market while helping Greenpeace work towards its goal of saving the ozone layer. Such arrangements also assist in educating consumers and the

wider population towards specific environmental issues, problems and solutions.

On the occasions when firms have included stakeholders, it is not clear that those stakeholders are involved in an effective fashion, and some potential benefits may, therefore, be overlooked. For example, involving stakeholders with a high indirect-influencing ability not only ensures that products are less environmentally harmful, but may change other stakeholders' beliefs about the firm. For example, having the Greenpeace stamp of approval and the resulting tens of thousands of pre-production orders allowed Foron to secure the capital investment needed (from another stakeholder group) to manufacture the new product. For this type of strategy to be effective, the firm has to establish links and gain the trust of external stakeholders before it can expect to gain their endorsement. The firm may *manage* the green NPD process, but the external stakeholders must have some *ownership* as well. Failing to gain their trust and support can only hamper the greening process and could result in its outright failure.

Unexpectedly, there was no suggestion by any of the US firms in the study that stakeholders could proactively be leveraged to influence 'Others'. In fact, the US respondents felt that groups with specific environmental expertise had a minimal ability to modify others' behaviour and were not important to the overall NPD process. The fact that US respondents did not suggest they could use strategic partnering activities more aggressively is surprising, especially given the fact that, internationally, this practice appears to have been successfully used in both the green and non-green areas.

Conclusions

In general, it appears that the US respondents are not being truly open and receptive, and are not learning from others operating in the green product area. One possible explanation is that there is still some distrust between the firm and its external stakeholders ('old habits die hard') and firms are, therefore, wary of bringing these external groups into the formal planning process. For example, McDonalds and the EDF spent many months developing the terms of reference of their cooperative agreement, which included things such as what issues the EDF could examine and limited McDonalds' ability to publicise the relationship. Without developing trust between the parties, it may be difficult to have open dialogue and develop cooperative environmental relationships that maximise the potential gains for both parties. This will make it unlikely that any resulting learning will be transferred across the firm, or integrated into the firm's 'memory' as would be expected of a learning organisation.

To help explain this behaviour, it is useful to understand that while all organisations learn, not all organisations are learning organisations. To be a learning organisation requires proactive interaction with external green stakeholders and a willingness to incorporate new environmental ideas, as well as test 'new things'. Firms must develop an ability and willingness to trust outsiders and reduce the perception that failures will be punished. This enables risk-taking to be rewarded, resulting in organisational learning. Ultimately, it comes down to the changing of the firm's culture, which is frequently a slow and difficult process.

It seems that some firms are trying to make the shift, as an increasing number are starting to appoint environmental managers to ensure compliance with environmental regulations and push their respective organisations to be greener. Thus, environmental issues are starting to be taken seriously at senior levels, and this may open opportunities for marketers to take an active role in the greening of the firm and its NPD processes. Marketers are uniquely positioned to help proactively lead the greening charge, as they already interface with a range of external stakeholders (eg. suppliers, regulators, customers).

Increasingly, other business functions have been devoting attention to the environment, including finance, product development, strategic management and marketing. Recent research suggests that there is a positive relationship between environmental and business performance, which may enable green activities to be integrated into corporate culture (Feldman et al.

1997, Porter and van der Linde 1995). The emerging consensus among business leaders is that seeking social good and business successes is no longer an 'either or' proposition, but rather a case where both are very much interwoven (Menon and Menon 1997).

Therefore, involving stakeholders in the green NPD process is paramount for establishing long-term competitive advantage. This will require that the firms adopt more of a learning organisation culture (eg. outward looking, risk taking) if they hope to maximise the benefits that these alliances offer. •

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Eco-design and integrated chain management: dealing with networks of stakeholders

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Besides technical challenges that have to be met in order to reduce the ecological effects of products, this paper argues that organisational challenges have to be dealt with as well. Two strategies are distinguished: *eco-design*, the development and successful marketing of green products, and *integrated chain management*, the improvement of the ecological performance of an existing product. When a company wants to employ one of these strategies successful, it has to deal with a network of stakeholders. Based on three case studies taken from the Netherlands, the paper provides some lessons on how to do this. In addition, the government perspective is taken as well; the fact that the introduction of environmentally sustainable products hinges on organisational challenges provides some lessons for policy programmes covering the development of greener products.

Introduction

In 1989, the Dutch government gave a new impetus to society with its National Environmental Policy Programme (NEPP). With this programme, the Environmental Ministry took the concept of environmental sustainability as a starting point for new policy programmes, and as a mechanism to re-focus existing activities. Giving special attention to the ecological effects of products throughout their life cycle was an important operationalisation of the concept of environmental sustainability. This attention focussed on two strategies. The first, eco-design, dealt with the incorporation of ecological criteria into the design process of new products. Integrated chain management became the label for attempts to improve the ecological performance of existing products. The idea of involving the whole product chain was central to this second strategy.

Since then, a number of initiatives have been undertaken that can be seen as the implementation of these strategies. Below, three such cases are described. Each case is the result of the activities of a core actor, as well as the activities of other companies in the product chain,

including governmental agencies and societal actors.

Eco-design and integrated chain management are closely related to activities of companies throughout the product chain. At first sight, it seems important that these companies cooperate in order to reduce the ecological effects of their products. However, as these cases will show, cooperation is sometimes, but certainly *not* always, necessary. On the contrary, sometimes cooperation forms a barrier to such initiatives.

The focus of this paper is, then, how companies should deal with the network of stakeholders in order to employ a successful eco-design or integrated chain management strategy. Equally important are the consequences for actors willing to steer companies into the direction of such initiatives. Thus, in drawing lessons from the three cases, attention will be focussed on the way in which companies and governmental agencies have to deal with this network of stakeholders in developing eco-design and integrated chain management.

Three cases

Parallel with the preparation of the comprehensive policy programme, the Environmental Ministry developed a policy paper on the prevention and re-use of waste. This paper was accepted by Parliament in 1988 (VROM 1988). In line with the general concepts, this policy paper took the product life cycle as a starting point. It identified a number of important sources of waste, and proposed a strategy for developing a plan for diminishing that waste stream. Importantly, the paper left specific goals and actions open: the strategy was to discuss these with members of the product chain. The three cases described here are all linked in one way or another to this policy paper. They involve the products milk packaging, PVC packaging, and PVC piping systems. Between 1988 and 1995, the ecological effects of these products became subject to debate. For each product, the product chain is described first. Then, the activities are described and analysed (for a full account, see Boons 1995; also Boons 1996).

Milk packaging

Traditionally, fresh consumer milk was delivered by milkmen in glass bottles. Parallel to the development of supermarkets, disposable milk cartons have replaced glass bottles. Milk 'cartons' consist of carton board covered with a small film of polyethylene.

The product chain

The product chain relevant for this case is that of dairy products and, more specifically, fresh milk. In the Netherlands, milk is produced by a large number of farmers, which have organised themselves into just over one hundred cooperatives. These cooperatives are responsible for packing and selling milk (products) to retailers as well as independent milkmen. During the period under study, a trend towards concentration took place. Four of the cooperatives processed eighty percent of the total amount of milk produced in the Netherlands.

In 1988, eighty percent of the fresh milk for consumption was packed in milk cartons, and twenty percent in glass bottles. Glass bottles can be used a number of times, so diary producers do not have an intimate relationship with producers of glass bottles. The relationship with producers of milk cartons is more intensive. In Holland, three producers of milk cartons are important, Tetra Pak being the most known. Because milk cartons are used only once, their design and overprint can be changed, thus providing interesting marketing possibilities. Apart from that, Tetra Pak has also provided dairy producers with the equipment which is used to fill the cartons. The fact that these machines are specifically designed for milk cartons points to the dependency of the dairy producers on a packaging system, and thus on Tetra Pak.

While there are still milkmen active in Holland, fresh milk is predominantly distributed through supermarkets. Albert Heijn is market leader, and plays an important role in the Association of Retailers (CBL). After the milk is consumed, glass bottles are returned to the dairy producers via a deposit system; they are collected by the retailers. Milk cartons are disposed of by the consumers via the waste collecting system which is managed by municipalities. They dispose of this stream by having it burned in regional incineration plants.

Retailers had as a principle that no new reusable packaging was acceptable, because it demanded space and handling which did not profit the retailer. Thus, a powerful coalition within the product chain blocked this alternative packaging.

Introducing new milk packaging

Since the early eighties, Dutch environmentalist groups have criticised disposable milk packages. They prefer the glass bottle, mainly because of its re-usability. For these groups, the milk carton symbolises the growth of disposable packaging.

During the mid eighties, the multinational General Electric Plastics (GE Plastics) – which specialises in 'industrial' plastics (used in for instance car bumpers) – developed a new milk packaging, a re-usable bottle made of polycarbonate. The primary reason for this was not to develop a sustainable alternative for milk cartons, but to try and enter the consumer market with a recognisable product. In that way, the name and qualities of polycarbonate would be exposed. Their choice for milk packaging was based on the fact that in the US, polycarbonate bottles were used for baby food.

Their first step was to contact the dairy producers. Although the large dairy producers were interested in this new development, it was quite clear that the product chain as a whole was not responsive. Dairy producers would be forced to invest in a new system for filling bottles; moreover, they would have to clean these bottles, an extra activity. Retailers within CBL had as a principle that no new reusable packaging was acceptable, because it demanded space and handling which did not profit the retailer. Thus, a powerful coalition within the product chain blocked this alternative packaging.

Initially, GE Plastics saw the milk packaging as a 'marketing' project, which was not related to environmental issues. At one point, however, GE Plastics was approached by consumer organisations and environmentalist groups. These groups formed a coalition in order to put pressure on industry to introduce 'green products' to the market, due to the following reasons. The policy paper discussed above called for intensive discussions on a number of waste streams. Both environmental groups as well as consumer organisations were invited to participate in these discussions. In order to do so more efficiently, and to make the most out of this opportunity, these organisations pooled their resources. This included joint consumer-oriented actions to put pressure on specific products, as well as the joint collection of information on the ecological effects of products.

This coalition thought the polycarbonate bottle to be a good alternative to the disposable milk carton. Subsequently, information was exchanged and discussed between GE Plastics and the coalition. Within GE Plastics, a positive judgement on the polycarbonate bottle was seen as important not only for a successful introduction, but also as a way of preventing the damage to the image of polycarbonate. In the end, based on the information given by GE Plastics, environmentalist groups and consumer organisations concluded that the polycarbonate bottle was, from an ecological

perspective, a good alternative to the milk carton.

As a direct result from the policy paper on the prevention and re-use of waste, the Dutch Environmental Ministry (VROM) initiated a discussion group whose aim was to propose measures to reduce the amount of packaging waste generated in the Netherlands. In this group, governmental officials participated, as well as members from industry and from national environmentalist groups and consumer organisations. Industry was represented by the Foundation for Packaging and the Environment (SVM). Rather than representing sector-based interests, this organisation represented the whole packaging chain, including material producers, packaging producers, users of packaging, and retailers. The first task of this group was to analyse a number of specific packaging waste streams. Of course, this procedure relied heavily on information from industry. Together with the fact that the SVM acted as a representative of the whole product chain, and thus internalised possible differences in opinion between members of industry. This gave SVM a strong position in the process. As mentioned above, environmentalist groups and consumer organisations decided to join forces in order to counterbalance this position. They managed to generate detailed independent information.

Based on the information collected, parties started negotiations on possible reductions of packaging waste. During these negotiations, the Environmental Ministry put forward a list with disposable packages which could be substituted with reusable packages. One of these was the milk carton. As the Ministry could not provide the arguments for the ecological advantages of these substitutions, the SVM was able to reach a compromise. It was agreed that industry would perform 'eco studies', comparing the ecological effects of the disposable and reusable packaging of twenty consumer products. In addition, they committed themselves to substituting the disposable packaging if the reusable packaging had a better ecological performance, and if there would be no substantial economic objections to such a substitution.

Coordinated by the SVM, industry performed these studies. After long discussions, the opposition of milk carton producers was broken, and the polycarbonate bottle was taken into account into this study. The results, made public in December 1995, were in favour of the polycarbonate bottle. Subsequently, one dairy producer has introduced the bottle. However, it sees the bottle not as an alternative to the milk carton, but as a substitute for the reusable glass bottle.

Analysis

The outcome of this case is a clear example of eco-design. It is important to note that, at least initially, the ecological effects of the polycarbonate bottle, as well as the milk carton that it was supposed to replace, did not enter into the considerations of the central actor, GE Plastics. When this aspect was brought under their attention by environmentalists, GE Plastics happily used this consideration, and started to expand on it.

This outcome came about only after a number of barriers were overcome. A first barrier is the structure of the product chain. The main characteristic of this product chain is the strong dependence of dairy producers on the food retailers, who control the only distribution channel for fresh milk. As far as packaging is concerned, the actors in this part of the product chain have a common interest: no handling of used packaging. As a result, the dairy producers are dependent on their suppliers of milk cartons. This dependency is strengthened by the contracts these suppliers, notably Tetra Pak, have negotiated. In these contracts, delivering filling equipment, service, and packaging are closely interrelated.

A second barrier was that GE Plastics could not launch its product on the market single-handedly. Their first attempt to enter the product chain consisted of negotiations with individual dairy producers. This was not successful. In a second try, they formed a network, which served as an alternative to a part of the existing product chain. This network, of which they formed the hub, consisted of producers of the bottle and the filling equipment producers. In addition, consumer organisations were drawn into the

network, as they promoted the bottle. In addition, through their alliance with environmentalist groups, the attractiveness of the bottle for dairy producers was increased. In the end, one dairy producer joined the network. The network also contained a company which is able to recycle the material of used bottles.

A third barrier was the role of the SVM. Although it existed before the period under study, it developed into an important coordination mechanism within the product chain as a result of governmental interference. It should be noted, however, that the SVM does not deal with milk packaging, but is involved in the total packaging chain. Members of this organisation have an interest in products that are on the market rather than potential products (such as the polycarbonate bottle). Thus, the SVM is essentially motivated to search for improvements in existing products. When the SVM was allowed to perform eco-studies on a number of products, initially this resulted in a choice for existing products only. Only as a result of fierce opposition from consumer and environmentalist organisations, in addition to lobbying by GE Plastics, was the polycarbonate bottle taken into account. In summary, the SVM acted as a stalling mechanism on the introduction of new products such as the polycarbonate bottle, due to its its implementation of agreements with the Environmental Ministry,

PVC packaging

The second case concerns packaging made from polyvinyl chloride (PVC). This material was developed after the Second World War, and has since found a great number of applications. One of these is the use as packaging material. With the right supplementary substances, it has characteristics which make it useful for packaging food for longer periods.

The product chain

In the Netherlands, PVC granulate, the raw material of which PVC products are made, is produced by two companies. One of these, LVM, ended its activities in 1989. The other company, ROVIN, is a joint venture of two companies (Akzo Nobel and Shell). These companies produce the raw materials necessary to produce PVC, ie. ethene and chlorine. In addition to the PVC produced by ROVIN and LVM, the PVC processed in the Netherlands was obtained through import.

There are several companies which produce PVC film, the basic material necessary to produce PVC packaging. One of the more important ones in Holland is a subsidiary of the German chemical multinational Hoechst AG. Often, these companies mould the film into packaging, which is sold directly to the producers of the products to be packed. Otherwise, this film is sold to companies that have their own capacity to produce the packaging to pack their products. Most of the actors involved in the production of PVC and PVC packaging are members of the Dutch Association of Chemical Industry. Apart from this association, there are no close links between the first and second part of the product chain.

Due to the fact that PVC is used as a packaging material for a great variety of food products, the next phase of the product chain consists of a great number of companies operating in different sectors of industry. This part of the product chain shows a great variety of actors. For our discussion, the Association of Retailers (CBL) is an important organisation, as it had virtually all food retailers as members. This market also has a clear leader in the retailer Albert Heijn.

Consumers of food products are thus confronted with PVC packaging. In this part of the product chain, the Consumentenbond, a consumer organisation with over half a million members, is important. Consumers dispose of the packaging material through the normal waste system, where it ends up in incinerators or is dumped on waste sites.

Eliminating PVC packaging

In 1989, consumer organisations and environmentalist groups focused their attention on PVC packaging. Their consumer-oriented actions received considerable media coverage. They gained momentum with the publication of a research report of the National Institute for Public Health and the Environment (RIVM), which had

found high amounts of dioxins in the milk of cows grazing in the neighbourhood of an incineration facility. Scientists as well as environmentalist groups claimed that PVC, mostly from packaging, in the waste stream was responsible for the emission of dioxin by the incinerator. This was not the first time that the ecological effects of PVC became subject to public, as well as political, discussion in the Netherlands. As a result, two initiatives emerged.

The first initiative involved companies producing PVC and PVC products. These firms were to a great extent part of multinational companies, operating on international markets. As a result, they were confronted with negative publicity in other countries as well. The rising negative image of PVC internationally led these companies to form the Steering Group PVC and the Environment. Its goals were to assemble all information on the ecological effects of PVC and PVC products, and to decide on an action plan based on this information. The Steering Group did not aim to involve companies throughout the product chain. Instead, it saw itself as a study group devoted to assembling relevant scientific data, which could be used to decide on future actions. It was explicitly acknowledged that this could include the elimination of certain products made of PVC. Thus, while the Steering Group consisted of actors active in different phases of the product chain, for instance producers of the raw material chlorine were not willing to participate in the group. Significantly, the Group also did not include companies involved in the retail and user phase of the food packaging product chain. The Steering Group issued two reports, and acted as an information and discussion forum for its members, as well as a lobbying device towards the national government. In this capacity, the Steering Group was successful in preventing a legal ban on PVC packaging proposed by left wing members of Parliament.

As the producers of PVC and PVC products were trying to close ranks, a second initiative developed. The market leader in the retailing part of the product chain, Albert Heijn, decided that it would be best to try and replace PVC packaging with other materials. A first motive for this decision was the consumer-oriented actions of environmentalist groups and consumer organisations, as well as the discovery of dioxin in milk from cows. In addition, Albert Heijn had, for a number of years, been confronted with health related problems with PVC. Finally, this company was involved in the development and implementation of a 'green' strategy.

In a meeting of the Association of Retailers (CBL), Albert Heijn suggested a ban on PVC packaging. As a result, the CBL formulated a Code of Conduct for its members, stating that within a year from December 1989, all PVC packaging should be eliminated. The CBL subsequently coordinated the activities necessary to implement this Code. It helped their members approaching suppliers

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A new coordinating mechanism emerged: the Steering Group for PVC and the Environment. This was clearly a result of pressure from consumers, combined with political attention.

via a questionnaire, stating the Code of Conduct and asking them if they could replace the packaging within this period. Due to this concerted action, after one year, almost all PVC packaging had been replaced. Thus, even before the Steering Group had been able to present its action programme, food retailers banned PVC packaging from their shops. Individually, Hoechst did try to convince CBL that this was an unwise decision. Other members of the Steering Group, afraid that their products would be linked to the eliminated PVC packaging, turned away from this attempt.

Analysis

In this case, companies in the production part of the product chain initiated a project aimed at integrated chain management. They actively collected information on the ecological effects of PVC, and discussed the actions that could be taken to minimise those effects. It is clear from the lobbying activities performed by the Steering Group that the initiative was defensive in the sense that alternatives to PVC were not taken into account. However, this defence proved to be ineffective for PVC packaging, though. The Steering Group could not prevent actors in the retail part of the product chain eliminating PVC packaging.

With respect to the often mentioned need for cooperation, this case provides an interesting contrast. First of all, a new co-ordinating mechanism emerged: the Steering Group for PVC and the Environment. This was clearly a result of pressure from consumers, combined with political attention. This co-ordination mechanism exceeded the product chain under discussion, as it contained firms involved in the production of different PVC products. Another characteristic is that it covered different phases of the product chain (ie. production of PVC and production of PVC products, as well as production of one of the raw materials). A last characteristic was that, although the emphasis was on the collection of information, there was an explicit attempt to formulate common goals and action plans.

This organisation was new in the sense that it provided a perspective not on one phase of the product life cycle, but the total life cycle instead. This was reflected in the membership of the group: different phases were represented. However, it could be argued that the Steering Group was both too broad as well as too narrowly focused. This follows from the fact that it broke down when pressure was increased. When the retail phase of the product chain decided to replace PVC packaging, the companies directly involved (ie. producers of this product) were left to themselves. Thus, the Steering Group was too broad in incorporating different products, which did not want to become associated with the elimination of a PVC product. On the other hand, the membership of the Steering Group was too narrow: because the retail phase was not represented, its decisions were not related to activities in the production phase of the product chain.

Secondly, an existing cooperative organisation was activated: the Association of Food Retailers (CBL). In this case, it played an active role in coordinating the implementation of the strategy of its members towards their suppliers. This shows the power of one part of the product chain over other parts; essentially, the decision of one company, which used an existing coordinating mechanism to use the leverage of its competitors, was sufficient to replace a product which had been used extensively for decades.

PVC piping systems

PVC piping is a product which is used widely in the Netherlands, both in sewage systems and in water supply systems in buildings. Alternative products, such as piping systems made of other plastics, steel, and concrete, have only a modest market share. Due to the elimination of PVC packaging described in the preceding section, actors in the product chain for PVC piping systems acknowledged the need to undertake action. They were urged to do so by several societal actors, which thrived on the successful elimination of PVC packaging. The fact that plastics used in building projects were subject to the aforementioned policy paper on the prevention and re-use of waste was an additional incentive.

The product chain

The first phase of the product chain is identical to the one described in a previous section. The second phase is the production of piping systems. Eighty percent of the PVC piping systems produced in the Netherlands is covered by six companies, of which WAVIN, Draka Polva, and Dijka are the most important. Together, these six companies form the Federation of Plastic Piping Producers (FKS). Interestingly, these companies all produce piping systems from alternative plastics as well. In addition to the members of the FKS, there are some small companies operating in the market.

A significant characteristic of this product chain is the close link each of the main producers of PVC piping systems has with a single PVC producer. WAVIN is 50% owned by Shell, while Draka Polva and Dijka are subsidiaries of Solvay and the LVM respectively.

The retail phase of the product chain consists of wholesale traders specialised in building material. Piping systems form only a minor part of their trade. The installation of PVC piping systems takes place in building projects. In this part of the product chain, architects, building companies, and contractors are active. Between them, decisions on what materials to use are made. These actors work together on a project basis.

Developing an economically feasible recycling system

WAVIN, the main producer of PVC piping systems in the Netherlands, has a long experience with recycling some of its products on a commercial basis. In reaction to the attention given by societal actors, this company decided to develop a system for

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collecting used piping systems. For them, this was the next step in a corporate strategy aimed at extending the recycling experience to all its product groups. This strategy was also based on an in-house comparison of the ecological effects of PVC piping systems and alternative systems. According to WAVIN, this comparison led to recycling of PVC as the best option. This choice is based on the consideration that PVC has no inherent ecological problems, while its price/quality performance exceeds that of other materials used in piping systems. The opposition by Greenpeace and national environmentalist groups to the use of chlorine clearly shows that WAVIN's choice was a contested one.

Based on its experience, WAVIN concluded that a recycling system would have to be developed in cooperation with other producers. Only cooperation would make it possible to recover the used material necessary for an economically feasible recycling unit. The FKS, chaired by WAVIN, became the coordinating unit of the system. The members agreed to work together in the collection of used PVC piping systems, urging their customers to return used material and waste from building sites. Also, the three leading companies agreed to develop a recycling unit which would also process the material recovered by the three smaller companies. In addition, there was an agreement between the three leading companies to exchange knowledge on different recycling techniques. As a result of this coordinated initiative, an economically feasible recycling system was developed. Furthermore, the three leading companies developed products (piping systems) in which the recycled material could be used again.

There are some additional factors that have contributed to this successful initiative. Parallel to the activities in the product chain, the Environmental Ministry started a discussion on waste from building sites. Among the results of this discussion was a 'letter of intent' between the Environmental Ministry and the FKS. In this agreement, the Environmental Ministry stated that it would promote the recycling initiative by forbidding the dumping or incineration of used piping systems. Thus, the supply to the recycling system was secured.

In a similar vein, producers of PVC piping systems started initiatives within the product chain for adapting the quality norms that were used throughout the building sector. These norms did not allow for the use of reused material, and thus provided a barrier towards the system and products developed by the FKS and its members.

It is important to note that, although successfully judged by its own goals, the recycling initiative was not welcomed by several societal actors. Environmentalists argued for the elimination of PVC because it contained chloride. After the elimination of PVC packaging, their main target became PVC piping systems. They found support in a life cycle assessment (LCA), in which alternative piping systems were compared. PVC was not considered to be the best option, even when recycling was taken into account. Environmentalist groups have used these results in consumer oriented actions, trying to influence them to use those alternatives. Until now, they do not seem to have been successful. They have also cooperated with small firms which tried to enter the piping systems market by claiming that they provided a 'green' alternative to PVC piping systems.

Analysis

In terms of the typology developed in section two, the outcome of this case can be characterised as an example of integrated chain management focussed on material recycling. The fact that this outcome could be established is due in the first place to the fact that an existing coordinating organisation in the product chain, the FKS, could be used to implement this idea. The FKS takes on a new activity in the form of organising the collection of used piping systems, as well as coordinating the first steps in R&D necessary to make recycling possible.

The initiative is strengthened by governmental actions. Making use of the wish of the Environmental Ministry to get some result in the prevention and recycling of waste from building sites, their well organised initiative was welcomed by the Ministry, and indeed used in

the formulation of rules which further strengthen this initiative. Together, this strategy makes the recycling of PVC piping systems a dominant alternative to both the existing product and alternative products.

At first sight, it is puzzling why companies that produce alternatives to PVC piping systems do not react by stimulating the demand for these alternatives which is created by public pressure. Although difficult to calculate, it seems reasonable to expect that such a strategy would involve less costs than developing a recycling system and new products. Two characteristics of the organisation of the product chain seem responsible for the outcome.

First, although there was substantial public pressure to substitute PVC piping systems, consumers did not exert that much pressure on the producers of PVC piping systems. Retailers were the link between the producers and the actors involved in the installation of piping systems. These actors were mainly motivated by price, and prefered to be able to use existing building material and techniques rather than change towards a 'green' alternative. Although there were exceptions to this rule, they were small consumers, and thus could not put pressure on the retailers.

At least as important was a second feature: the close link between producers of piping systems and manufacturers of PVC. As piping systems were an important application for raw PVC, and if producers of piping systems would stop using PVC, this would form a direct threat to PVC producers. In addition, this substitution would further undermine the image of PVC. This was one of the reasons why PVC producers have developed close links with companies such as WAVIN and Dijka. The fact that these companies were also producers of alternatives is thus only an additional lock on the substitution of PVC piping systems.

Dealing with networks of stakeholders: lessons to be learned

The cases described above shows clearly that diminishing the ecological effects of products is not just a technical challenge. The successful introduction of a 'greener' product, and improving the ecological performance of an existing product implies that actors have to deal with a large number of interested parties. The connections between these parties can be of great influence on the probability that 'green product' initiatives are successful. In this section, some general conclusions are drawn. In addition some lessons from the cases will be derived. Some of these apply to companies, others apply to governmental agencies and societal actors interested in steering the activities of companies.

Making and breaking networks of stakeholders

In one sentence, the thrust of this paper is that for eco-design and integrated chain management to be successful, actors must be able to make as well as break networks of stakeholders.

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In order to successfully develop and introduce a new product, a company must make a network with suppliers, customers, in order to be able to provide a feasible alternative to an existing product. The milk packaging case illustrates this point. The same goes for integrated chain management initiatives: the recycling of a product involves a number of parties which need to be actively involved in the development phase. These observations are similar to those concerning product development and improvement in general. Specifically for 'green' products, the involvement of environmentalist groups is essential. Involving them in the network can be a valuable asset.

This is not to say that such networks should always include every actor in a product chain. As the three cases show, choosing members of the network carefully is important. Excluding powerful parties, such as retailers in the PVC packaging case, makes the network ineffective. On the other hand, building a network across different product chains can lead to undesired outcomes, as the breaking down of the Steering Group 'PVC and the Environment' shows.

As important as the making of networks is, breaking networks of stakeholders is equally important. In both eco-design and integrated chain management, there is an existing network of companies, consumers, and related organisations, that is connected with the product. Improving that product, or substituting it, implies that this existing network must be altered or replaced. As the stakes of the parties in the existing network may be high, they can form considerable opposition, such as the SVM did in the milk packaging case. With respect to PVC piping systems, the existing network was instrumental in developing the recycling of PVC piping systems, but it was equally successful in shifting attention away from substituting those systems.

Lessons for companies

The lessons for companies can be divided into two categories: those related to dealing with actors in the product chain, and those related to dealing with governmental agencies.

A first lesson concerns the eco-design strategy. The activities of GE Plastics show that, operating as an individual company dealing with the direct customer of the new product (in this case, the polycarbonate milk packaging) is not successful. A new product, especially packaging, consists of an interrelated set of elements, including a range of different actors. Thus, apart from the dairy producers, retail organisations, consumers, and plastics recyclers are involved. When a company wants to provide a feasible alternative to an existing product, it should form a network of actors that can break the existing network of companies that is connected with the 'old' product.

The recycling case shows that such a network is not only important in eco-design, but also when integrated chain management is introduced. WAVIN

made use of the existing network of producers in order to be able to develop a economically feasible recycling system. A similar conclusion can be drawn when looking at the way in which PVC packaging was eliminated. Here, retailers succeeded in collectively putting pressure on their suppliers.

Dealing with governmental agencies that seek to steer companies into the direction of eco-design and integrated chain management provides threats as well as opportunities to companies that want to initiate such activities themselves. The opportunity lies in the fact that the involvement of the government can provide a stimulus for other companies to participate in the collective activities that were above described as necessary. In addition, through altering market constraints, government can influence the success of a certain initiative to a great extent.

On the other hand, governmental initiatives to coordinate activities of companies can provide a threat, as they tend to mobilise defensive coalitions. In addition, when such coordination is initiated, and is intended to lead to some sort of collective plan, then the companies involved will not be inclined to undertake action before the content of such a plan is clear. This can result in substantial time loss, especially when the product is discussed as part of a broader category of products (ie. milk packaging in the discussion on packaging waste). An important lesson in this respect is to be involved in such initiatives. GE Plastics first did not participate in the discussion groups, for it thought of the milk bottle primarily as a marketing project. Their involvement in later on came just in time to include their product as an alternative in studies that would prove to be crucial in the decision made by dairy producers.

Figure 1 summarises these lessons.

Lessons with respect to eco-design:

- form a network as an alternative to the existing product chain
- be aware of possibilities within the existing chain to mobilise defence
- be aware of governmental initiatives that can attract defence

Lessons with respect to integrated chain management:

- make use of existing coordinating organisations
- a material is too broad as a focus for integrated chain management
- do not exclude powerful parts of the product chain

Figure 1: Lessons for companies

Lessons for governmental agencies and societal actors

Parties interested in steering companies towards 'green' products have to deal with two issues. The first issue concerns the instruments they have to influence companies. As the elimination of PVC packaging shows, mobilising market

One of the important lessons to be learned from the case studies is that such organisations can be an effective diffusion mechanism of initiatives throughout a sector, but they can also be an effective lobbying mechanism, aimed at stalling such diffusion.

Rather than looking for ways in which all interested parties should be involved in an initiative, government should look for actors in a product chain who can, because of their market power, force other actors in the direction of product substitution.

pressure is a powerful tool in the hands of environmentalist groups. To a certain extent, governmental agencies have that power as well through their own procurement departments. This instrument was used to some extent with respect to PVC sewage systems. It should be noted that this does not involve costly negotiations with the companies involved; the market mechanism is used to exert influence on companies. This has the additional advantage that companies cannot protest against the very mechanism of which they so often present the virtues.

A related instrument, which is only open to governments, is to alter market constraints. By banning certain kinds of products, or raising their price, the alternatives to 'green' products can be put in a disadvantageous position. This instrument was used by the Environmental Ministry to increase the feasibility of the recycling of PVC piping systems. Although effective, this instrument has the disadvantage of being a limit on the functioning of the market mechanism. This rules it out as an acceptable tool in certain countries, especially if used on a large scale.

In the three cases, the main instrument used by the Environmental Ministry is to initiate coordination of the activities of companies. Indeed, one of the main purposes presented in the policy paper on the prevention and re-use of waste was to bring together companies and societal organisations that had a stake in a certain product. Under supervision of government, these parties would discuss and negotiate how to decrease the ecological effects of the product in question. Often, the Environmental Ministry would take existing coordinating organisations in a sector as a starting point; involving the SVM, and the FKS are a case in point. One of the important lessons to be learned from the case studies is that such organisations can be an effective diffusion mechanism of initiatives throughout a sector (ie. the FKS, and CBL), but they can also be an effective lobbying mechanism, aimed at stalling such diffusion (ie. the SVM). This implies that initiating coordination can turn against the party who wants to steer companies towards greener products.

Translated into a lesson, this means that rather than looking for ways in which all interested parties should be involved in an initiative, government should look for actors in a product chain who can, because of their market power, force other actors in the direction of product substitution. The way in which the Environmental Ministry stimulated the recycling of PVC piping systems is an example of this strategy. If, however, a governmental agency provides the opportunity for all actors to discuss possible avenues for product substitution, complex discussions, and eventually negotiations can result. This process slows down activities that are being developed, because it actually organises the defence of the status quo. The case of the polycarbonate bottle is an example of this chain of events.

A final instrument, again available to governments only, are rules. While the actual application of this instrument is difficult, time consuming and politically contested, the credible threat of formulating this tool can be an important stimulus to help companies to accept the use of the other instruments.

Apart from the issue of what instruments are available, an equally important point is the issue of how companies can be steered into the direction of truly sustainable activities. Although the three cases all show successful instances of either eco-design or integrated chain management, it is not evident that these initiatives are optimal when evaluating them to some criterion of environmental sustainability. For instance, the recycling of PVC piping systems is an improvement from the existing situation, but serious doubts remain whether it is not more environmentally sustainable to replace PVC with another material. More or less the same applies to the milk packaging case. The strong position of food retailers in the Netherlands implies that product recycling of food packaging, such as the polycarbonate milk bottle, will never replace disposable packaging. As this part dominates the product chain, it is able to aim at improvements which have an optimal cost benefit structure for them. Again, there is a possible improvement from the existing situation, but whether it is truly environmentally sustainable is questionable.

Especially problematic is the fact that the mechanisms that seem to be the ones that are effective and acceptable (market pressure and initiating coordination) are at the same time not suited to give a specific direction to the companies at which it is directed. This issue in the end is the responsibility of a government: it should weigh the advantages of helping a company initiating change towards a greener product, or forcing this company to use its coercive power to steer this activity in a direction that is sustainable from the perspective of society, instead of from the perspective of an individual company. Figure 2 summarises these points. •

- Enabling market pressure is an effective and non-contested way of moving towards environmentally sustainable products
- Initiating coordination can mobilise innovation as well as defence to change
- Involving existing coordinating organisations can be efficient, but usually they imply a certain outcome, thus they are effective only in a certain direction
- Rules are effective as a threat to actually put them to use
- Networks of actors do not necessarily produce the most environmentally sustainable outcome.

Figure 2: Lessons for governmental agencies

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Ecologically sound coffee machine concept design

Yellow Design and Yellow Circle

The coffee machine is designed to allow for the water filter to be positioned above the coffee pot, mug or cup

Yellow Design and Yellow Circle has designed a modular coffee machine which in its basic form is a stand, an electric water boiler and a removable filter. A hot plate, timer and other equipment may also be added.

The water filter is positioned so that the filter and coffee pot, mug or cup sits directly under it, thus enabling the use of one's own dishes with the standard unit. The machine can be converted by the addition or omission of various inserts to serve as tea maker or even baby food warmer.

The modular design of the unit means that any connections, screws and joints may be dissembled for ease of repair and maintenance, giving the machine the potential of an extended life span and cost-effective repairability. Material saving design and modern technology also ensure a positive energy balance in manufacture and use.

In addition, the design concept ensures the product is appropriate to the various demands made upon it, such as multi-purpose use, different environments and the use of different personal catering accessories.

The coffee machine was awarded a Design Distinction in the ID 43rd Annual Design Review in the category 'Concepts'.

Yellow Design and Yellow Circle are design consultancies based in Pforzheim and Cologne, Germany, respectively and headed by Professor Günter Horntrich. For further information contact Frank Wuggenig on +44 181 390 7682.

right: The modular unit is detachable to facilitate refilling from the tap

far right: The hot plate may be used generally or as a baby food warmer

Hippo Water Roller

The Hippo Water Roller Trust, South Africa

Access to water in rural communities and developing countries is the most basic human need. Millions are forced to walk many kilometres daily to collect and carry their water requirements for the day, a task normally performed with much difficulty by women and children.

The Hippo Water Roller is a water container designed to transport larger quantities of water than was possible using traditional methods with ease over difficult terrain. Water buckets for instance, often weighing up to 20kg, would be carried on the head. This skill developed from an early age causes suffering, requires much energy and results in severe health consequences such as the early ageing of the spine. The roller enables 4 to 5 times this quantity to be conveniently rolled on the ground rather than carried.

The roller has been tested extensively in the field. The large opening has a water-tight lid which allows for hygienic storage and easy cleaning of the drum. It is important to prevent unhealthy algae growth. The design of the clip-on steel handle provides the ability to properly control the roller on inclines, declines, and over rocky terrain. Finally, with its large water capacity and the mechanical rolling action, the addition of water purification powder into the barrel at the start of the journey back from the water source, creates clean water .

By using the roller, communities are empowered to enhance their 'quality of life' by having access to larger quantities of water, with improvements in hygiene, cooking and subsistance farming as a result. To date approximately 20,000 people have benefited from the Hippo Water Roller project in South Africa alone.

Further information and pictures can be viewed at the following WWW URL: www.technews.co.za/hippo/

Traditionally, water buckets weighing up to 20kg are carried on the head.

The Recyclability Map: application of demanufacturing complexity metrics to design for recyclability


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Dr Kosuke Ishii is Associate Professor in Mechanical Engineering at Stanford University. His research interests embrace product life cycle engineering and robust design for quality. He serves as chair of the ASME Computer and Information in Engineering Division, and is also associate editor of the Journal of Mechanical Design (ASME) and Artifical Intelligence in Engineering (Elsevier). His various awards include the National Science Foundation (NSF) Presidential Young Investigator Award, the Lucent Foundation Industrial Ecology Faculty Fellowship, and the GM Outstanding Long Distance Learning Faculty Award. Dr Ishii obtained his BS (Mechanical Engineering) from Sophia University, Tokyo, holds Masters degrees from Stanford (Mechanical Engineering) and the Tokyo Institute of Technology (Control Engineering), and completed his PhD (Mechanical Design) at Stanford.

This paper discusses the development and validation of a new design analysis tool – the Recyclability Map – and associated recycling complexity metrics which are proving valuable in the early identification of product sub-assemblies with recyclability enhancement opportunities. The Recyclability Map combines sort complexity and scrap rate information available to the designer at an early stage in the design process. The map helps designers optimise recyclability by highlighting sub-assemblies where appropriate material selection and disassembly re-designs can reduce scrap rate and disassembly costs. Rigorous use of the tool also promotes improved communication and knowledge exchange between product designers and recycling organisations. Research contributions include development of the sort bin scoring metric to model the impact of variable recycling process technologies in demanufacturing, and elaboration of the Recyclability Map approach. Re-design of inkjet printer sub-assemblies for improved recyclability is used as a validation example.

Introduction

Recent regulatory and industrial product retirement initiatives mandate firms to optimise product designs for environmental impact, in addition to customer-driven performance requirements (Allenby, 1993). European product take-back regulations (Beitz, 1993) and Japanese recyclability laws (Hattori and Inoue, 1992) impose a tight focus on 'design for recyclability' (DfR) objectives, utilising appropriate materials selection strategies (Ishii et al, 1994). Common to traditional 'design for environment' (DfE) approaches is a designer-centric viewpoint that emphasises design phase planning for post-life product disposal (Ishii et al. 1992; Marks, et al. 1993).

This paper analyses the perspective of the corporate recycling organisation (CRO) that oversees and executes enterprise demanufacturing operations. An advanced CRO assesses and

performs recycling operations for the firm's product families and generations (Ishii et al., 1995). In contrast to product design organisations, the CRO maintains a broad, global view of product retirement and recycling processes (Figure 1).

From the CRO's perspective, the product recycling and retirement process is highly variable and is generally unknown to the product design team. Research has identified three important sources of external uncertainty in demanufacturing process operations:

- advancements in recycling process technologies
- 'country to country' disparities in recycling processes
- variability in timing of product retirement.

In contrast, traditional designer-oriented DfR approaches assume a static, homogeneous, controlled and well-known recycling process environment. Current DfR optimisation methods thus fall short in accounting for factors outside the control of the product designer. This can make effective advance planning for product retirement extremely difficult.

The authors leverage the CRO viewpoint to propose a new framework that partitions DfR assessment metrics around two core concepts: *product-independent uncertainty* and *product-dependent complexity*. This approach motivates development of the Recyclability Map, a design phase chart which can be used to 1) identify and validate sub-assembly-level recyclability

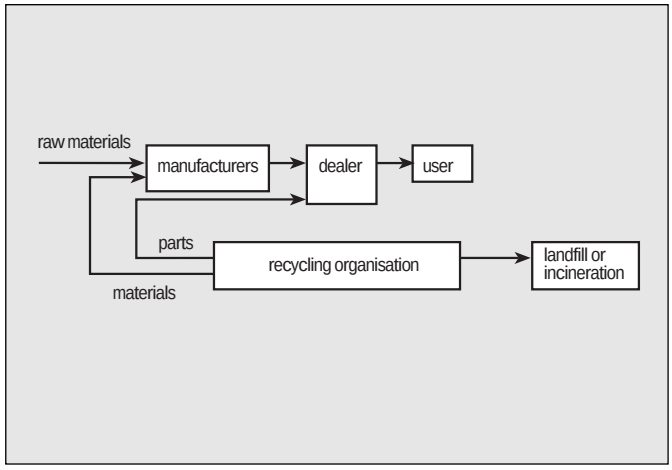

Figure 1: Design method focusing on demanufacturing process

design improvements, and 2) compare the effects of demanufacturing process variability on design recyclability optimisation. The map combines sort complexity and material recovery efficiency (scrap rate) metrics, helping designers improve the system-level recyclability through appropriate material and modularity selection strategies. A Hewlett Packard inkjet printer case study illustrates practical use of the Recyclability Map.

Uncertainty in design for recyclability

Robust DfE approaches mandate designers to optimise product recyclability for highly variable 'end of life' context factors outside the manufacturer's control. Significant sources of such product-independent uncertainty which are frequently encountered in DfR analysis include:

- variability in the timing of product retirement
- recycling process and technology variations and advances
- incomplete requirements, design and impact data.

Regulations and industrial standards are additional examples of enterprise-external factors that also impact product configuration and materials selection decisions.

Variable timing of product retirement

Academic DfE research assumes that products are retired exclusively near the end of their useful life, when the customer upgrades or discards the item. Stanford's investigations, however, reveal that the timing of product retirement can occur at any point in the product life cycle.

A recent case study developed with Hewlett Packard (HP) demonstrated that many HP inkjet printer products are retired within weeks of their manufacture date due to excess retail inventories, customer

returns, and wholesaler overstocks returned directly to the manufacturer for disposal, reconditioning or spare parts extraction (Jeon, et al., 1997). Corporate and independent recycling organisations perform full or partial disassembly of relatively new, unused products, together with disassembly of older products at the end of their useful life. Thus, the timing of product demanufacturing can vary greatly for some product classes.

Recycling process and technology uncertainty

The technical sophistication of locally available recycling processes strongly determines the depth of product disassembly and sorting required. The degree to which a particular recycling process can handle different types of plastics, for example, dictates the level to which plastics must be separated for colour, filler content, and other characteristics.

After-sale product units are exposed to a variety of demanufacturing processes across national boundaries, between recycling organisations, and over time. Table 1 suggests a taxonomy for ranking recycling processes according to the level of technology employed. 'Level 1' processes are those which employ essentially no special separation and reconstitution technologies; at the high end of the scale, 'Level 5' processes are the most technically sophisticated, such that no advance separation is required. Traditional DfE research assumes that products face only one level of recycling technology.

Incomplete product and environmental impact data

Significant segments of the industrial product design community are concerned about increasingly stringent DfR requirements in the face of persistent incomplete product and environmental impact data.

Two critical data 'holes' are noteworthy:

- future disassembly and sorting process costs
- materials compatibility, environmental impact, and processing cost data.

Typically, if and when such data becomes available, it arrives too late in the design, and is often difficult to use. Because the demanufacturing process occurs in the future at many diverse locations, it can be difficult to design to known disassembly processes and costs. The absence of adequate process, materials and environmental impact data introduces additional uncertainty as to the recycling optimality of a particular design. Ideally, DfR methods should generate useful evaluative metrics under conditions of high product-independent uncertainty, and with minimal data collection and analysis.

Level	Characteristics	Process description	Disassembly and sorting
1	Unsophisticated recycling	Each part is sorted into its own bin, regardless of material content	Maximum disassembly and sorting required High cost retirement process
2	Function-based recycling	Combine similar parts into the same sort bin, based on part function	Intermediate disassembly and sorting
3	Material-based recycling	Each material is sorted into its own sort bin, regardless of part function	Intermediate disassembly and sorting
4	Material family recycling	Combine some different materials into the same sort bins	Minimum disassembly and sorting required
5	Advanced recycling technology	Combine all materials into one sort bin	No disassembly, sorting; Lowest cost process

Table 1: Technology levels of recycling processes

The disassembly reverse fishbone diagram

To encourage design engineers to incorporate recyclability, the authors have defined the reverse fishbone diagram as a graphical representation of the product disassembly process (Ishii and Lee, 1996) (Figure 2). Construction of the diagram or disassembly tree motivates designers to 'walk through' the demanufacturing process and optimise the design for efficient disassembly. The disassembly tree illustrates the demanufacturing process sequence, major steps, and component 'end fates'; increased depth and breadth of the tree corresponds to higher disassembly complexity and cost.

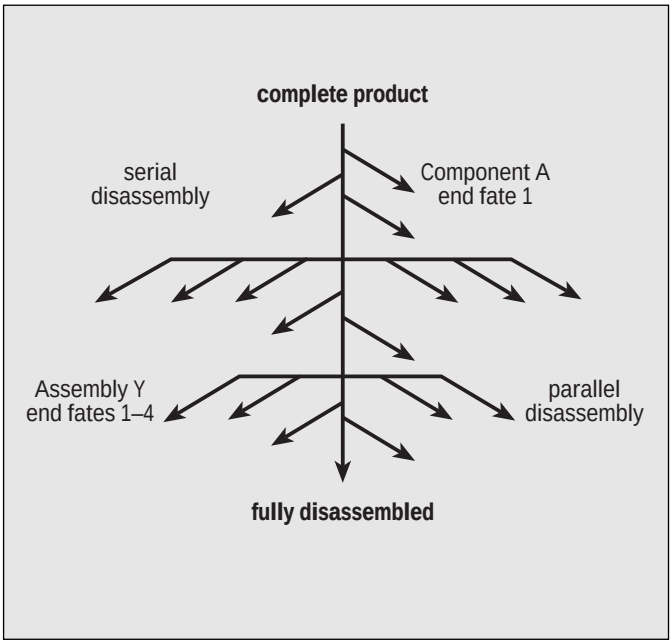

Figure 2: Reverse fishbone disassembly tree

Although the reverse fishbone diagram has proved effective for improving the recycling modularity of a single product model, it falls short of helping designers generate effective recyclability ideas in material selection and assembly designs for product families and generations.

Demanufacturing complexity metrics

Sort complexity

Sort complexity captures information about the difficulty and cost of the disassembly process as influenced by the following design-independent variables:

- level of recycling technology employed (Table 1)
- level of product reuse and re-manufacture.

Sort complexity strongly influences the level of disassembly required when recycling a product or reusing parts. High sort complexity entails greater disassembly costs and therefore the designer must pay greater attention to disassembly and materials complexity.

The 'number of sort bins' is the principal sort complexity metric, where a 'sort bin' is defined as any distinct post-sorting end fate or destination for a product, module, sub-assembly or component. Examples of sort bin categories include 'scrap', 'ABS', 'steel', and 'motors'. The sort bin metric is easy to understand and readily estimated by the Corporate Recycling Organisation (CRO). When considered in the context of the reverse fishbone diagram, the number of sort bins corresponds to the number of different 'end fates' for all the leaves on the diagram. In general, more sort bins indicate deeper levels of disassembly, higher material count, and lower parts commonality. A good DfE modularity strategy should lead to fewer sort bins for a given level of recycling process technology.

In theory, any given product can be sorted into one, a few or many sort bins, depending on the level of recycling technology employed. A highly sophisticated recycling technology (eg. 'Process Level 5', Table 1) requires only one sort bin, since the recycling process is capable of taking in and separating all component materials. On the other hand, sending the entire product to scrap (requiring landfill or incineration) also requires a single 'scrap' sort bin. It is assumed that the 'scrap' bin is the least desirable option

among all possible sort bins because it is environmentally most harmful. When particular materials require costly handling, such as toxic or radioactive materials, those sort bins should receive negative weightings or cost penalties. Other 'usual' sort bins are ranked approximately equivalently.

Materials complexity

Materials complexity generally refers to the number of materials utilised in a component, sub-assembly, or product. It is determined during the design phase and plays an important role in determining disassembly decisions and total recycling cost. Depending on the particular context, the materials complexity metric may be extended to account for the following additional distinctions:

- *number of material classes:* the number of different material classes strongly influences the materials complexity of components and assemblies. Broadly, we can group materials into the following categories: plastics, ferrous and non-ferrous metals, paper and wood, hazardous materials, and other.
- *materials compatibility:* some combinations of materials may not be processed together during recycling. This is a strong function of the current level of recycling technology, as mentioned before.
- *materials requiring special handling:* materials that are difficult and/or very costly to handle.

In its simplest form, the materials complexity metric does not reward or penalise particular material classes or materials selected by the designer; all materials are assumed to be broadly equivalent in 'goodness' or 'badness' ranking from an environmental perspective. Note that materials complexity and compatibility concepts are meaningful only insofar as the available recycling technology is unable to fully process all materials in a non-disassembled state.

The Recyclability Map

Recyclability map fundamentals

The Recyclability Map is a design chart for the early identification of sub-assembly level modularity and disassembly and materials selection re-design strategies that support reduced recycling costs. Used in concert with the reverse fishbone diagram, it promotes robust advance planning of disassembly and sorting processes in the face of highly variable product-dependent and product-independent influences. It is most useful during the layout design phase, when alternate materials and configurations are under consideration. In addition, the map supports tracking of DfR re-designs for sub-assemblies performed over the history of a product platform, and thus can serve as a system-level tool to track and compare recyclability improvements across product families and generations.

The Recyclability Map derives its analytical power from the unique use of simple sort complexity and material recovery efficiency metrics. Combining these metrics into an intuitive graphical representation facilitates quick trade-off analysis for design improvements at the sub-assembly level, without placing heavy burdens on the designer for extensive data analysis. Sort bin count serves as a proxy model of the effects of alternative recycling technologies and processes, allowing designers to roughly compare a single design under alternative recycling process technology assumptions.

Information required to construct the map

The Recyclability Map plots the sub-assembly sort bin 'score' against its scrap rate. Construction of the map (Figure 3) requires layout design information and recyclability assessments provided by designers and recycling experts. First, the 'end fate' of major sub-assemblies and components must be identified; this requires prioritisation of product maintenance, parts reuse, recycling and regulatory compliance goals by designers and life cycle support entities. Analysis of product service and teardown reports is one method of assessing part fates using historical data.

Sub-assembly scrap rates (x-axis coordinates) are estimated based on the percentage of total parts sent to landfill or incineration. A low scrap rate is preferable, indicating a high material recovery efficiency for a module. The authors assign equal weighting to all parts in a module by using

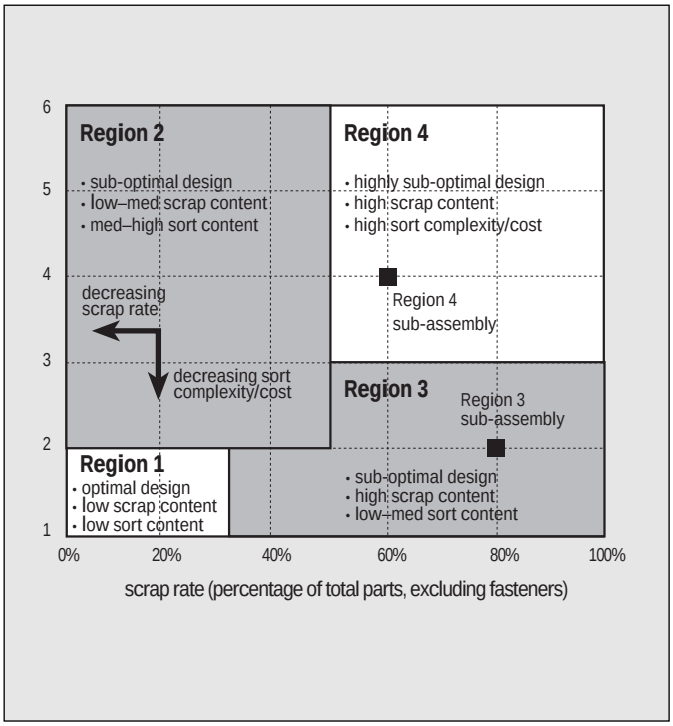

Figure 3: The Recyclability Map and its regions

simple part counts that exclude fasteners.

Sub-assembly sort complexities (y-axis sort bin count) are typically assessed by the CRO based on design team materials and configuration choices. For each module or sub-assembly, the CRO identifies the total number of sort bins required during teardown, removal, and disassembly. Sort bin count serves as a proxy metric for disassembly and sort cost; high sort bin scores are sub-optimal because they imply larger demanufacturing costs. Sort bin counts can vary significantly, depending on the recycling process, recycling technology and regulatory environment assumed.

Successful use of the Recyclability Map requires early communication between designers and recycling organisations. Understanding the range of possible recycling process technologies which are likely to be employed is essential.

Construction of the Recyclability Map

Using the derived scrap rates and sort bin scores, the designer plots all product sub-assemblies against the map's x-axis and y-axis. If the current product is an iteration or version within a product family or generation, the designer can estimate x-y coordinates on the current map starting with previously generated Recyclability Maps for related products with similar modules. Emergent patterns and clusters of sub-assemblies should be noted, along with their position on the map. As the design progresses, the map is updated to reflect sub-assembly re-designs. Design improvements may shift a sub-assembly to successive locations and regions.

Interpretation of Recyclability Map regions and paths

Analysis of Recyclability Map patterns requires an understanding of how the map regions, sub-assembly re-design paths and re-design costs relate to the underlying design space. The initial x-y coordinates of a sub-assembly suggest material selection and disassembly strategies for recyclability optimisation. Design improvements – reductions in scrap rates and/or material or sort complexity – move sub-assemblies between regions (Figure 3, Table 2) along re-design paths or trajectories (Figure 4, Table 3).

Region 1, characterised by low scrap rates and low sort costs, is optimal for all sub-assemblies. Ideally, all sub-assemblies should fall in – and move towards – this region. Here, the product requires only minimal disassembly and sorting, such that only one or two sort bins are required, and close to full material recovery is achieved. In practice, however, Region 1 is difficult and costly to reach.

Region 4 is highly undesirable for all sub-assembly designs because here they evidence high scrap rates and high disassembly and sorting costs. Recyclability improvements to Region 4 sub-assemblies are achieved through scrap rate reductions (shift left,

	Recyclability characteristic	Design optimality	Designer actions
1	High material recovery rate Low disassembly and sort costs	Optimal design Zero penalty	Move all subassys towards this region, via Region 2.
2	Medium-low material recovery rate High disassembly and sort costs	Sub-optimal design Moderate penalty	Move sub-assemblies towards Region I. Move away from Region 4.
3	Low material recovery rate Low disassembly and sort costs	Sub-optimal design Moderate penalty	Move sub-assemblies towards Region 2, and if possible, towards Region I. Move away from Region 4.
4	Low material recovery rate High disassembly and sort costs	Highly sub optimal design Large penalty	Move all sub-assemblies out of, and away from, this region.

Table 2: Regions of the Recyclability Map

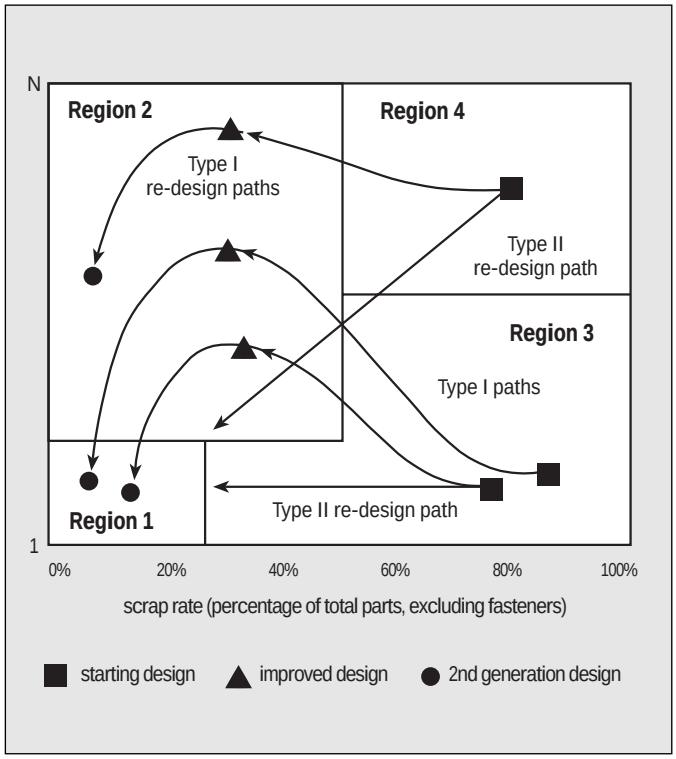

Figure 4: Re-design paths for sub-assemblies

towards Region 2), a reduced sort bin score (shift down, towards Region 3), or concurrent adoption of both strategies (shift 'southwest', towards Region 1). Transfer of a sub-assembly towards Region 2 is essentially a materials selection decision; a downward shift towards Region 3 implies easier disassembly, a reduction in materials complexity, or change to a more sophisticated recycling technology.

Most product sub-assemblies typically fall into Region 2 or Region 3. Region 2 sub-assembly designs initially evidence low scrap rates and high material recovery efficiencies. The recyclability of these sub-assemblies can be improved through further increases in the recovery rate (shift left) and/or reduction in sort complexity and cost (move down).

Region 3 is where many sub-assemblies begin. Module designs in this region are characterised by low material recovery rates and low sort complexity and cost. Ideally, Region 3 sub-

Re-design path	Characteristics	Feasibility & cost
Type I	Re-design for Region 2 in short term Target Region 1 over successive product generations	Incremental redesign Easier to achieve for single models Low-moderate cost redesign
Type II	Re-design for Region 1	Major re-design required Difficult to achieve within a single product generation Higher cost re-design strategy

Table 3: Classes of sub-assembly re-design paths

Figure 5: Hewlett Packard 855C inkjet printer

assemblies should seek to move directly towards Region 1; in practice, however, they will typically move first towards Region 2, since contemporary recycling processes are not sophisticated enough to support concurrent scrap rate reduction and sort complexity minimisation.

As a rule, the designer should prioritise design improvements for Region 3 and 4 sub-assemblies. Recyclability gains achieved from re-design of these sub-assemblies are likely to be substantial compared to Region 2 sub-assembly re-designs. Inter-region boundaries shown (Figures 3 and 4) are not rigorously specified, and may be shifted.

Re-design paths of Type I move a sub-assembly through Region 2 before moving to Region 1 (Figure 4, Table 3). These paths are typically easier to achieve within a typical design project, and are less costly than Type II paths. Type II re-design paths move a sub-assembly from its current design region directly towards Region 1. These paths are high cost, and as such are difficult to achieve for a single product. Successive generations within a product family, however, might gradually pursue a Type II trajectory over several re-design generations.

Once a strategy for DfR improvements to a particular sub-assembly has been decided, the reverse fishbone diagram can help designers to quantitatively verify reductions in disassembly times and sort bin count. The re-design analysis thus iterates between progressive versions of the reverse fishbone disassembly tree and the Recyclability Map.

Application example: analysis of inkjet printer recyclability

The Recyclability Map was developed by Stanford graduate student researchers during recyclability re-design of a Hewlett Packard (HP) 855C inkjet colour printer (Figure 5). The printer is a high production volume, moderately complex electromechanical device that utilises materials ranging from commodity thermoplastics to costly special purpose metal alloys. Because it is sold principally in the US and Europe, designers must plan for a broad

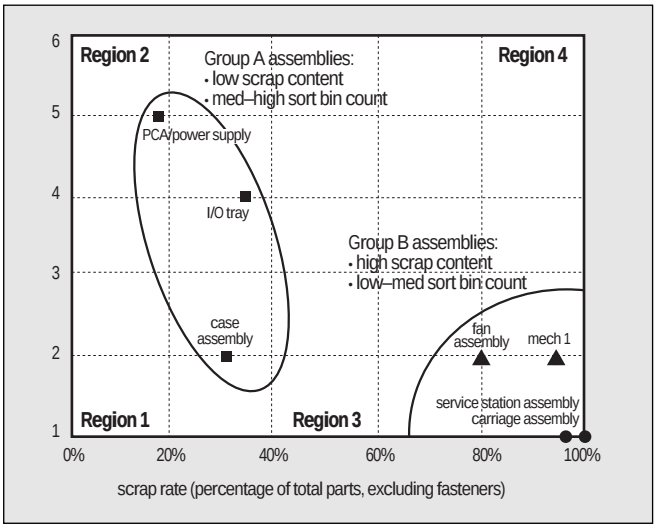

Figure 6. Recyclability Map for the HP 855C Printer

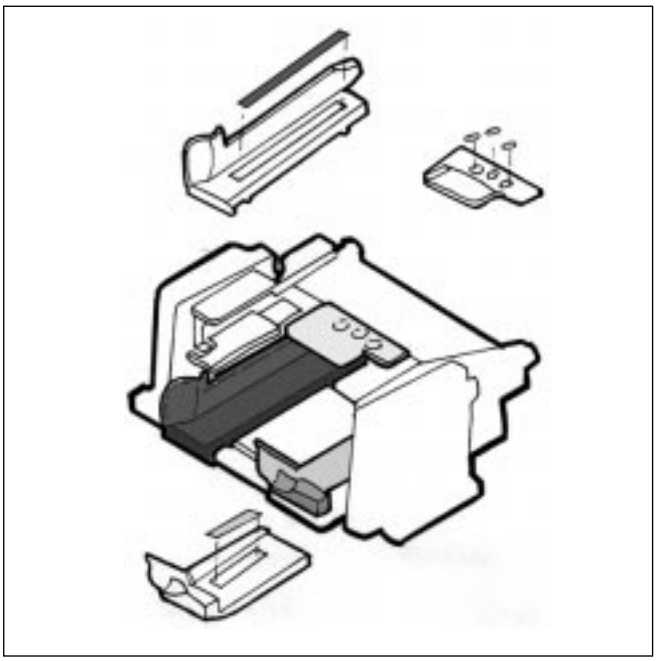

Figure 7: Printer input/output paper tray

variety of disassembly and recycling process scenarios.

Application of the Recyclability Map analysis methodology to the printer yielded two major groups of sub-assemblies for further redesign analysis (Figure 6). Group A assemblies (Region 2, upper left) included the input/output (I/O) tray, logic board printed circuit assembly (PCA), power supply and external case housing; evidenced a high recovery rate in their original design, along with a moderate sort bin count. Group B assemblies (Region 3, bottom right) consisted mainly of parts to be scrapped – the paper feed module ('Mech 1'), fan assembly, service station assembly, and carriage assembly – and accordingly were assigned low sort bin scores.

For the I/O tray (Figure 7), the re-design path suggests potential improvements by reducing the associated scrap rate and sort complexity (Figure 8). This can be achieved through appropriate material selection (enhancing material recovery) and a reduced sort bin count. The team cut the number of plastic materials from three to one (all ABS), and improved the disassembly process by changing fastening methods. The new design achieved a reduction in sort bin count from four to three, reduced scrap by 50% (from nearly 35% to less than 15%), based on part count, and decreased disassembly time by 70%.

At an early point in the project, when relatively little data was available, the chart successfully

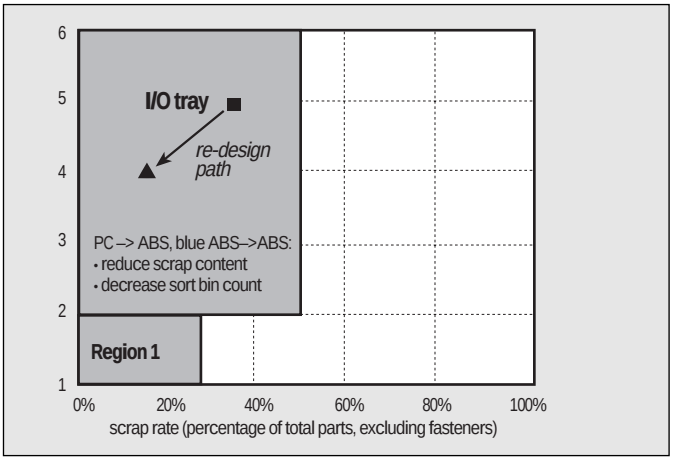

Figure 8: Re-design path for printer paper tray

identified areas of sub-assembly level improvement and generated specific materials selection candidates. The student team was unable to generate these ideas using the reverse fishbone disassembly tree alone.

The map was generated using data provided by the HP Hardware Recycling Organisation (HRO), an HP product retirement facility which demanufactures HP printers. Collaboration with the HRO was essential and illustrated the benefits of early communication between designers and recycling experts.

Limitations of the Recyclability Map

The utility of the Recyclability Map depends on the data available to the designers, and the extent of analysis required. Successful use of the map depends on prior knowledge of the fate of all parts for each sub-assembly analysed. Understanding the current and projected market demand for parts reuse and recycling is essential. In the worst case, the designer should consider all reusable parts as candidates for removal.

In its current form, the Recyclability Map assumes equal weightings are assigned to all sort bins, parts and functional modules. This has the advantage of simplicity, but may introduce distortions into the model that could be corrected through differential weightings. Our current sort complexity approach explicitly assumes that most sort bins are approximately equally desirable, ie. we do not ascribe formal penalties or weightings to particular bin classes. Where particular materials require special, costly handling, such as toxic or radioactive materials, those sort bins should probably receive cost or environmental penalty weights, while other 'normal' sort bins can be ranked equivalently.

In using part counts, all parts in a module are assigned equal weighting; thus a spring and plastic housing are considered equivalent in this scheme. Weighting by mass, volume and/or material type/class might provide more accurate estimates of assembly scrap/recovery rates. Simple fasteners are excluded from part counts (ie. weighting = ø), as they can bias certain classes of sub-assemblies towards the left side of the map (lower scrap rates), depending on the type of fastener material employed. Functional modules are equally weighted as well, such that actuator assemblies and static load-bearing structures (such as housings) are counted as equivalent. This may restrict comparisons between sub-assemblies.

Conclusions

This paper introduced the Recyclability Map as a new design tool for the early identification of product sub-assemblies where appropriate material selection and part re-designs can increase material recovery efficiency and reduce disassembly costs. We began with a description of demanufacturing metrics useful in representing product-dependent complexity and product-independent uncertainty. The paper then described the Recyclability Map, and how it is used together with the reverse fishbone to perform DfR trade-off evaluations. The HP inkjet printer study illustrated the practical application of the Recyclability Map.

The map is useful as a guide to assembly-specific re-design

changes. It provides a basis for planning of incremental product recyclability design improvements, and for assessing the effects of externally-driven demanufacturing process variability.

Feedback from industry indicates that the Recyclability Map is effective in the following DfR tasks:

- early identification of recyclability improvements at the sub-assembly level
- advance planning and tracking of recyclability improvements across product families and generations
- assessment of product designs under alternative recycling process technology environments.

The Recyclability Map motivates and supports early communication and collaboration between product design teams and CROs. •

Acknowledgments

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What are the key organisational issues when integrating eco-design?

First we need to look at the way that most businesses are organised at the product development or product realisation level. For eco-design to be practised successfully, it is imperative that it is adapted to the existing 'gate' processes that many firms now utilise. It involves not only understanding how the process operates from a procedural point of view, but also understanding the culture of the product development community. What we have found historically is that eco-design has been driven by champions who are outside of that community. Product designers and developers tend to be arrogant, and are generally talented and creative individuals, with strong engineering skills. They tend to be suspicious of anyone offering help, as well as anyone seeming to complicate their busy lives. So the challenge is to achieve acceptance by demonstrating that you understand their constraints, and that you have something to offer that will not interfere or obstruct their work, but will in fact augment the value of what they are doing.

What I have found with many design organisations, is that individuals generally acknowledge that it makes good sense to develop a green design. They are not oblivious to the concept. However, they are under very tight constraints in terms of cost, schedules and customer requirements. Some designers, on their own individual initiative, may incorporate eco-design innovations which comply with the design requirements. However, it is unusual for eco-design to be systematically incorporated into the product development process. The owners of the process tend to be general managers of divisions and vice presidents of product development, engineering, or marketing people who establish customer needs. A lot of the traditional champions of eco-design have attempted to develop design checklists or other kinds of

It does not require a highly academic analysis to drive a lot of eco-design concepts. The concept development stage is where the most fruitful work can be done.

tools, and then deliver them to the designers, assuming that the tools would be accepted and implemented. Frequently, they fail to do the ground work in terms of establishing an organisational role for these tools. The designers will only use these tools if they are required to articulate certain eco-design attributes as part of the 'gate' process.

Do you feel that the first generation eco-design tools have been appropriate for product designers?

As an example, I have worked closely with Johnson Wax, helping them to establish their 'design for an eco-efficiency' programme. I am very familiar with the constraints within which their designers have to operate. What they discovered was their designers were concerned about adopting tools that would interfere with their work and 'slow down' the process. It was felt that it would 'cost' many hours and weeks of labour in order to achieve a result which was of dubious value. That is why Johnson Wax decided to de-emphasise rigorous life cycle assessment (LCA) tools and to work with a more streamlined approach. Many companies are moving towards this kind of approach and I personally think that the first generation of LCAs are far too cumbersome. I think LCA should be used as more of a background activity which develops a platform for product evaluation. In the development phase, you need much simpler tools to support the rapid pace of activity, eg. in a matter of days, designers can go through many alternative designs and variations. You cannot afford to go through the quantification exercise if you don't acknowledge where the uncertainty is. I think we have a long way to go in terms of the tools, however I believe that very simple tools are adequate at this time. It does not require a highly academic analysis to drive a lot of eco-design concepts. The concept development stage is where the most fruitful work can be done. Once the product requirements have been established, there are far fewer degrees of freedom, although one can influence material selection and other decisions, that incrementally improve the product's performance.

There are some interesting eco-design R&D projects going on, but rarely is eco-design being integrated into the mainstream product development process. I think that many of us in the environmentally conscious community are impatient for the integration of eco-design. I personally believe that we cannot force the issue, although we can do research, demonstrate, and persuade. You really have to wait for the market to articulate its needs, and I think that market awareness is going to be slow to emerge, although in Europe it appears to be growing more rapidly than in the US. You will find that the decisions made by domestic consumers, as well as

industrial customers, will continue to be determined by cost, quality and performance first. A good eco-design will be fourth on the list of requirements. However, this need will become increasingly well articulated as people become better educated and more aware of environmental issues. So I think it's a gradual trend and we need to be patient; it won't happen overnight. It's really a cultural revolution. Some leading companies have actually chosen to try to educate their consumers. There are some genuinely progressive companies that are dominant in their markets, either first or second in market share, and are confident that they are not taking undue risks by encouraging eco-design. You have to admire that because it is purely a voluntary initiative, many of the followers, particularly in the US, will wait until the regulations are imposed, and then they will emulate the best practises that they see in the marketplace.

The whole concern about product 'take back' is something that industry has been aware of as a coming trend. But those companies who have chosen to implement 'design for disassembly' or other kinds of product 'take back' are companies that want to be ahead of the 'curve.' Instead of waiting for these requirements to emerge, they've attempted to create a more rational approach to life cycle design for their products and in the process the've been able to improve their profitability. I think Xerox is an excellent example. They started an asset recovery programme long before product 'take back' was even a threat, and they have done a very good job in market positioning, while achieving customer retention and a high quality image.

What would you say are the characteristics of the model eco-design management system? Could you answer with particular reference to the importance of eco-design metrics?

Let me take the second, first because I think that metrics are absolutely essential, and in fact, until recently, I have noted that metrics were lacking from many of the eco-design schemes. Designers live and breathe metrics. That is the only way they can evaluate the quality and acceptability of their work, so they want specific measures. They prefer to have them expressed in terms of targets, because designers are not very interested in interpreting the desires of the marketplace. They want their marketing and management team to do that. They want very precise specifications, so the metrics need to be developed. I think there has been a lot of good work done in this area and I think today there is a well established literature of viable metrics that support the broader environmental attributes of product design.

Many companies have developed useful metrics that characterise

There are some genuinely progressive companies that are dominant in their markets, either first or second in market share, and are confident that they are not taking undue risks by encouraging eco-design. You have to admire that because it is purely a voluntary initiative.

their product's life cycle performance and include things such as durability and reusability, recycled fraction, 'end of life' impacts, energy consumption, and modularity (looking at the lifetime of platform versus the product components). In fact I found that one of the best sources of metrics is the German Blue Angel Scheme. They do a good job of highlighting specific engineering-oriented product attributes. I think that if you take a given product and examine its environmental aspects across the life cycle, it is very easy to establish the appropriate metrics.

Now to the first question. I will take an extreme position and say that, to me, the model eco-design management system is one in which the word 'eco-design' does not appear at all. When these concepts are fully integrated and embedded, they will no longer have to be highlighted as a separate issue. I think that there are examples of this. If you look at software for instance, there was a time when incorporating software into products was somewhat unusual, but it was a technology that could be grafted onto an existing process. Nowadays, in most durable products, software is a valued and integral part of the total design.

What do you think are the key challenges of sustainability for product development and design?

We have begun to work with a number of companies that are trying to expand the scope of their eco-design to include not just eco-efficiency but also understanding of the social impact of products. It's a very interesting field, requiring new disciplines that have not existed in the past, when we have dealt strictly with the eco-efficiency aspects. What we have done is try to develop an understanding of the cause-effect relationships. When you develop, distribute and put a product in the marketplace. For example, do you create jobs, do you shift economic power, do you enhance communication, do you enhance mobility? There are a whole variety of societal impacts which are part of sustainability. Not just for producers, but the entire socio-economic sphere may be affected.

We have discussed the impatience of the environmental community, and I think that sustainability is the next generation issue. I think we still have a lot of ground to cover just in establishing eco-efficiency concepts as an integral part of the product definition. There are not many companies that are prepared to wrestle with the sustainability of their products, especially in the US. I have observed that the few companies who practice this approach are better informed, and tend to be very willing to spend time and energy on educating their stakeholders.

Interface, the floor company, is a good example, but unfortunately they are an anomaly. I think that they will have few imitators because they represent a bold strategy. The only reason that Ray Anderson, CEO and owner is willing to embark on this move towards sustainability, is because he is a completely self-assured individual. He has nothing to lose at this point, as he is a self made person, so he is willing to march into this unexplored terrain. Most executives are paranoid about their vulnerability to being let go if short term performance goals are not met. Unfortunately in the US we generally have a rather myopic perspective at the senior management level. They are really not thinking about sustainability on a 10–20 year time frame. •

Strategic marketing of greener products


Jacquelyn Ottman & Virginia Terry

President of J Ottman Consulting Inc, US; and Researcher in Sustainable Design at the The Surrey Institute of Art & Design, UK

Jacquelyn Ottman is the president and founder of J Ottman Consulting Inc. based in New York City. For the past ten years the organisation has helped businesses create competitive advantage by developing and marketing environmentally responsible products and services. Clients include 3M, Eastman Kodak, IBM, Interface and the US Environmental Protection Agency. The second edition of her book, Green Marketing: Opportunity for Innovation, has just been published. She is a member of the American Marketing Association, O2, the Product Development and Management Association, and the World Future Society.

Virginia Terry is a Researcher of Sustainable Design at the The Surrey Institute of Art & Design. Prior to moving to the UK, she was responsible for researching and writing the case study portion of Green Marketing (2nd edition), by Jacquelyn Ottman. She recently graduated from the Masters programme in Environmental Management at New York University where she was president of Students for Responsible Business. Her thesis focused on management of ecotourism projects in developing countries.

In order to significantly reduce environmental impacts, 'greener products' should replace their 'dirtier' products and find reliable markets. Therefore, strategic marketing of 'green products' is a growing issue. Drawing on examples primarily from the US, this article focuses on green marketing strategies that have brought success to many companies, discusses opportunities for innovative businesses and suggests direction for the future. Additionally this article highlights two companies, Interface and Canon, which have incorporated successful approaches to green marketing.

Introduction

In the past decades innovative environmental managers and product designers have made considerable progress toward reducing the environmental impacts of products. Driven by regulations, new technologies and consumer pressure, whilst designers have focused on particular eco-aspects of products such as increasing the amounts of recycled or recyclable materials; reducing in-use consumption of energy; reducing material intensity of products; and the impact of product take-back schemes. Experience with these and other concepts forms the basis of myriad guidelines, software and consultantcy services covering 'Green Product Design'. However, there are only a few strategic tools for marketers of green products, and even these have evolved in an ad hoc manner. Furthermore, greener products should replace their 'dirtier' counterparts if they are to make significant inroads towards reducing environmental impacts. For example, Fox Fibre, a frequently cited example of a more sustainable business, has inspired the green design community with their naturally coloured, certified organic and beautiful cotton fibres. But this same innovative business is experiencing financial problems because of unreliable markets. Green designs, and more sustainable designs, will only survive if there is a market for the products that leading edge companies have developed.

While strategies for successful marketing of greener products do exist, they are not widely known. How then, should businesses that have made strides in greener product design approach

Green Marketing? This article seeks to broadly address this question and present useful examples.

The green consumer

Although the green consumer movement has been the focus of many recent books, research projects, and corporate reports, it remains an ambiguous subject. Just what is a green consumer (ie. should we consider consumers of phosphate-free detergents 'green' or only those consumers who purchase detergents made from completely natural ingredients?) Is the green consumer willing to pay a premium for more environmentally sound products, and if so, how much more? What percentage of the purchasing public can be identified as green consumers? Where is the green consumer trend heading? Unfortunately, there seems to be only sketchy and inconsistent data to answer these issues.

The good news is that many reliable indicators show that consumer concern about the environment has steadily increased over the past two decades. For example, the 1996 Globescan Survey performed by Environomics of Canada indicated that the environment is a major concern for the general public, and that the majority of people see the integration of environment and economy as a win/win scenario. A Green Gauge Report 1996 study conducted by Roper Starch Worldwide (US) showed that 75% of Americans think they should take more positive action towards the environment. However the same report also showed that the percentage of Americans willing to pay more for environmental products has declined from 11% ten years ago to just 5% in 1996. This trend is not confined to the US. Generally, the consumer's increased environmental concern, and indeed his or her environmental sophistication does not necessarily translate into increased green purchasing. Clearly, marketing greener products will have to entail more than attaching a green label or featuring images of wildlife in media advertisements!

Identify the opportunities

The demand for greener products undoubtedly exists. So, therefore, do the opportunities to capitalise on that demand. Much of the demand will continue to be driven by regulations as producer responsibility, product take-back, and recycling schemes evolve. As recent history has shown, the more innovative companies will reap benefits, and those who are radically *re-thinking* products and processes will be the leaders of the future. Opportunities to increase the bottom line including:

- differentiating products and services in environmentally-oriented ways that command brand loyalty (eg. both Ecover and Henkel phosphate free detergents, the Earth's Best line of organic baby food)
- capturing new market share among governments and corporations with green procurement and purchasing programmes, eg. Philips energy efficient lighting, Hammermill recycled office paper
- capitalising on service potentials, eg. Interface
- creating alliances to reduce the costs and risks of entering into a new eco-innovation enterprise, eg. GM, Ford, Chrysler and US government creating an alliance to develop advanced battery technology for electric vehicles
- reinforcing a company's environmental position through cause-related marketing, eg. Canon
- capturing revenue streams through innovative strategies which extend the life of the resources of which a product was comprised eg. the Xerox series of refurbished copiers such as the 'Eco-series' and 'Renaissance' model; the Green Disk company which sells refurbishes diskettes
- innovating and setting new standards of best practice eg. Arco announcing a new gasoline formula designed to sharply cut auto emissions.

Highlight the direct benefits of greener products

It is vital to stress the direct and tangible benefits provided by greener design, such as energy efficiency or recycled content, rather than stressing the environmental attributes themselves. Reducing the environmental impact of a product improves the product's overall performance and quality in ways that are

Interface

Ray Anderson, CEO of Atlanta-based Interface, Inc, a leading maker of commercial carpet, carpet tile and other interior furnishings is shepherding his twenty four year old, $1 billion company on course 'to become the first name in commercial and industrial ecology worldwide.' Despite a product line that is based heavily on petrochemicals, Anderson is determined to make his company a working example of sustainability and zero waste.

Interface's first step towards sustainability begins with the implementation of a three-part educational programme: environmental training for the entire work force; an internal 'EcoSense' programme which outlines a seven front approach to sustainability and focuses on resource depletion, landfill use, pollution, and energy waste; and thirdly, internal environmental programme, QUEST (Quality Utilizing Employee Suggestions and Teamwork) which aims to increase employees' overall environmental awareness at home as well as in the workplace.

At Interface, education translates into profitable innovation. As of 1995, the company entered a revolutionary new phase, and raised environmental standards in the process: they began leasing carpets through a unique Evergreen Lease Programme. Under the programme, Interface actually retains ownership of its carpet tile, making itself, the manufacturer, responsible for the maintenance, repair, and ultimate recycling of the carpet tile. By assuming full life cycle responsibility of its products, Interface not only assures that the recycling loop will be closed, it maximises the potential to reuse natural resources while preventing a voluminous and potentially hazardous source of waste from going into landfills. The Evergreen Lease is especially effective with carpet tiles because only worn tiles are replaced, thus eliminating the need to install a whole new carpet, but providing a 'face lift' that goes on theoretically as long as the building stands.

If Interface has its way, one day its carpeting may be not just recyclable but biodegradable as well. In 1995, the R&D division developed a fully compostable carpet made of natural and degradable fibres, now undergoing testing. Meanwhile, the company continues to explore other initiatives and technologies brought about by heightening staff awareness of environmental management issues.

Interface may be in the earliest stages of its journey toward becoming a sustainable company, but it is already profiting from its innovations. Thanks to QUEST, the company has saved over $20 million by such activities as producing 100% post-industrial recycled nylon carpet, improving the efficiency of turnover for beams of yarn by 25%, reducing hexane solvent usage by 16% with the implementation of a new carpet drying procedure, and reducing scrap yarn from beams at one of their manufacturing sites by 75%.

These, along with many other efforts, have boosted efficiency and waste reduction while lowering operating costs and thus increasing profits to the tune of $35 million last year.

important, not just to the most dedicated and loyal green consumer, but to all consumers. For example, super-concentrated laundry detergents not only save energy and packaging, they save end space, money and effort (they are easier to carry). Organically grown food not only better preserves soil and reduces the amount of toxins in the water supply, they have superior taste and health benefits compared to their counterparts. Patagonia sells outdoor garments such as fleece sweaters made from recycled soda bottles. The material has insulating ability superior to virgin materials while providing comparable breathability. These are added values that should not be overlooked in the marketing process, for three important reasons:

- Consumers primarily buy products to meet direct needs, not the 'save the planet'
- Consumers purchase products out of self-interest. For example, the top environmental concern has to do with issues of health. Additionally the

Canon

At Canon, a corporate philosophy of 'kyosei' (living and working together for the common good) guides the company toward cause-related marketing that reinforces the company's position as a market and environmental leader.

In the US it began with the Clean Earth Campaign in 1990 which donated $1 to be divided between the National Wildlife Federation and The Nature Conservancy for each Canon toner cartridge returned to the company. The five year effort resulted in the recycling of several million toner cartridges along with a corresponding donation. The success of the program inspired Canon to deepen and enhance their cause-related marketing efforts.

Among other initiatives, the company now supports 'NatureServe', a comprehensive programme for sharing with the public The Nature Conservancy's scientific knowledge and expertise on natural resources; and 'Expedition into the Parks,' a programme with the National Parks Foundation to inventory and protect rare plant and animal species found in national parks.

These initiatives help Canon USA, Inc. show its environmental concern to its 9,800 employees in the Americas, and serve as a model to other companies. The depth and scope of these efforts allow Canon to promote their participation credibly to all stakeholders via such vehicles as the PBS series 'NATURE' and ads in National Geographic.

chance to save money is always appealing, as is the potential for self-actualisation.

- Businesses risk marginalising their products by wrapping them in a 'green cloak'.

To illustrate these points, consider two ads for natural cleaning products, both of which appeared in Mother Jones magazine (US). One ad features images of flowers, complemented by copy that focuses on saving the earth. In the same magazine was an ad for Citra-Solve made from d-limonene, an extract of orange peels. The latter, in contrast, contains *no* pictures of flowers or animals, just a sharp, single-minded focus on all the tough cleaning problems it can solve around the home and workplace. Of course, it doesn't completely ignore the environmental message. The copy addresses environmental attributes, but the focus is on other meaningful product benefits.

Another example is Rayovac (US), which introduced the first reusable alkaline battery in 1993. Rayovac was well aware of their product's environmental features, but they resisted the temptation to use soft images of natures such as wildflower fields or waterfalls that have become a cliché. Instead they went directly to heavy users, emphasising the products' ability to save money. A secondary campaign focused on environmental benefits, e.g. on headline announced, 'How to Throw Away 133 fewer Batteries This Year'.

Many organisations have already learned this lesson. The US Environmental Protection Agency's Energy Star programme and logo communicates dual benefits of cost savings and pollution prevention benefits. The copy on the logo reads, 'Saving the Planet, Saving Your Money'. Similarly, ads for Addison Heat Pumps (US) promises consumers that they can lower their heating and cooling bills in addition to minimising environmental impacts of fossil fuel based energy use. An ad from Kyocera (US) announced that the 'Savings Just Begin with Energy Star.'

All of these ads illustrate an important point about hte power of green marketing: the enviornmental benefits reinforces overall product quality and as such represents a source of 'added value' that can swing purchase decisions in a greener brands favour.

Educate and empower consumers

Consumers are concerned about the environment but as they have become more sophisticated, they require clear information about how choosing one product over another will benefit the environment. Consumer education results in their empowerment. Empowered consumers choose environmentally preferable products when all else is equal. Research from the Council on Office Products and the Environment (COPE, US) shows that there is a correlation

between knowledge of computers and likelihood of purchasing an energy-efficient personal computer (PC). In a COPE research study conducted in 1994, consumers who considered themselves 'very knowledgeable' about computers were more likely to buy an energy-efficient PC than those who did not consider themselves to be knowledgeable by a factor of three.

The credibility factor

Industry credibility suffered some debilitating blows over the past two decades when some businesses made unsubstantiated claims about environmental achievements. Eco-labels awarded by third parties are one approach to increasing credibility of environmental claims. These are now being offered by governments in about 30 countries around the world and the Organisation for Economic Cooperation and Development (OECD) has recently released a report discussing their affect on consumer behaviour. Although eco-labels have had only moderate success with individual consumers, they are having a greater impact on 'business to business' and government procurement practices and producers are increasingly making use of eco-labelling schemes. Germany's Blue Angel, America's Green Seal, Japan's Eco-mark are all signs that producers have opened their processes up for review, reinforcing their company's credibility in the eye of the consumer.

Businesses can also project credibility by being thorough – that is, by having a good environmental track record and by paying attention to details such as the use of recycled materials. Businesses should also be proactive. Leaders should take risks by advancing breakthrough environmental technology or by encouraging their company to be the first in the industry to sign voluntary environmental codes such as the CERES principles. Initiatives such as these should be effectively and strategically communicated to consumers in annual reports, in environmental reports, in stand-alone ads, and in media presentations – so that corporate image is enhanced and consumer trust is gained.

All claims should be accurate and based on scientific information. In 1991, Mobil suggested that their Hefty trash bags would biodegrade in landfills, and this cost them thousands of dollars in fines across seven states, not to mention lost credibility. The US Federal Trade Commission now offers guidelines for eight commonly used terms such as 'environmentally friendly', ozone safe' and 'made from recycled content.' Many in-house legal departments have also developed their own guidelines. However, guidelines for terms such as 'natural' and 'energy efficient' are not available. If no guidelines are offered for claims a company wants to make, it is best to be as specific as possible. All terms should be qualified and answer questions such as 'compared to what?', 'for how long?' or 'how much?'

The future

All of these factors contribute to 'business transparency' which will become increasingly important as green production and consumption evolve. Companies are likely, either due to regulation or voluntary action, to provide their customers with more and more information about their product's environmental impact so that they will be able to decide for themselves if a product suits their needs. Wellman (US) is already experimenting with this notion. An information tag attached to Wellman's recycled polyester fabric offers life cycle assessment (LCA) findings. Additionally, Tom's of Maine (US) toothpaste tubes identify not only all of the ingredients but also each ingredient's purpose and source. The CEO, Tom Chappell also delivers a signed letter on the side of all packages, telegraphing to consumers that a real person stands behind the claims.

Environmental marketing presents important opportunities for industry. Taking advantage of them requires creativity, foresight and environmental commitment. It means redefining the roles of business and products and working co-operatively with governments, consumer groups and NGOs. It may also mean a more visible role for CEOs. Products can certainly increase the 'quality of life', but their environmentally destructive impacts must be amended if we are to move towards sustainability. •

Special feature: eco-design websites

Edited by Iris V. van de Graaf

with additional research from Virginia Terry, Researcher, The Surrey Institute of Art & Design, UK

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
5627 KW Eindhoven
The Netherlands
tel/fax: +31 40 2428 483

O2 Global Network new homepage: http://www.hrc.wmin.ac.uk/o2/
e-mail: o2global@knoware.nl
mailinglist: http://ma.hrc.wmin.ac.uk/lists.o2global.db

'O2 News' will update readers of the Journal on the latest eco-design issues from around the world and on O2's national activities.

Eco-design update: web-sites around the world

http://www.ronald.jones.dk/mindovermatter/

Mind over Matter (MoM), Denmark

MoM is a future design resource for information and debate created by Niels Peter Flint and Sally Beardsley, and sponsored by the Danish Design Foundation. This interactive website focuses on the future and what it could be like if designers start to think 'out of the box.' The site is intended to be a platform for discussion and designers are invited to post papers, case studies and 'future scenarios.'

http://www.geocities.com/RainForest/3041/linkssd.html

Environmental Resources On-line, US

This site focuses on Sustainable Design and links to the Institute for Sustainable Design, the International Journal of Sustainable Development and World Ecology and Arcosanti, a sustainable city designed by Paolo Soleri. Another feature is Environmental Resources on-line which distributes weekly environmental news and updates mailed to members' email account.

http://www.insead.fr/Research/CMER/

The Centre for the Management of Environmental Resources (CMER), France

CMER is a unit covering corporate environmental management at INSEAD. Their site includes book chapters, published papers, reports and case studies related to issues including eco-design. CMER hosts events, conferences and workshops on a regular bases, which are listed on their events page.

http://www.home.sol.no/~martins/gripoo1.htm

GRIP Centre for Sustainable Production and Consumption

GRIP is a foundation financed by the Norwegian Ministry of Environment. The organisation's goal is to increase eco-effectiveness in Norwegian organisations, both public and private, by developing, testing and marketing methods that strengthen their competitive situation by increasing the amount of value they create per unit of environmental load.

http://www.cpm.chalmers.se/
Centre for Environmental
Assessment of Product and Material Systems (CPM), Sweden
CPM is a national competence centre at Chalmers University of Technology in Sweden. The overall goals are to gather and reinforce the Swedish competence within sustainable product development at a high international level; to provide industry and society with relevant methods and support for implementation of environmental aspects in decisions regarding products and materials. A major project being the establishment of an on-line life cycle assessment (LCA) database.

http://www.leidenuniv.nl/interfac/cml/lcanet/hp22.htm
LCANET European Network for Strategic Life Cycle Assessment Research & Development, Europe
LCANET is a network which focuses its efforts on 'state of the art' LCA methodology. The website serves as a platform for discussion of LCA research and development between European universities, research institutes, companies, non governmental organisations and the European Commission.

http://www.daedalus.edc.rmit.edu.au/
Centre for Design at RMIT, Australia
Eco-design, is one of the Centre's core areas of activity and comprises several innovative programmes and projects spanning the policy and practice of environmentally oriented product development. EcoReDesign(TM), is a national research programme aimed at minimising the environmental impact of manufactured products and maximising their competitiveness. The site also has information on product case studies, LCA, eco-design news-letters and eco-design events.

http://www.ie.uwindsor.ca/ecdminfo.html
Environmentally Conscious Design and Manufacturing (ECDM) Infobase, Canada
The ECDM Infobase is hosted by the Department of Industrial and Manufacturing Systems Engineering at the University of Windsor, Ontario. This site has a number of useful web-based links for the International Journal of Environmentally Conscious Design and Manufacturing including on-line abstracts from the journal, the internet mailing list, on-line courses and other eco-design links.

http://www.dfe.stanford.edu/
'Design for Environment' (DfE) at Stanford University, US
The sites give an overview of DfE activities in the Design Division of the Mechanical Engineering Department.

http://www.me.mtu.edu/research/envmfg/
Environmentally Conscious Design and Manufacturing Research Group (ECDMRG), US
ECDMRG performs research in a number of areas involving the creation, use and afterlife of products. Key interests include the design of environmentally friendly products and manufacturing processes, and the reuse, remanufacturing, demanufacturing and recycling of products. The site leads to detailed information on some of their current projects which include assembly/dissasembly of products for reuse, life cycle cost models, and eco-design guidance tools.

http://www.cfsd.org.uk
The Centre for Sustainable Design, UK
Provides information about CfSD's core programmes and activities in:
- sustainable product development and design
- manangement of eco-design
- design impacts of environmental communications
- education.

O2 text meeting

A text meeting is a meeting using e-mail. Everybody who wants to join should send a message to o2global@knoware.nl or subscribe on the www page:

http://advanced1.seneca.nl:520/~o2global/

During the meeting, he/she will then receive all the contributions that are sent by the attendees of the meeting and can discuss ideas further by sending new messages. •

Book

Ecological Design
Sim Van der Ryn
and Stuart Cowan
Island Press,
Washington DC, USA
1996
201 pages
paperback edition £12:50

One of the difficulties in writing about ecological and sustainable design is 'scale'. Specific issues related to a particular design project have to be understood within the context of a plethora of wide ranging, interrelated issues at the global level. These wider issues include the natural environment, society, culture, and human values. Detailed design interventions not only have to be seen against the complex background of these broader considerations, their contribution, significance and validity have to be made clear while simultaneously being dwarfed by the sheer magnitude of the problems. Thus, contextualising 'design' in ecological and sustainable terms is a precarious balancing act between the large and the small, the general and the specific. In Ecological Design, Sim Van der Ryn and Stuart Cowan have achieved this in a way which is scholarly, insightful and reflective. They also write in a straightforward style, using plain English rather than academic hyperbole, a virtue not always evident in contemporary design writing.

The authors define ecological design as 'any form of design that minimises environmentally destructive impacts by integrating itself with living processes.' This is accomplished, in part, by bringing together expertise from many disciplines which, traditionally, may have rarely been associated. Ecological design, it is convincingly argued, is an integrative and ecologically responsible approach which 'provides a new way of thinking about design.'

The first part of the book, entitled 'Bringing Design To Life' provides an overview of sustainability and design, a summary of the underlying principles and philosophy of ecological design, and an examination of the processes of nature and design principles which link different levels of scale.

The foundations and meanings of ecological design and sustainability are explained clearly and concisely without resorting to 'doom and gloom' statistics and scenarios. While the destruction caused by our present practices is fully acknowledged, the general tone is positive, forward-looking and inspiring. And so rooted in basic common sense (or perhaps uncommon wisdom) that it is humbling to realise that we have become so self-oriented, apathetic and/or short-sighted that our approaches to design, business and life in general are so out of kilter with what we ought to be doing.

The meaning of sustainable development is much richer and much more unsettling than meeting 'the needs of the present without compromising the ability of future generations to meet their own needs.'[1] In fact, the 'technological sustainability' implied by 'Our Common Future', from which the above quote is taken, is, thankfully, given short shrift by Van der Ryn and Cowan. Their approach is both refreshing and much more profound, going to the heart of our

crisis and locating its roots and its solution in the human condition – in human values, human relationships, and knowledge and understanding of place and nature. The work of David W. Orr is referred to in summarising the characteristics of ecological sustainability. These characteristics include a recognition of the fallibility and limitations of people – factors which seem to be less willingly acknowledged in the 'technological sustainability' approach. Human scale, local initiatives and traditional knowledge are other essential ingredients, together with a recognition of nature as 'the best model we have for all the design problems we face'.

In reading some of the observations in this book, with well considered and juxtaposed examples, the foolishness of our current ways of doing things becomes only too clear. 'Design' is identified as a central ingredient because it is the manifestation of an epistemology, of 'what is most valued in our culture.' It is our cultural values and concomitant 'myopic design' which have led to our present predicament, and so it is cultural values and design which have to change.

The authors describe ecological design as 'a form of engagement and partnership with nature that is not bound to a particular design profession. While we've often done well in applying design intelligence to narrowly circumscribed problems, we now need to integrate ecologically sound technologies, planning methods, and policies across scales and professional boundaries.'

A brief history of the development of ecological design is followed by a consideration of nature's processes and 'scale linking'. The interconnectedness across scales, which occurs in nature, is used as an organising principle for considering ecological design. The argument is made that much of our present crisis is a result of this organising principle being ignored. Interventions such as storm drains, instead of natural drainage, sewage treatment plants instead of utilising wetlands, and the use of imported rather than indigenous materials, are just a few of the examples given to illustrate how our ways of thinking, and our ways of designing, work against rather than with nature, and tend to ignore connections between the levels and scales within the environment. A strong case is made for reassessing our approaches to design and adopting an approach which takes into consideration the 'whole;' an approach which, potentially, would overcome many of the flaws in our hitherto fragmented processes and procedures, and which would start to integrate our actions with the natural environment.

The second part of the book, entitled 'The Ecological Design Process' begins with a design example, the 'compost privy'. This example is used to illustrate the authors' five principles of ecological design:

- solutions grow from place – designs should be locally appropriate rather than being based on standardisation and centralisation.
- ecological accounting informs design – in conventional design economic costs are carefully analysed, in ecological design environmental costs also have to be carefully analysed.
- design with nature – by incorporating natural processes the environmental impacts of our designs can be significantly reduced.
- everyone is a designer – involving the community and listening to people, as part of the design process, breaks down the traditional distinctions between designers, clients, users, etc.
- make nature visible – design can be conducted in ways which allow people to be aware of the processes and this encourages mindfulness and a sense of responsibility.

Each of the last five chapters of the book is dedicated to a discussion of one of these five design principles. 'Solutions grow from place' includes a discussion of sustainability in traditional cultures, the value of local knowledge and the importance of designing for place. There are many astute observations, which again and again call into question our current approaches to, and pace of, design education and design practice:

> 'Local knowledge is best earned through a steady process of cultural accretion.'
>
> 'Humble local acts, each respecting the whole web of life, add up to a sustainable culture.'

The subsequent chapters are peppered with numerous examples which illustrate alternative approaches to design and, explicitly and implicitly, challenge our conventional techniques and procedures.

References
1 Our Common Future – The World Commission on Environment and Development (Oxford University Press, Oxford, UK, 1997, page 42).

This is a thought-provoking and inspiring book which clearly articulates the ethos of design for a sustainable future. However, if you are looking for a 'how to...' manual for ecological design then this book isn't it. In fact, read this book to find out why there can never be a 'how to...' manual for ecological design – to produce such a book would be to continue what the authors term 'dumb design.'

Exhibition

'Challenge of Materials' gallery
Science Museum
London
SW7 2DD
UK
✆+44 (0)171 938 8080
Open every day 10am – 6pm
Adult admission £5.95

The major new 'Challenge of Materials' gallery at London's Science Museum is a celebration of strange (and often beautiful) material qualities, an exploration into the make-up of materials, and a showcase for their uses, often outlandishly presented. The exhibits range from a spectacular glass bridge to a wire wedding dress and an inflatable, rubber, lip-shaped seat. As well as focusing on the materials themselves, the exhibition grapples with the environmental implications of their production, use, reuse and eventual disposal, bringing together the material world and environmental responsibility.

The 'Challenge of Materials' gallery was recently voted Design Week's Gallery of the Year 1997. As a permanent gallery, it plays a key role in furthering the Science Museum's main aim, increasing the public's understanding of the history and contemporary practice of science, medicine, technology and industry. The Museum has approximately 1.5 million visitors a year.

One of the major exhibits in the new gallery which examines the environmental implications and issues surrounding materials is a touch screen 'interactive' computer-based exhibit which challenges visitors to design a T shirt, with minimal environmental impact. The visitor is invited to make design decisions at six steps within the life-cycle. He or she firstly selects a fibre type for their T shirt and then, by choosing from a range of predetermined options, continues their selections through dyeing, printing, laundering (washing and ironing) to final disposal.

The interactive exhibit is based on research undertaken by the Museum by the Textiles-Environment-Design project at Chelsea College of Art and Design, London, UK. The project's aim was to raise awareness of environmental issues surrounding textile production, use and disposal. Furthermore, the 'Interactive' aims to challenge commonly held preconceptions such as the belief that natural fibres necessarily cause less environmental damage than synthetic ones, and it seeks to show that environmental impacts, associated with the entire life of a textile garment, have to be considered.

The 'Interactive' is based on an abridged life-cycle study, which focused on the six stages mentioned above in relation to three fibre

types: cotton, polyamide (nylon) and viscose, which represent the contrasting groups of natural, synthetic and regenerated fibres. The environmental impacts resulting from the study were numerous and involved highly complex inter-relationships of resource use, energy consumption and waste emissions. These impacts had to be translated into simple concepts without trivialising key issues, as the average Science Museum audience is aged between 8 and 12.

The result is a fun, five minute journey through the life of a T shirt which concludes with a part qualitative, part quantitative environmental assessment of the T shirt design. The assessment does not directly compare the environmental credentials of the varying fibre types, but attempts to communicate the enormously wide-ranging impacts associated with textiles in production, use and disposal.

Communicating its environmental message through clever imagery, the 'Interactive' lights up as the visitor approaches the installation, capturing their face on-screen and pasting it on top of a Monty Python-style animated body. Both these images and the accompanying text used throughout the 'Interactive' were developed and tested carefully so as to avoid racial and gender stereotypes and visitor prejudice about certain terminology and environmental impacts of specific fibres. Research showed, for example, that if visitors had to select a fibre type for their T shirt from named fibres, nine times out of ten they would select a natural fibre (normally cotton) in an attempt to be environmentally friendly. This led to the 'Interactive' being organised in such a way so as to encourage impartial selection: the visitor makes a choice about fibre-type for their T shirt from a textures box of tree anonymous fabric swatches.

As the visitor, role playing as responsible designer, negotiates each step of the life-cycle, the environmental impacts accrued flash up on screen. The 'Interactive' gives a cumulative measure of water and energy consumption, illustrated by icons: 100 litre bath-fulls of water and televisions which light up when the energy consumed by the T shirt is equivalent to that of a day of continuous TV watching. The display also includes a non-numerical environmental summary of plus and minus points which draw attention to a range of impacts from useful by-products to less desirable greenhouse gas emissions. In the final screen, the visitor can reassess their design, compare it to two others and then re-run the programme, modifying their design choices. The grand finale sees the T shirt (still with the visitor's face intact) appear at a fashion show, strut down the catwalk to audience applause and photo flashes of the fashion paparazzi.

All that is remaining is the conclusive challenge of transferring the message of the 'Interactive' to the designers and producers in the real world. Media like the Interactive are useful for communicating information in a museum setting, but with the many limitations of time and complexity, a Museum-based information tool can only touch on some of the many environmental and cultural implications of designing, making and using fabrics. The next step would be to design a more sophisticated tool for different interest groups and one which allows a wider range of inputs to enable a better two-way transfer of information.

Kate Fletcher is a researcher and lecturer in environmentally responsible design in the textile sector.

DIARY OF EVENTS

Managing eco-design 1: online conference

Managing eco-design 2: online conference

Textiles, design and environment: online conference

Towards Sustainable Product Design 2: online conference

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The Surrey Institute of Art and Design
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19 May 1998

Sustainable technologies for a cleaner world
London, UK

✉ Jeremy Spandler
The Waterfront Conference Company
9 Grosvenor Gardens
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29 May 1998

Marketing, design and environment workshop
Surrey, UK

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June 1998

Next generation eco-design tools workshop
Surrey, UK

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2–4 June 1998

ET '98
Birmingham, UK

✉ Joanne Bowyer
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9–12 June 1998

Environmentally friendly refrigeration '98
Beijing, China

✉ Mr Liang Liang
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Room 109, Hui Zhi Office Building
No. 68, Xue Yuan Nan Lu
Haidian District
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email: onis@Public3.bta.net.cn

17–21 June 1998

1st international Factor 4+ congress and trade fair congress
Klagenfurt, Austria

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tel +43 463 56800 61
fax +43 463 56800 39
email: ktnmessen@mail.carinthia.co.at

2–3 July 1998

Eco-management and auditing conference
Sheffield, UK

✉ The Conference Manager
ERP Environment
POP Box 75
Shipley
West Yorkshire BD17 6EZ
UK
✆ +44 1274 530408
fax +44 1274 530409

26–28 August 1998

NordDesign '98
Stokholm, Sweden

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31 August – 4 September 1998

Cleaner production and sustainable product development Summer course
Amsterdam, The Netherlands

✉ Brigette Hertz
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1007 Rb Amsterdam
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16–18 September 1998

Life cycle design '98 5th CIRP seminar on life cycle engineering
Stockholm, Sweden

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16–18 September 1998

5th international seminar on life cycle engineering
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17–18 September 1998

Buisness strategy and the environment conference
Leeds, UK

✉ Conference Manager
ERP Environment
PO Box 75
Shipley
West Yorkshire BD17 6EZ
UK
✆ +44 1274 530 408
fax +44 1274 530 409

23–25 September 1998

Euro Environment 98 conference and exhibition
Aalborg, Denmark

✉ The Conference Manager
Aalborg Congress and Kulter Centre
Europa Plads
PO Box 149
DK 9100
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email: euro@akkc.dk,

30 September – 2 October 1998

Environmental engineering and management conference
Barcelona, Spain

✉ Liz Kerr
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October 1998

Towards Sustainable Product Design 3 conference
incorporating
Managing eco-design 3 conference
London, UK

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26–28 October 1998

Green Building Challenge 98
Vancouver, Canada

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16–19 November 1998

CARE Innovation '98 International Symposium and Brokerage event
Vienna, Austria

✉ Mr Bernd Kopacek
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A-2700 Wiener Neustadt
Austria
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fax +43 2622 27367 22
email: care_vision_2000@magnet.at

25–27 November 1998

Third international conference on ecobalance
Tsukuba, Japan

✉ Ms Shoko Tsuda
Ecomaterials Forum
The Society of Non-Traditional Technology
Kotohira Kalkan Building 3F
1-2-8 Toranomon
Minato-ku
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email: mitoh@snet.sntt.or.jp

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.

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

Author, A., and B. Author, 'Title of Journal Article: Subtitle', in Journal, Vol.x No. x (January 19xx), pp. xx–xx.

These should be listed, alphabetically by author surname, at the end of the article.

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