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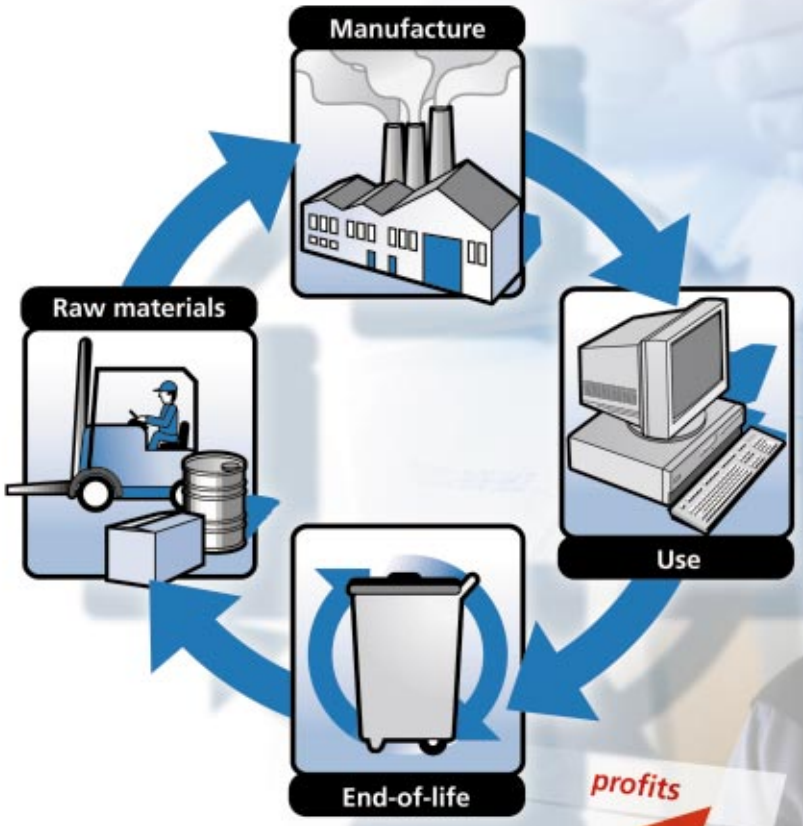
GG294

Cleaner product design: an introduction for industry



Cleaner product design: an introduction for industry

This Good Practice Guide was produced by Envirowise

Prepared with assistance from:

Cardinal Environment Ltd

Summary

Cleaner product design (cleaner design) is the design of a product to minimise its environmental impacts over its entire lifetime and to satisfy customer requirements. The result is often a product that is cheaper to make and to use. Cleaner design involves identifying how a product gives rise to environmental impacts during its life-cycle (raw materials, manufacture, distribution, use and end-of-life) and then investigating how these impacts can be reduced through design.

A product's environmental impacts can be reduced by addressing ten key considerations. The goals of cleaner design include reduced raw material use, elimination of hazardous materials, reduced use of energy and water, less pollution and waste, increased service life and greater potential for recycling. The aim is to achieve all of these without compromising efficiency, performance and quality.

Cleaner design can be incorporated into the traditional design process and can be applied to the redesign of existing products or the development of new products. The cleaner design cycle aims to promote continual improvement and involves four elements: researching the product; identifying cleaner design priorities; designing the cleaner product (function and form); and design review.

The potential benefits of cleaner design include:

- lower production costs;
- improved product function and quality;
- increased market share;
- improved environmental performance;
- improved relationships with customers and suppliers;
- continued compliance with legislation;
- easier disassembly and increased potential for recycling;
- longer product design life.

This Good Practice Guide is intended to help companies of all sizes to assess the opportunities for cleaner design for their products and to integrate cleaner design into their normal design process. The Guide explains what cleaner design is, the benefits of carrying out cleaner design and what it involves. Checklists are provided to help companies to plan and implement a cleaner design programme. Sources of further help and information on cleaner design tools are also given. A companion Good Practice Guide (GG295) *Cleaner Product Design: Examples from Industry*, describes the different ways in which nine well-known companies have implemented cleaner design.

Contents

Introduction

This Good Practice Guide aims to introduce directors and managers - particularly those in small to medium-sized enterprises (SMEs) - to cleaner product design. Cleaner product design (cleaner design) is the design of a product to minimise its environmental impacts over its entire lifetime. This will help to reduce costs, increase market share and improve both functional and environmental performance. Cleaner design is sometimes referred to as 'Ecodesign' or 'Design for the Environment'.

There is more than one way that a company can implement cleaner design. This Guide outlines the basic principles involved and some of the potential solutions. These include raw material selection, reduced raw material use, lightweighting, more efficient distribution and use, improved potential for recycling and reduced end-of-life impacts. Different projects will involve some or all of these considerations to a greater or lesser extent.

The Guide aims to help companies to evaluate their products, assess opportunities for implementing cleaner design and incorporate it into their normal design process, rather than give advice on how they should design their products.

This Guide explains what cleaner design is, the benefits of carrying out cleaner design and what it involves. Checklists are provided to help companies to plan and implement a cleaner design programme. Sources of further help and information on cleaner design tools are also given.

A companion Good Practice Guide (GG295)[1] *Cleaner Product Design: Examples from Industry* describes different ways in which nine well-known companies have incorporated cleaner design into their business. Although all these examples feature large companies, the thought processes, steps and issues are the same for all sizes of company.

> *'Cleaner design makes good business sense and is part of the company's overall commitment to contribute to sustainable development.'*
>
> ***Royal Dutch/Shell Group (Shell International BV)***

[1] See Section 6.1 for details of how to obtain a free copy.

Why carry out cleaner design?

Companies are being increasingly driven to improve their environmental performance by:

- stricter product-related environmental legislation;
- the need to meet changing customer requirements;
- the need to maintain and increase market share;
- supply chain pressure;
- the need to cut production costs.

On average, 80% of a product's overall cost is a consequence of its design. It is now widely accepted that this is also the case for environmental impact. Cleaner design, therefore, offers significant opportunities to improve a company's overall financial and environmental performance.

Cleaner design has also been shown to produce significant business benefits. Research undertaken for Envirowise found that companies that had successfully undertaken cleaner design considered it an integral part of good business practice. They stated that cleaner design had helped them reduce costs, maintain competitive advantage and demonstrate the benefits arising from their environmental policy.

Generally, the potential benefits of cleaner design include:

- **Reduced production costs** by creating product designs that call for less material, energy or water during manufacture.

> *'Cleaner design has led to a definite reduction in raw material and production costs, and improvements in production efficiency.'*
>
> ***The Boots Company plc***

- **Product compliance and appropriate design life** by creating product designs that meet the requirements of existing and future legislation, eg easier disassembly and increased potential for recycling.

> *'Care in material selection can help to future-proof the company against, for example, future legislative changes.'*
>
> ***Tetra Pak (Carton Packaging Division)***

- **Improved customer satisfaction and increased market share** through delivery of:
  - better quality or more efficient products with reduced running costs, for example, through reduced water and energy use;
  - products with reduced environmental impacts during their life-cycle, for example, through reduced use of hazardous materials.

'Benefits (although hard to quantify) have been customer appreciation and enhanced company profile.'

Volvo Car Corporation

Two smaller companies benefit from cleaner design

Varian Medical Systems UK Ltd foresaw that new legislation on waste electrical and electronic equipment would increase its production costs unless it adopted a fundamental change to the way it developed its products - from design onwards. A convincing business case was made for the introduction of cleaner design to reduce production costs and to maintain the company's competitive advantage. Cleaner design allowed the company to achieve significant cost savings and productivity benefits. For more information, see Case Study (NC201) *Electronic Equipment Manufacturer Benefits from Cleaner Design* and its companion Report NR201.

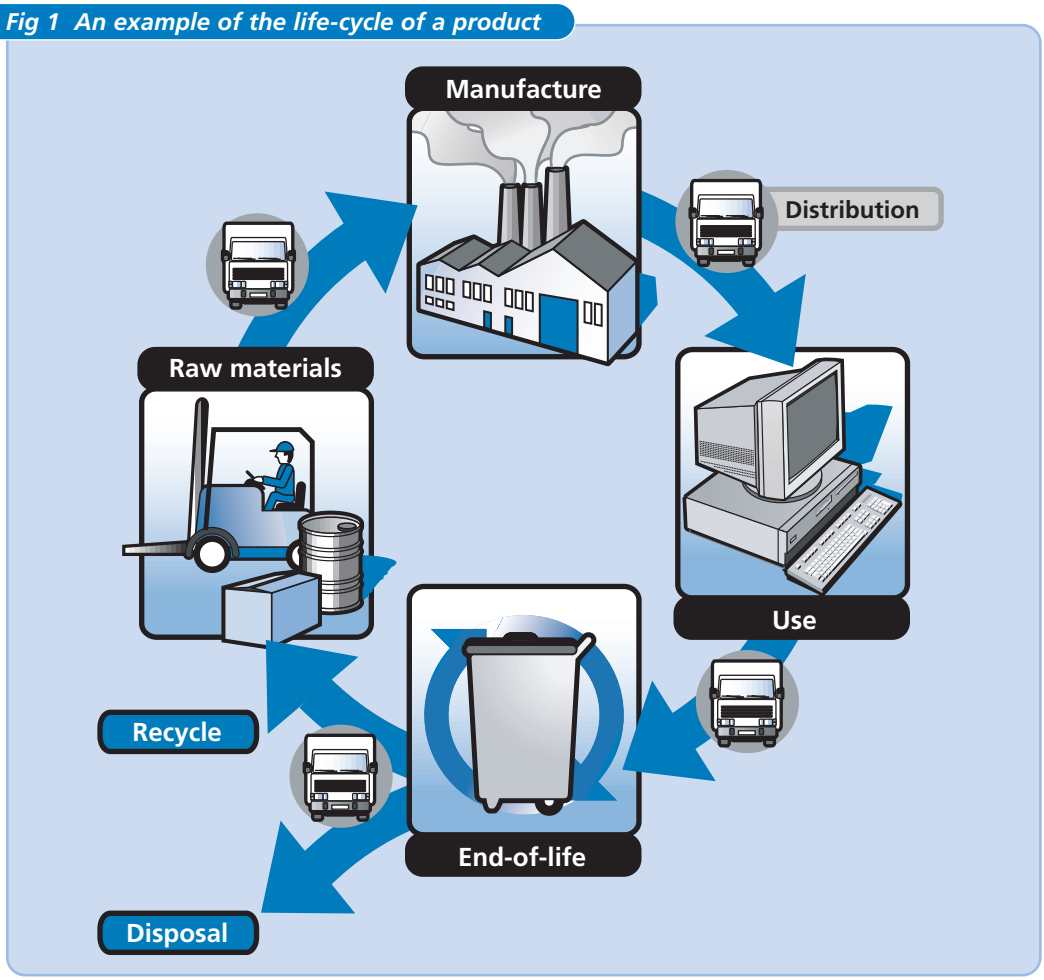
As a first-tier supplier to the automotive industry, Continental Teves UK Ltd faced increasing pressure to reduce costs and to provide its customers with evidence of its environmental commitment. Cleaner design provided a way of addressing these issues within the context of overall good management. For more information, see Case Study (GC236) *Driving Down Waste Puts the Brakes on Costs*.

Copies of GC236, NC201 and NR201 are available, free of charge, through the Environment and Energy Helpline on freephone 0800 585794 or via the Envirowise web site at www.envirowise.gov.uk

What is cleaner design?

Cleaner design involves satisfying your customers' requirements (and optimising the function delivered to them), whilst using the minimum amount of resources and creating the minimum amount of environmental impact over the product's life-cycle (see Fig 1).

Fig 1 An example of the life-cycle of a product



Your products use materials and energy and, in most cases, produce waste at each stage of their life-cycle. Transport is usually involved between each stage; this also uses materials and energy, and produces waste. The life-cycles of most modern products are complex, but most of their environmental impacts usually arise from just a few key characteristics.

One of the aims of cleaner design is to move from the traditional linear approach to product life (manufacture, use, dispose) to a more cyclical approach that allows material to be re-used or recycled at the end of its life. This reduces the burden of extraction from natural resources, and reduces the amount of waste disposed of to landfill.

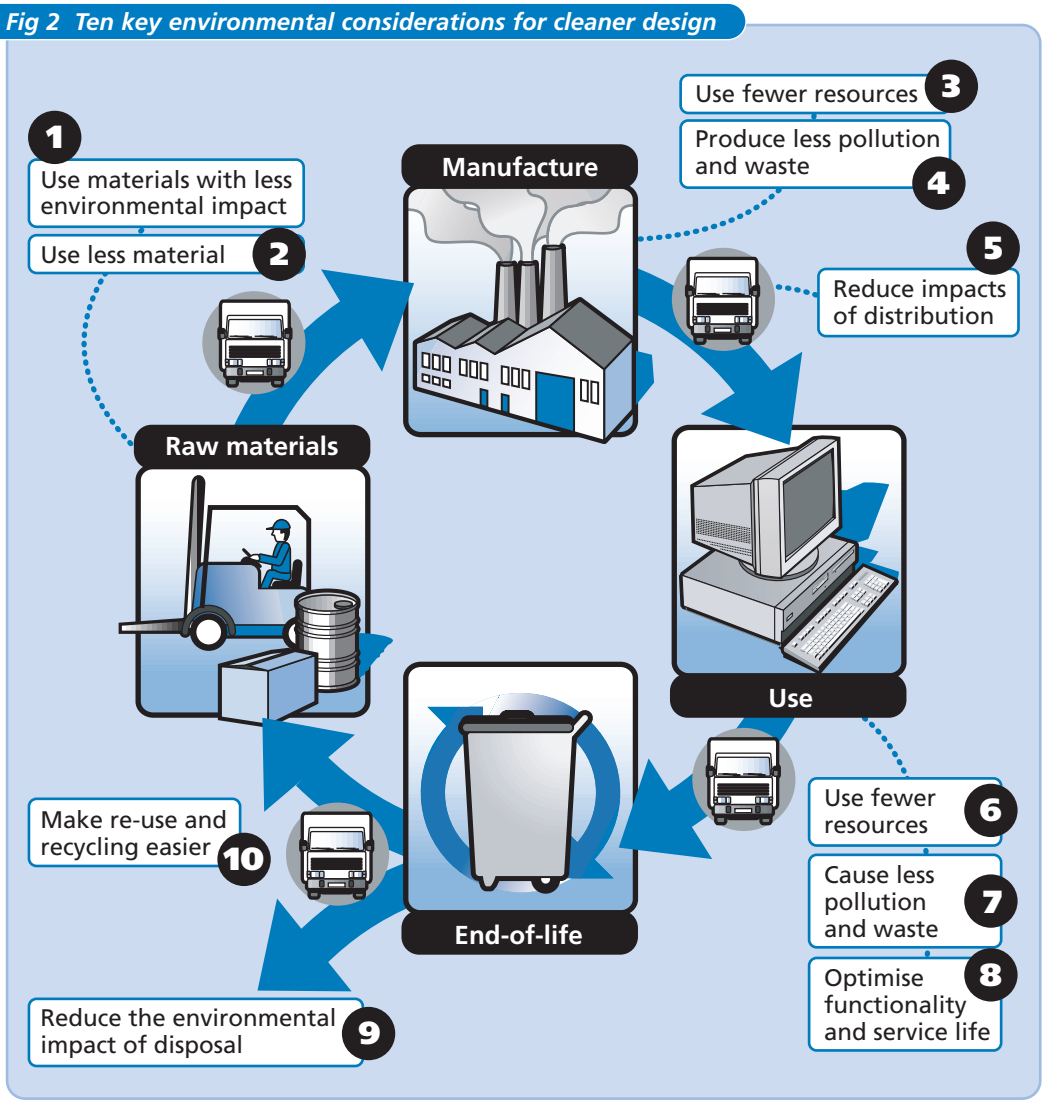
When designing a cleaner product, you need to consider whether improvements can be made at each stage to reduce the environmental impact over the entire life-cycle. In some cases, this may require the use of tools such as life-cycle assessment (LCA). For an overview of LCA, see publication (ET257)[2] *Life-cycle Assessment - An Introduction for Industry*.

[2] See Section 6.1 for details of how to obtain a free copy.

3.1 Key environmental considerations

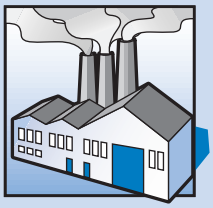
The environmental performance of your product can be improved by taking account of ten key considerations covering the various stages of the life-cycle (see Fig 2). These considerations can help you to identify design priorities and to focus on areas that will reduce costs and environmental impact. Section 4 explains how to incorporate these key considerations into the design of your product.

Fig 2 Ten key environmental considerations for cleaner design



3.1.1 Raw materials

- **Use materials with less environmental impact.**
  - Using renewable materials and recyclates instead of materials from limited deposits will reduce resource depletion and create opportunities and markets for using waste, thus diverting it from disposal.
  - Using materials that have less environmental impact during their production, eg using less energy or causing less pollution, will reduce the product's environmental impact and could also reduce the need for expensive controls during production.
- **Use less material.**
  - Reducing the amount of material used to make the product will in turn reduce resource use, the transportation of material and the amount of waste when the product is eventually discarded.



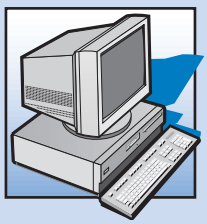
- Using fewer hazardous materials, or reducing the amount used, may reduce the environmental impacts and costs associated with the raw material itself, product manufacture and product disposal.

3.1.2 Manufacture

- **Use fewer resources.** Designing the product so that the manufacturing process uses less process materials, energy, water and other resources will reduce the adverse environmental impacts of production and increase your efficiency.
- **Produce less pollution and waste.** Designing the product so that less pollution and waste occur during its manufacture will reduce local environmental impacts and may lead to safer working conditions for your employees.

3.1.3 Distribution

- **Reduce the impacts of distribution.** Reducing the weight and volume of packaging and designing the product's transport and storage to use less energy and to produce less waste and pollution will reduce environmental impacts and costs. Using robust packaging that can be re-used may also bring cost and environmental benefits.



3.1.4 Use

- **Use fewer resources.** Designing the product so that its use and maintenance require less materials, consumables, energy and other resources will reduce the adverse impacts of the product and the costs of using the product, eg electricity and water consumption.
- **Cause less pollution and waste.** Designing the product so that it causes less pollution and produces fewer emissions and less waste will reduce its environmental impact during use.
- **Optimise functionality and service life.** Useful functionality reduces the need for additional products or resources to achieve the same task and can make the product more efficient to use. Giving the product a longer service life will require fewer products to be manufactured, thus reducing the pollution associated with product production, delivery and disposal.

3.1.5 End-of-life

At the end of its 'first' life, your product (or parts of it) may be re-used, remanufactured, recycled[3], destroyed in an incinerator to recover energy or disposed of to landfill.

- **Make re-use and recycling easier.** Re-using, remanufacturing and/or recycling all or part of the product can significantly reduce raw material use and divert material away from limited landfill space.
- **Reduce the environmental impact of disposal.** Where re-use or recycling is not achieved the product is disposed of. Landfilling the product consumes limited landfill capacity and, depending on the material content, poses potential toxicity problems to land, watercourses and groundwater, eg through chlorinated solvents in landfill leachate. Incineration with energy recovery provides an alternative 'disposal' option for the product, although it requires control systems to reduce emissions. The product can be designed to minimise these impacts.

These key considerations provide a useful checklist when thinking about the cleaner design of your product. However, to design a cleaner product the impacts should be considered together, over the whole life-cycle.

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[3] See the Glossary in Appendix 1 for definitions of these terms.

Compromises will always need to be made, for example, in the form of trade-offs between different environmental impacts, and there may not be one clear solution to your new cleaner design. For example, some factors, such as material toxicity, affect all stages of the life-cycle, whilst the two goals to increase service life and reduce material use may need to be rationalised during the design process. Section 4 of this Guide aims to help you consider all the appropriate issues and prioritise those which offer the greatest potential for environmental and functional improvement.

What does cleaner design involve?

4.1 The design process

Although product design processes vary, most companies follow a general pattern including at least some of the following stages:

- **Market demand or opportunity.** The demand for a new product is identified, and its position in the market is considered in general terms. This stage, which is often informal, usually produces general concepts and specification of key features.
- **Concept development.** The commercial and technical benefits and the feasibility of the initial concept are examined. Alternative approaches to meeting the market need are evaluated, and probably one or two will be taken forward into detailed design. If product design is contracted out to a specialist design house, then this stage may simply produce a design brief or specification.
- **Detailed design.** This stage produces full details of the product or service. It defines both form and function and will also determine other issues such as efficiency and service requirements. It usually produces detailed documentation to allow the development of prototypes.
- **Prototype.** Prototypes allow various aspects of a design to be tested and assessed. The product may then be amended and improved in the light of the findings.
- **Testing the final design.** Before the design enters normal production, trials are carried out to check that the final design meets its specification under a range of circumstances.
- **Production.** The product is put into full-scale production and its performance monitored.
- **Review.** At each stage of the process, feedback from customers and/or from production, sales and marketing personnel is obtained. The design may be modified subsequently; for some products, design modification may be an almost continuous process leading to regular upgrading of the product.

4.2 The product/service concept

Consideration of the customer's requirements is key to the development of a new product or service.

- Is it the product itself or the function provided by the product that which the customer wants or needs?
- What does the customer really value in the product?

If your customer buys a product to fulfil a specific function, consider the best way of delivering that function. This may lead to new approaches using a radically different system. If it is a service that the customer requires, then perhaps leasing is the best way forward. For example, some office equipment can be leased to provide a service rather than purchased as products. In this business model, the equipment is designed to have a long life and be easy to service. It is also designed to maximise remanufacture and recycling potential, and to minimise disposal costs.

Focusing on what customers value in a product can help both product design and delivery mechanisms. For example, do companies want to buy mobile phones or do they want the ability to communicate with staff while they are out of the office? Getting customer feedback can help ensure new products and services meet their needs.

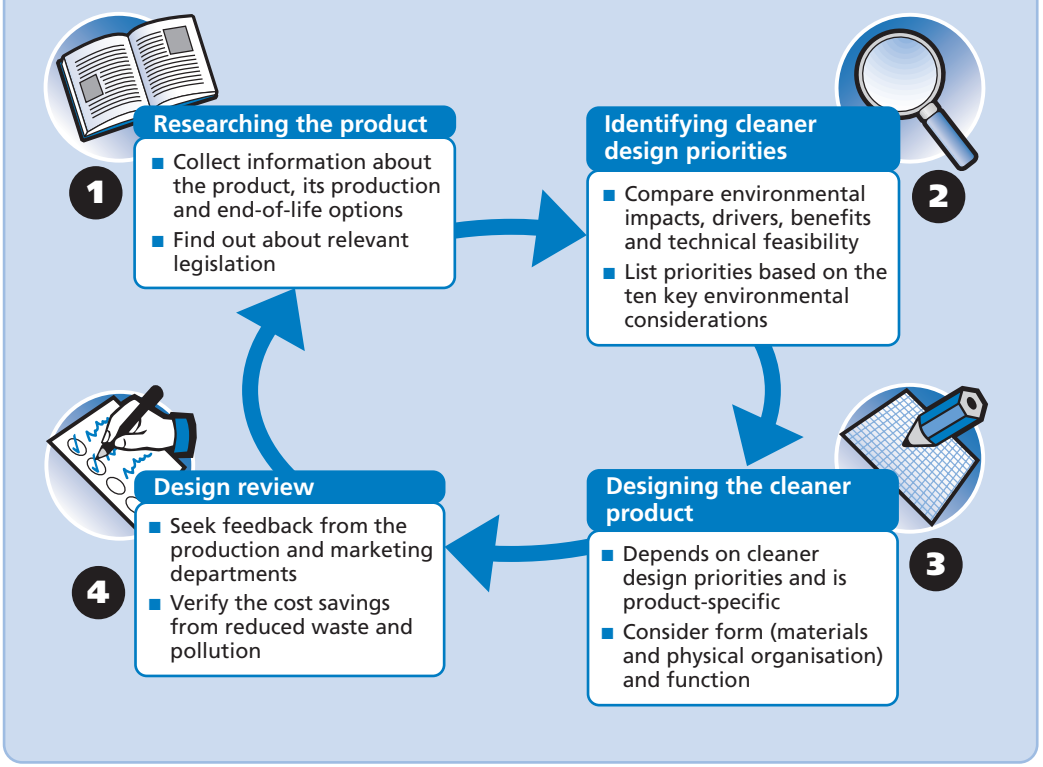
Service benefits the environment and saves money

Interface Europe Ltd developed a service based on the principle that companies require their floors to be covered, rather than to own the covering. By providing a service to replace worn carpet tiles, Interface enables its customers to keep their floors covered in good condition without having to replace the whole carpet. Interface retains ownership of the product throughout its life. The service reduces material use, costs and waste and gives customers the function they want.

4.3 The cleaner design cycle

The decision-making process for cleaner design has four elements in a continual improvement process (see Fig 3). More than one cycle may be undertaken before your product reaches the marketplace. Alternatively, the design process may be covered by one cycle, which begins again to take account of new drivers for redesign such as feedback from customers or the sales department.

Fig 3 The cleaner design cycle



The aims of this decision-making process are to:

- improve product environmental performance;
- reduce life-cycle impacts;
- increase market share;
- reduce costs.

The work involved in the four elements of the cleaner design cycle is described in more detail below.

4.4 Researching the product

4.4.1 The aim of your research

The design of any product must meet the demands of the intended market and the requirements of relevant legislation. In addition, it is important to understand the properties of the materials and processes used in its manufacture. In cleaner design, it is also necessary to know about the environmental impacts of the materials used, the manufacturing process, the product's use and the product's disposal at the end of its life.

The aim of your product research is to understand which aspects cause the greatest environmental impacts and how these may be addressed.

4.4.2 What information do you need?

Information is required for the ten key considerations (see Section 3.1 and Fig 2). Identify the main issues for each, the quantity per unit product, the main concerns associated with them and opportunities for improvement. For example, the main issues associated with the amount of raw material used are likely to be the heaviest components. The issues associated with waste and pollution during use may be material waste, harmful emissions or liquid waste, and the amounts of these created per product should be estimated.

Checklist 1 provides a template to help you get started on collecting the information you need. Fig 4 shows part of a completed version of this checklist for an electronic product, while a blank version is given in Appendix 2 for you to use and adapt to your particular needs.

- The level of detail researched will depend on your resources and objectives.
- Use the tools and sources of information suggested in Section 4.4.3 to help you obtain sufficient results for your needs.
- After initial investigations, you may want to reduce the scope of your detailed analysis by setting cleaner design priorities (see Section 4.5).

You may find that this information-gathering activity will identify other opportunities, unconnected with cleaner design, to innovate or to modify existing products.

Fig 4 Example part of a completed checklist for researching an electronic product

Checklist 1: Researching the product

	Key consideration	Main issues (ie list different materials, resources and pollution)	Quantity per product (estimate if necessary)	Main environmental concern(s) (quantify if possible)	Ideas for improvements (set targets if desired)
Raw materials 	Amount (weight of) materials	Stainless steel frame	50 g	- Energy to produce - Pollution caused by nickel and chromium production	Reduce weight
		Plastic casing	150 g	- Energy to produce - Resource depletion - Toxic emissions in manufacture and disposal	Reduce weight by 30% Use recyclate or polymer from renewable resources
		Copper wire in cord	4 g	- Energy to produce - Scarce resource	Enable re-use/recycling
		Instructions (paper) etc	10 g	- Bleach or chlorine in production	Use bleach- and chlorine-free recycled paper or put instructions onto a web site
	Impact of materials (eg hazardous)	Lead solder etc	3 g	- Hazardous waste - Hazardous emissions and waste in manufacture	Replace with lead-free solder

Generic advice

- Set yourself realistic objectives for the scope and level of detail of your investigation.
- Carry out in-house investigations based on the template shown in Checklist 1 (see Appendix 2).
- Use existing company records, product specifications and other documents to carry out your own research.
- Dismantle your product to see how easy it would be to recycle. It may be helpful to follow the dismantling exercise and cleaner design checklist in Good Practice Guide (GG296)[4] *Cleaner Product Design: A Practical Approach*.
- Investigate the use of life-cycle assessment (LCA)[5], abridged LCA or product specific checklists. As more people research their products, more information is available on the main issues associated with different products or classes of products.
- Benchmark your product's environmental performance against previous products or competitors' products. If efficiency performance data are not displayed on the product, you can calculate energy and resource use using information given on the EPIC[6] web site (www.ukepic.com). When considering the product's performance, be careful to compare like with like, ie compared products should deliver the same function.
- Keep abreast of forthcoming legislation through journals, trade associations, business support organisations, etc or by contacting the Environment and Energy Helpline on freephone 0800 585794.
- Employ a consultant to help gather information, assess environmental impacts and identify the main concerns.
- Contact the Environment and Energy Helpline, as above, for information about typical resource use and waste generation in your sector.

'Use trade associations, libraries and consultants as information sources. Use consultants to keep the company up-to-date as it may be expensive to keep an in-house resource.'

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4 See Section 6.1 for details of how to obtain a free copy.

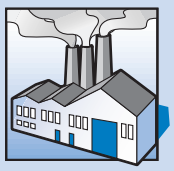
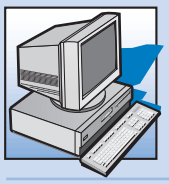
5 For an overview of LCA, see *Life-cycle Assessment - An Introduction for Industry* (ET257). See Section 6.1 for details of how to obtain a free copy.

6 EPIC (Environmental Product Information Consortium) is a product database developed by the Department for Environment, Food and Rural Affairs to act as a central source of environmental performance data on traded products for use by retailers, consumers and others. Initially, available data are for energy performance.

4.4.3 Life-cycle specific advice

Table 1 provides advice on how to assess environmental impacts relating to specific stages of the life-cycle of your product.

Table 1 Researching the product: life-cycle specific advice

Stage	Actions
Raw materials 	■ Talk to the suppliers of your materials and components. It may be difficult to obtain information about every part of every component. You may need to ask your suppliers to provide proof of the assertions they make or use a materials declaration list. ■ Collect information on possible material substitutes that are: - less hazardous; - from renewable or recycled sources; - produced with less environmental impact. ■ Identify materials databases that contain information on environmental impacts. ■ Ask the product design team about areas where material may be used more efficiently.
Manufacture 	■ Ask the production director for information and talk to operators about sources of unnecessary waste. ■ Calculate the resource consumption and pollution of different components or production processes. Can these be reduced by changing the product design?
Distribution 	■ Ask your dispatch department whether you could use less packaging, re-usable packaging or packaging with a lower environmental impact.
Use 	■ Look for ways of designing the product so that it lasts longer. A good place to start to identify weaknesses is to look at records of complaints and reasons for return. ■ Ask your customers about the product's efficiency and whether it has any redundant functions.
End-of-life 	■ Identify existing options for product re-use, recycling or recovery. Can these be improved?

Information and tools to help with many of these research tasks are described in Section 6.

Assessing the environmental impacts of a product

RMC Group plc aims to assess the environmental impacts of the manufacture, use and disposal of its products. The approach to the research for its autoclaved aerated concrete (AAC) product is described in Good Practice Guide (GG295) *Cleaner Product Design: Examples from Industry*.

4.5 Identifying cleaner design priorities

At crucial points in your design process, you will need to assess different cleaner design ideas and identify your priorities for creating a cleaner product.

Researching your product should have given you ideas about how it affects the environment and how you could create a cleaner product. You now need to decide which of these ideas to take forward. Prioritising effort early on will save time and money later.

When deciding which ideas to take forward, consider:

- the scope for environmental gain;
- compliance with existing and future legislation, eg legislation which increasingly places responsibility for disposal onto the producer is likely to come into effect over the next few years;
- the scope for direct cost savings;
- the scope for indirect cost savings, eg reduced waste treatment;
- the potential marketing benefit for the product and the company;
- the customer and supply chain relationship, eg increased satisfaction or closer working;
- progress towards achieving and conforming to your environmental management system (EMS);
- the work involved and the likely costs of implementing the change;
- the feasibility and risk involved.

The weighting you apply to these factors will depend on your company's own overall aims, strategy, market, product and circumstances.

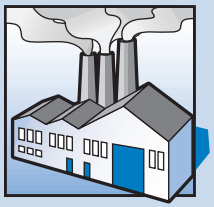
Use Checklist 2 (see Appendix 2) to help you to establish your company's cleaner design priorities for a particular product. This checklist is based on the ten key considerations described in Section 3.1. Rate the four factors in the checklist as 'high', 'medium' or 'low' importance for each key consideration. An example of a completed checklist for an electronic product is shown in Fig 5. Alternatively, you can use the checklist to score each factor for each key consideration on a scale of 0 - 10, based on quantitative or semi-quantitative information. Choose a method of scoring that best suits your company. Use your answers either as an initial screen (when the scope of work and the costs involved may be vague) or to focus your design priorities before finalising your business case.

When considering the scope for environmental gain, use the information gathered during product research (see Section 4.4). Information that you obtained about relevant legislation will also help you to identify any regulatory drivers.

Involving people with marketing, sales, design, production and environmental responsibilities in your decisions will also help to increase understanding of the cleaner design process and to obtain a cleaner design appropriate for your company.

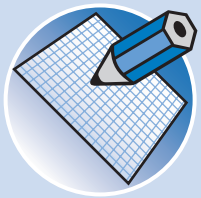
Fig 5 Example part of a completed checklist for identifying cleaner design priorities for an electronic product

Checklist 2: Identifying cleaner design priorities

	Key consideration	Scope for environmental gain	Legal drivers	Cost savings	Marketing advantage	Conclusion
Raw materials 	Use less material	HIGH - Reduce weight - Reduce number of components	LOW	HIGH	LOW	HIGH PRIORITY
	Use materials with less environmental impact	HIGH - Use lead-free solder	HIGH	HIGH	HIGH	TOP PRIORITY
Manufacture 	Use fewer resources	HIGH - Increase use of recyclates - Re-use of materials	MEDIUM/ HIGH	MEDIUM/ HIGH	HIGH	MEDIUM PRIORITY
	Produce less pollution and waste	HIGH	HIGH	HIGH	HIGH	HIGH PRIORITY

You may find that decision-support software tools help you to assess the options. One of the tools being developed to help companies make balanced decisions about the design and end-of-life management of their products is CHAMP (**Cha**in **M**anagement of **P**olymers). CHAMP provides companies with methods and tools to help them to select materials, products and processes with the least environmental impact over one or more life-cycles. It is applicable to all products, not just those containing plastics. Case Study (FP272) *Getting the Most from Plastics - a sustainable approach to materials management* describes the CHAMP approach and methodology, and gives examples of its use in industry.

FP272 and other tools and resources are available free of charge through the Environment and Energy Helpline on freephone 0800 585794.



4.6 Designing the cleaner product

The cleaner design priorities form a key part of your design strategy. These require implementation during the design stages of product development. Before embarking on a detailed design, it is important to have a scope of work in mind, with cost estimates or budgets.

Your cleaner design priorities may cover one or more of the ten key considerations (see Section 3.1 and Fig 2). There may be more than one way of achieving the desired outcome and there will be barriers to overcome in terms of function and form. Approaches to achieving the improvement in environmental performance and overcoming possible barriers are described below.

Use Checklist 3 in Appendix 2 to help you to summarise your design opportunities in relation to the environmental impact of your product.

4.6.1 Reducing the environmental impact from raw materials

Use less material

- Reduce the amount of raw materials used in the product by:
  - retaining the current form and reducing material use where possible (eg designing thinner sections or reducing the number of fixings);
  - changing the form specifically to reduce materials (eg miniaturisation).

Analyse how the product function is delivered and whether it can continue to be delivered with less material or even without the material at all. This can often be achieved, without compromising quality, through a more detailed understanding of how the product is used and through improvements in manufacturing technology. This process of lightweighting or dematerialisation will not only bring environmental benefits, it will also reduce your manufacturing and transport costs - thus increasing your profits.

Using less material per can saves £2.3 million/year

A lightweighting project at Coca-Cola Enterprises Ltd involved designing a new beverage can with a reduced end diameter. This saved over £1 per thousand cans and allowed the company to save £2.3 million/year in the UK alone. For more information, see Good Practice Guide (GG295) *Cleaner Product Design: Examples from Industry*.

Use materials with less environmental impact

Material substitution includes:

- eliminating or replacing hazardous substances;
- using materials that are renewable, recycled or more cleanly produced, eg recycled plastics and glass, timber produced from sustainable forests, textiles grown in organic agriculture systems and paper produced with fewer harmful additives.

> *'Use of recyclates can save material costs, but the company had to invest initially to stimulate post-consumer structures for material collection and processing.'*
>
> ***Ford Motor Company (Europe)***

To encourage change and to be certain what substances are present in a material or a component, ask your supplier for a detailed materials declaration. This requirement could become part of your contract with the supplier.

Finding out about the material content of products

The Ericsson Corporation developed and used a materials declaration tool to help its suppliers document the material content of its products. For more information, see Good Practice Guide (GG295) *Cleaner Product Design: Examples from Industry*.

External verification may be available to give independent confirmation of the production methods for cleaner materials, eg the Forestry Stewardship Council (FSC) provides certificates for renewable timber products.

Implementing cleaner design through material substitution

The development team at IBM has successfully replaced virgin polymer in the design of an existing high volume product with 100% recycled content resin, without compromising production.

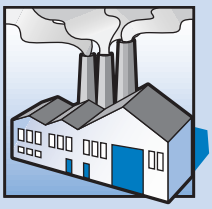
Nike Inc is committed to the substitution of organically-grown cotton for conventionally-grown cotton for yarn used in its basic T-shirt programme. Nike is supporting farmers to move to organic cotton production and has introduced a farm certification scheme.

The Volvo Car Corporation (VCC) has worked with its suppliers and contractors to eliminate the use of hazardous materials in its vehicles or vehicle components. VCC has developed a 'black' list of substances whose use is banned and a 'grey' list of substances whose use should be limited. VCC has recently adopted the Common Ford Motor Company list: Restricted Substance Management Standard.

These three Industry Examples are described in more detail in Good Practice Guide (GG295) *Cleaner Product Design: Examples from Industry*.

4.6.2 Reducing environmental impact during manufacture

Designing the product so that less energy, water and consumables are required during manufacture will not only improve environmental performance, it will also reduce operating costs.



'Minimising the number of manufacturing steps enables the company to stay in business by taking out cost while keeping functionality.'

Marconi Applied Technologies

Changing the product design to reduce pollution and waste during manufacture may involve:

- changing the shape of components to make them easier to machine or mould - thus generating less waste and using less energy;
- switching to materials that result in less waste and/or reduce energy consumption during manufacture;
- reducing or eliminating the use of hazardous materials;
- using a simpler design with fewer components: this will also reduce assembly time, thus achieving significant cost savings.

For example, changing the nature of machined components can reduce swarf production. Eliminating the use of lead solder or solvent-based adhesives will improve the working environment as well as reducing pollution. For more information on the use of lead-free solder see *Lead-free Solder: the Issues* (EN287) available free of charge through the Environment and Energy Helpline on freephone 0800 585794.

'It is useful to talk to operational people - they can see opportunities.'

Lattice Group

4.6.3 Reducing environmental impact during distribution

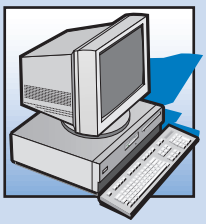
- Consider transport and storage, eg:
  - Does the product require refrigeration? If so, can storage be minimised?
  - Can the product be made close to the point of use?
  - Can the product be made in response to demand (ie minimum stock)?
- Use less material for packaging[7]. This can be achieved by:
  - Using packaging of the appropriate size.
  - Using returnable and re-usable packaging.
  - Redesigning packaging to protect vulnerable components only.
  - Labelling the product instead of the packet where possible. This advertising will last throughout its life.

'A focus on lightweighting and materials selection in packaging is essential to maintain profitability.'

Britvic Soft Drinks

[7] For advice on reducing packaging use and costs, contact the Environment and Energy Helpline on 0800 585794 or visit the Envirowise web site at www.envirowise.gov.uk

4.6.4 Reducing environmental impact during use



Opportunities to reduce pollution and resource consumption during the product's use may have been identified during your initial research (see Section 4.4).

General measures to reduce resource consumption, pollution and waste during use include:

- providing instructions on how to use the product efficiently;
- fitting better controls (automatic or manual) to optimise energy and material use;
- improving the insulation on hot or cold elements.

A product's functionality and service life can be extended through:

- more durable design;
- making it easier to repair and service;
- making it adaptable to different tasks, related either by the technology or by the function.

Although such features can increase the product's purchase price, the customer achieves long-term benefits from reduced energy and resource consumption. European Union labelling schemes on items such as refrigerators and washing machines are making customers more aware of the lifetime benefits of more efficient products. These benefits can form a core part of your marketing.

Customers informed about the lifetime costs of household appliances

The Electrolux Group has produced an electronic guide highlighting the amount of money customers could save by buying more energy-efficient appliances. The tool is designed to be used by potential buyers at retail premises. For more information, see Good Practice Guide (GG295) *Cleaner Product Design: Examples from Industry*.

4.6.5 Reducing environmental impact at end-of-life

The key to improving environmental performance at this stage of a product's life-cycle is to appreciate why it is no longer used and what happens to it. You can then make appropriate design changes to minimise the environmental impacts.

Make re-use or recycling easier

Re-using the product in its current form (ie without processing) is a way of extending its useful life. However, the product design needs to incorporate the requirements of subsequent uses. For packaging and containers, this may mean extra durability and the introduction of a re-use system.

Another key aim is to facilitate product remanufacture or recycling. Focus on:

- The physical organisation of the product, ie its structure and the way in which its components and materials are put together. Reducing the number of fastenings and making fastenings easier to undo will help to make the product easier to disassemble and recycle.
- The product's material content. The use of some materials, eg hazardous substances, makes reprocessing difficult.

'Minimising the number of materials in a product will make it easier to recycle.'

BTexact Technologies

There are also a number of other actions you can take to improve control of your product's final destiny, eg:

- label re-usable and recyclable components;
- use existing distribution channels to collect used products or components;
- keep up-to-date with developments in recovery and recycling;
- discuss ways of recovering and recycling your product with your trade association, waste management companies or companies offering similar products.

Reduce the environmental impact of disposal

For parts and components that will not be recovered, re-used or recycled, try to:

- reduce the volume;
- wherever possible (and appropriate), build in biodegradability;
- reduce or eliminate the use of hazardous materials in the product design.

Redesign for remanufacture and recycling

The document company, Xerox, has redesigned a photocopier component, the developer roll, as part of a programme to reduce production costs through greater re-use and recycling. On their first return to the factory, most of the developer rolls can be re-used directly in production. The rest are sent, together with second-life developer rolls, to the company's recycling facility. For more information, see Good Practice Guide (GG295) *Cleaner Product Design: Examples from Industry*.

4.7 Design review

Feedback from the production and sales departments throughout the design process is vital to confirm the manufacturability and the marketability of your cleaner products. This feedback may lead to modifications and contribute ideas for further cleaner design initiatives. It provides the impetus to begin the cleaner design cycle again and to achieve continual improvement.

4.7.1 Feedback from production

Ask the production manager for data on the performance of the new design during production on fully-operational equipment. Trials on existing manufacturing lines may lead to changes in production equipment, while further feedback will be needed when the new design is in full production.

Opportunities may arise to:

- improve the final product quality or increase production and assembly efficiency, eg through material substitution, reduced material use and design simplification;
- simplify the production process or increase line speeds;

- reduce packaging use;
- reduce waste, and energy, water and material use during manufacture.

4.7.2 Feedback from sales and marketing

Seek information from sales and marketing staff about any distribution issues and the market response to the cleaner product.

Use this feedback to:

- assess the robustness of the cleaner product and its packaging during distribution and storage;
- confirm the marketability of the cleaner design;
- analyse customer response to the product, eg which aspects of the new design are gaining a favourable reaction;
- identify areas where further development might be welcomed and areas where there may be customer resistance to change.

Cleaner design to meet market needs

The cleaner design programme operated by the Electrolux Group is intended to meet market demands and to deliver cost savings to customers by reducing energy and water consumption during the operation of its products. The programme includes a marketing and communications strategy to make customers aware of the connection between the product's environmental performance and cost savings. For more information, see Good Practice Guide (GG295) *Cleaner Product Design: Examples from Industry*.

Conclusion and next steps

Cleaner design involves incorporating ten key considerations (see Section 3.1) into the design of your product with the aim of improving its environmental impact over its entire life-cycle (raw materials, manufacture, distribution, use and end-of-life). You can incorporate cleaner design into your established product design processes or use it directly to drive a design project.

The drivers for cleaner design include:

- opportunities to reduce operating costs and thus increase profits;
- stricter and more product-related environmental legislation;
- new customer requirements and supply chain pressure for improved environmental performance;
- opportunities for brand enhancement and market development.

> *'One of the main unquantified benefits is brand enhancement.'*
>
> ***Hewlett-Packard Company***

The benefits of cleaner design may be summarised as:

- reduced unit costs;
- improved product functionality and quality;
- longer product design life;
- increased market share;
- improved customer satisfaction;
- easier disassembly and increased potential for recycling;
- improved environmental performance;
- continued compliance with legislation.

> *'Cleaner design has brought environmental and customer benefits. As a result the company's image has benefited.'*
>
> ***Esso UK plc***

The cleaner design cycle, which aims to promote continual improvement, incorporates four elements:

- researching the product (see Section 4.4);
- identifying cleaner design priorities (see Section 4.5);
- designing the cleaner product (see Section 4.6);
- design review (see Section 4.7).

5.1 How to get started

To achieve success, you will need to consider some or all of the following:

- Obtain senior management commitment to cleaner design. Their support is essential because cleaner design requires:
  - access to specific information on environmental issues;
  - dedicated time from staff;
  - centralised project co-ordination.
- Appoint an internal Champion for cleaner design. Good Practice Guide (GG27)[8] *Saving Money Through Waste Minimisation: Teams and Champions* provides practical advice on organisational aspects of building commitment.

> *'Establish senior management support and an internal Champion, start integrating environmental aspects into the normal management systems (can improve later) and keep it simple - it is easy to overcomplicate and 'lose the wood for the trees'.'*
>
> ***Tetra Pak (Carton Packaging Division)***

- Hold a workshop on cleaner product design in your company based on the material given in Good Practice Guide (GG296)[9] *Cleaner Product Design: A Practical Approach*. This includes a disassembly/redesign exercise aimed at helping delegates think about how to minimise the impact of products.
- Produce a business case for cleaner product design. Research carried out for Envirowise suggests that different companies use different material resources to different extents. You will need to determine the benefits and potential cost savings from cleaner design for your company and the financial resources you will need to implement it. As part of this process you could:
  - obtain feedback from your marketing and sales department about customer interest in environmental issues or supply chain pressures for improved environmental performance;
  - ask production and design staff whether production costs are attracting attention or whether your product designs are out-of-date compared with those of competitors;
  - determine the resource requirements, timescale and activities associated with the four elements of the cleaner design cycle.

Advice on how to prepare a financial justification is given in Good Practice Guide (GG82) *Investing to Increase Profits and Reduce Wastes*[10]. For help in developing the environmental case, contact the Environment and Energy Helpline on freephone 0800 585794.

[8,9,10] See Section 6.1 for details of how to obtain a free copy.

- Find out more about cleaner product design:
  - obtain copies of some or all of the free Envirowise publications listed in Section 6.1;
  - look at some of the sources of further help and information given in Section 6.2;
  - find out more about the tools mentioned in Section 6.3.

Management system allows cleaner design to operate

Black & Decker Corporation has set up a Design for the Environment programme to provide an organisational infrastructure to deliver cleaner products and achieve continual improvement in its environmental performance. For more information, see Good Practice Guide (GG295) *Cleaner Product Design: Examples from Industry*.

Further information

6.1 Envirowise publications

The following Guides and Case Studies are available, free of charge, through the Environment and Energy Helpline on freephone 0800 585794 or via the Envirowise web site at www.envirowise.gov.uk:

- *Cleaner Product Design: Examples from Industry* (GG295);
- *Cleaner Product Design: A Practical Approach* (GG296);
- *Life-cycle Assessment - An Introduction for Industry* (ET257);
- *Electronic Equipment Manufacturer Benefits from Cleaner Design* (NC201); more detailed information is given in the accompanying Report NR201 - both publications are about Varian Medical Systems UK Ltd;
- *Driving Down Waste Puts the Brakes on Costs* (GC236) - a Case Study at Continental Teves UK Ltd;
- *Saving Money Through Waste Minimisation: Teams and Champions* (GG27);
- *Investing to Increase Profits and Reduce Wastes* (GG82).

6.2 Sources of help

The following web sites and books provide a good starting point for further information on cleaner design:

- **Envirowise** (www.envirowise.gov.uk) for the latest information on Envirowise seminars, workshops, publications and links to other sites.
- **Design Council** at www.design-council.co.uk/sharinginnovation/index.html
- **UNEP TIE** (United Nations Environment Programme Technology Industry and Economics). Technical case studies from the International Cleaner Production Information Clearing House at www.emcentre.com/unepweb/tec_case/index.htm
- *Ecodesign Navigator.* Evans, S.M., McAloone, T., Sweatman, A., Bhamra, T. and Poole, S. (1998). ISBN 1871315743. £50. Available from Dr Tracy Bhamra, International Ecotechnology Research Centre, Cranfield University, Building 37, Cranfield, Bedfordshire MK43 0AL. Tel: 01234 754108.
- *Ecodesign: a Promising Approach to Sustainable Production and Consumption*. Brezet, H. and van Hemel, C. (1997). UNEP/Rathenau Institute/Delft University of Technology. ISBN 928071631X. £100. Available from SMI (Distribution Services) Limited, PO Box 119, Stevenage SG1 4TP. Tel: 01438 748111, Fax: 01438 748844.

The **Environment and Energy Helpline** on freephone **0800 585794** can:

- provide free, up-to-date advice on environmental issues;
- tell you about relevant environmental and other regulations that could affect your operations;
- send you copies of relevant Envirowise publications;
- arrange for a specialist to visit your company if you employ fewer than 250 people (at the discretion of the Helpline Manager).

6.3 Useful tools for product research

- **Material selection tools.** These will help you to assess which materials have the most potential to harm the environment. Some are lists of materials with regulatory restrictions and others are databases containing environmental, physical, chemical or other information about particular materials. Sources include:
  - *Ecodesign Navigator* (see Section 6.2), which contains information about selected commercially available material selection tools;
  - trade associations and professional bodies;
  - larger companies with in-house systems accessible to suppliers working to solve particular cleaner design issues.
- **Materials databases and related sources.** Those which contain environmental information include:
  - *Eco Profiles for the European Plastics Industry.* A series of reports for the Association of Plastics Manufacturers in Europe (APME) Technical and Environmental Centre. For the latest reports please go to the APME web site (www.apme.org) and check the literature section.
  - *Evaluation of Life Cycle Inventories for Packaging*. Habersatter, K. and Widmer, F. (1998). Buwal, Switzerland. A 177 page report including life-cycle inventory data. Found at: www.buwal.ch/publikat/english.htm
  - *Idemat - an Environmental Materials Selection System* by the Environmental Product Development, Faculty of Industrial Design Engineering, Delft University of Technology, The Netherlands. Found at: www.io.tudelft.nl/research/dfs/idemat/index.htm Other tools are also available on the web site.
  - *Life Cycle Design Manual - Environmental Requirements and the Product System.* Keoleian, G.A. and Menerey, D. (1993). National Pollution Prevention Centre, University of Michigan, USA. Ref: US EPA 600/R-92/226. Obtainable from NPPC, University of Michigan, Dana Building 43E, Ann Arbor, Michigan 48109-1115, USA.
  - *Eco-indicator 99: Methodology Report* and *Eco-indicator 99: Manual for Designers.* A damage-oriented LCA impact assessment method. PRE Consultants, The Netherlands. Can be downloaded from the web site at www.pre.nl
- **Design for disassembly and recycling (and for service, refurbishment and remanufacture) tools.** These are additions to the design for manufacture and assembly (DFMA) tools in common use, and are generally available from the same source as DFMA tools. Other commercial systems are referred to in *Ecodesign Navigator* (see Section 6.2) or on web sites on cleaner design[11].

[11] For a list of useful web sites, visit the Envirowise web site at www.envirowise.gov.uk

- **Regulatory tracking databases.** These provide information on environmental, health and safety and other product-related legislation, and will help to provide the necessary regulatory information during product research. They are available from trade associations and professional bodies, as well as specialist environmental consultants. The Environment and Energy Helpline provides free advice on environmental legislation.
- **Waste minimisation guides.** These provide information to help companies identify opportunities to prevent pollution and minimise waste. A wide range of publications and tools are available from Envirowise through the Environment and Energy Helpline on freephone 0800 585794 or on the web site (www.envirowise.gov.uk).
- **LCA tools.** These are useful during a review of the environmental impacts of a product during its life-cycle. Information on the following LCA tools is given in *Ecodesign Navigator* (see Section 6.2) or on web sites on cleaner design.
    - **Life-cycle inventory tools.** Given the data for a product/process, these tools create an inventory of environmental aspects, eg waste generated during the life-cycle.
    - **Full LCA tools.** These include an LCA inventory, and produce data showing the extent of environmental impacts resulting from particular product life-cycle stages.
    - **Specialised LCA tools.** These are full LCA tools oriented towards a particular product or process, eg packaging.
    - **Abridged LCA tools.** These are simplified and cheaper versions of full LCA tools that use qualitative data or present information in an evaluated form. They include matrices developed in-house by larger companies to evaluate the environmental impacts of their products.
    - **Product-specific life-cycle checklists.** These are developed for particular products or classes of products that have similar main environmental impacts. An example of such a checklist is given in the Report (NR201) *Electronic Equipment Manufacturer Benefits from Cleaner Design: A demonstration at Varian Medical Systems UK Ltd*.

Glossary

De-materialisation	Process of reducing or eliminating a product's material content so that the product function is achieved in another way.
Emissions	Solid, liquid and gaseous substances released into the environment as a result of physical, chemical and biological processes. Also includes noise, heat and radiation.
Environment	Surroundings and conditions in which an organisation operates including air, water, land, natural resources, flora, fauna, humans and their interrelation.
Environmental aspects	Elements of an organisation's activities, products and services that can interact with the environment.
Environmental impact	Any change to the environment, whether adverse or beneficial, wholly or partially resulting from activities, products or services.
Environmental performance	A measure of the adverse or beneficial environmental impacts arising during a product's life-cycle.
Hazardous substances	Substances to which even slight exposure may seriously affect human health or the environment.
Life-cycle impacts	Environmental impacts of a product throughout its life-cycle (from manufacture or extraction, to distribution and use, and then disposal) taking account of the raw materials and energy consumed.
Lightweighting	Design process used to make a product lighter by considering a product's function and attempting to maintain product functionality with less material.
Packaging	Products and materials used for the containment, protection, handling, delivery and presentation of goods. This includes raw materials and processed goods at all stages in the production and sales process from the producer to the consumer, including non-returnable items used for the same purposes.
Recovery	Extraction of useful substances or components (including energy) from waste materials and products.
Recycling	Reprocessing of waste products or materials into a form that allows them to be used as raw materials in another (or the same) production process. Includes organic recycling, but excludes energy recovery.
Recyclates	Products of the process of recycling.

Refurbishment	Process of servicing and repairing a returned used product/part/component so that it can be resold as a fully functioning product/part/component.
Remanufacture	Application of the production process to returned products/parts/components so that they can be resold as fully functioning products/parts/components.
Renewable materials	Materials that can be replenished at a rate equal to or greater than that at which they are being consumed.
Re-use	Process of using the same product/part/component more than once.
Take-back	Practice (sometimes arising from a legal requirement) of returning products to their point of sale or distribution or manufacture.

Checklists

The following checklists are provided to help you implement cleaner product design in your company. Please photocopy and use as required.

- Checklist 1: Researching the product (see Section 4.4)
- Checklist 2: Identifying cleaner design priorities (see Section 4.5)
- Checklist 3: Designing the cleaner product (see Section 4.6)

Checklist 1: Researching the product

	Key consideration	Main issues (ie list different materials, resources and pollution)	Quantity per product (estimate if necessary)	Main environmental concern(s) (quantify if possible)	Ideas for improvements (set targets if desired)
Raw materials 	Amount (weight of) materials				
	Impact of materials (eg hazardous)				
Manufacture 	Resource use				
	Pollution and waste				
Distribution 	Impacts of distribution				
Use 	Resource consumption				
	Pollution and waste				
	Functionality and service life				
End-of-life 	Re-use, remanufacture and recycling				
	Disposal method				

GG294 published by Envirowise (www.envirowise.gov.uk).

Helpline 0800 585794

Checklist 2: Identifying cleaner design priorities

	Key consideration	Scope for environmental gain	Legal drivers	Cost savings	Marketing advantage	Conclusion
Raw materials 	Use less material					
	Use materials with less environmental impact					
Manufacture 	Use fewer resources					
	Produce less pollution and waste					
Distribution 	Reduce impacts of distribution					
Use 	Use fewer resources					
	Cause less pollution and waste					
	Optimise functionality and service life					
End-of-life 	Reduce the environmental impact of disposal					
	Make re-use and recyling easier					

NB In the Conclusion column rank the consideration overall as ‘high’, ‘medium’ or ‘low’ priority and indicate which has ‘top’ priority.

Checklist 3: Designing the cleaner product

	Key consideration	Yes	No	If so, how?
Raw materials 	Can you use less material?			
	Can you use materials with less environmental impact?			
Manufacture 	Can you use fewer resources during manufacture?			
	Can you produce less pollution and waste during manufacture?			
Distribution 	Can you reduce the impacts of distribution?			
Use 	Can you reduce the resources consumed by the product during its use?			
	Can you reduce the pollution and waste created by the product's use?			
	Can you optimise functionality and service life?			
End-of-life 	Can you make re-use and recycling easier?			
	Can you reduce the environmental impact of disposal?			

Envirowise - Practical Environmental Advice for Business - is a Government programme that offers free, independent and practical advice to UK businesses to reduce waste at source and increase profits. It is managed by AEA Technology Environment and NPL Management Limited.

Envirowise offers a range of free services including:

- Free advice from Envirowise experts through the Environment and Energy Helpline.
- A variety of publications that provide up-to-date information on waste minimisation issues, methods and successes.
- Free, on-site waste reviews from Envirowise consultants, called Fast Track Visits, that help businesses identify and realise savings.
- Guidance on Waste Minimisation Clubs across the UK that provide a chance for local companies to meet regularly and share best practices in waste minimisation.
- Best practice seminars and practical workshops that offer an ideal way to examine waste minimisation issues and discuss opportunities and methodologies.

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