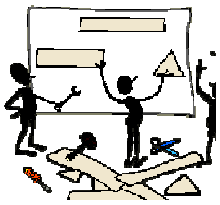
Background material

Ecodesign information

Improving products with Ecodesign

The aim of this section is to show how the environmental performance of products can be improved. This requires life cycle thinking, a target-oriented search for effective improvement strategies, a selection of successful measures and an efficient implementation of these measures in the ongoing planning, decision-making and management processes of a company.



The main objective of this section is to describe the necessary planning and decision-making steps and to demonstrate the practical application of the Ecodesign **P**roduct **I**nvestigation, **L**earning and **O**ptimization **T**ool (PILOT), a software tool for integrating environmental aspects into product design and development.

The Ecodesign examples contain the results of an Ecodesign Workshop held in August 2002 at the Ugandan Cleaner Production Centre (UCPC) in Kampala. They demonstrate how the concept of Ecodesign can be put into practice.

This section of the background material has the following structure:

- Motivation – Why should environmental aspects be included in product development?
- What is Ecodesign? – Provides an overview of product-related environmental considerations.
- A tool for Ecodesign – Describes PILOT as a practical tool for learning and applying Ecodesign.
- How to redesign a product? – Describes how improvements can be achieved.
- Further sources of information on Ecodesign.

1 Motivation

More and more people realize that the global economy in its current form is not sustainable. Therefore it is essential to find new solutions, especially in the area of product development. The question is how *sustainable development* and its idea of economic, environmental and social aspects can be linked to product development. This corresponds to our understanding of sustainable product design or Ecodesign. Companies who wish to ensure their long-term success must implement multidisciplinary processes as well as new proactive approaches to solutions.

Reduce material and energy intensity during the life cycle

There are various reasons why a company should introduce Ecodesign. One important incentive is the improved environmental performance of the company's products. This can be achieved, for instance, by avoiding or reducing adverse environmental impacts, by reducing material and energy intensity during the life cycle of a product as well as by fulfilling health and safety standards within a company.

Environmental impacts are often related to resource consumption, which is, in turn, responsible for increased cash flow. If sustainable product design is combined with better resource management, cost-effectiveness is increased. The analysis of products as well as interdisciplinary working methods and the consideration of consumer needs can generate innovative product ideas, either by life cycle thinking or by searching for improvement strategies and successful Ecodesign measures. Furthermore, Ecodesign ensures the future success of the company as it defines responsibilities, motivates employees and thus gains stakeholders' confidence.

Legal constraints

Several directives and laws apply worldwide in the field of environmental protection. Recent examples are the Directives on **Waste of Electrical and Electronic Equipment (WEEE)**, on the **Restriction of Hazardous Substances (RoHS)** or the **Energy using Product (EuP)** Directive of the European Union.

The European WEEE Directive 2002/96/EC was introduced because the amount of electronic waste within the EU was continuously growing. Moreover, this waste is not sufficiently recycled and, consequently the hazardous components of electrical and electronic equipment are a major concern within the European Union.

The WEEE directive is therefore aiming at preventing, reducing, reusing, recycling and recovering waste of electrical and electronic equipment. The directive encourages design and production methods that facilitate the dismantling, recovery, reuse and recycling of waste from electrical and electronic equipment.

This directive is a good example for the different demands from stakeholders. A more detailed list is provided in Table 1:

Type of stakeholder	Type of demands
End-user demands	Individual demands to achieve customer satisfaction
B2B customer demands	Demands to achieve competitive advantage
Environmental directives and regulations	Mandatory requirements to fulfil legislation
Eco labels	Voluntary product criteria to achieve certification
Standards	General/procedural requirements

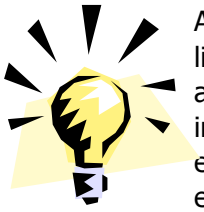
Table 1: Types of stakeholders and types of demands

Engineers have to be informed about environmental aspects

Once the necessity of product-related activities has been accepted, the environmental information has to be transmitted to engineers in product development in order to support the decision making process towards a more environmentally-conscious product design. The main questions are:

- How to integrate Ecodesign into product development?
- How to improve products with Ecodesign?

2 What is Ecodesign?



A product has various environmental, social and economic implications throughout its life, starting from raw material extraction to manufacturing, distribution, product use and finally to the treatment at the end of the life cycle. Environmental effects occur, for instance, when resources are taken from or emissions are released directly into the ecosphere. They can cause environmental problems such as global warming, smog or eutrophication of water. Similar cause and effect chains can be identified for economic and social implications.

Take into account the whole life cycle of a product

In order to obtain effective improvements, the entire life cycle of a product has to be optimized and all the auxiliary processes required by the product to fulfil its intended functions must be considered. Instead of focusing on the individual product aspect only, the whole product system has to be evaluated and optimized.

The aim of Ecodesign is primarily to reduce the adverse impact of a product on the environmental, economic and social context.

Ecodesign is defined as follows:

Definition of Ecodesign

Through an intelligent utilization of the available resources, Ecodesign aims at a product and process design that ensures maximum benefit for all actors involved as well as consumer satisfaction, while causing only minimum environmental impacts.

From this definition the following guiding principles for Ecodesign can be derived:

Guiding principles for Ecodesign

- Service orientation (from product to service, e.g. textiles for cleaning);
- Resource efficiency (e.g. low fuel consumption with hybrid or three-litre car);
- Use of renewable resources (e.g. bio-plastics made from starch);
- Multiple use (e.g. all-in-one devices such as printer, fax, scanner, copier);
- Flexibility and adaptation abilities (self-learning system);
- Failure tolerance and risk prevention (precaution or control system);
- Ensuring work, income and quality of life (fair trade and equal chances).

The four levels of environmental actions – the s-curve of innovation

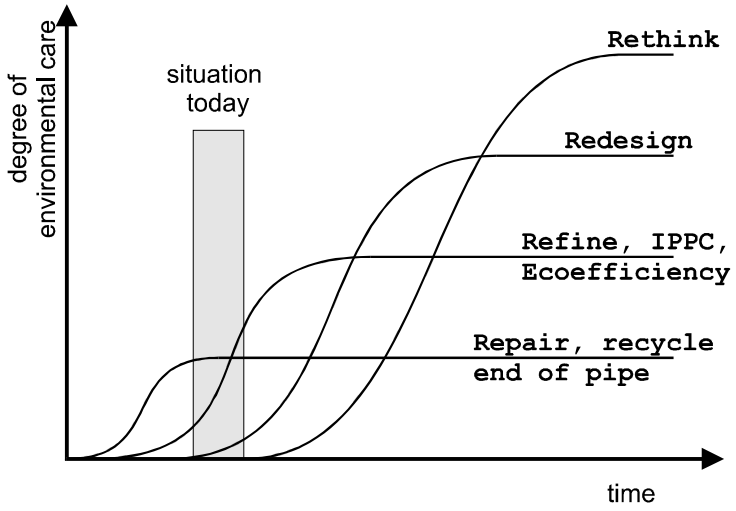


Figure 1: Four levels of environmental actions (source: Schnitzer, Hans, Graz University of Technology)

We assume that we want to improve the process of developing films for printing photographs. The environmental problem could be seen in the chemicals used and discharged into the wastewater. In this case, the different levels of environmental improvements can be shown as:

The "S-curve": Environmental improvement from repair to rethinking

- **First level: Repair**
  Question: Can I separate the chemicals from the wastewater?
- **Second level: Refine**
  Question: Can I reduce the chemicals?
- **Third level: Redesign**
  Question: Can I reuse the chemicals?
- **Fourth level: Rethink**
  Question: Can I avoid the chemicals at all?

It is obvious that a more advanced approach results in a more efficient environmental improvement. Therefore the following order was established:

- Repair (small improvements only);
- Refine (larger potential for improvement);
- Redesign (significant improvement possible); and
- Rethink (best solution, since the problem is avoided – caution: instead of the original problem, another – not yet noticed – might arise).

So far, several projects have been carried out and the benefits derived from the implementation of Ecodesign can be summarized as follows:

- **Future-orientation of the company:**

  Responsibility, motivation, corporate image, confidence of stakeholders, achieving better ratings;

- **Innovative products:**

  Multidisciplinary work, improving product quality, customer needs, optimizing functionality, new consumer segments;

- **Improved environmental performance:**

  Reduction of material and energy input, avoidance of waste and emissions, toxic products avoidance, compliance with environmental standards;

- **Improved cost structure:**

  Operational costs during use, purchase costs of energy, auxiliary and process materials, procurement costs, reducing costs for waste disposal.

3 Ecodesign PILOT: A tool for practical implementation

Ecodesign PILOT is a product development tool that supports the decision making process in product design and contributes to finding appropriate Ecodesign measures to improve the environmental properties of a given product. Therefore, Ecodesign PILOT proposes an assessment procedure for product design evaluation. In addition, it is a learning tool devised to enhance the understanding of the complex subject of Ecodesign. The objective is to stimulate interest in environment-related product innovation and to provide clear advice on the implementation of Ecodesign for specific products. The target group for this tool includes engineers in product development, environmental experts and designers as well as employees involved in the implementation of environmental management systems.

PILOT is an interactive instrument available on CD-ROM, offering three access points to Ecodesign. These are *product life*, *development* and *improvement* (see Figure 2).

Product life: learning everything about Ecodesign

Development: applying Ecodesign to new products

Improvement: redesigning existing products

Figure 2: The three ways to access Ecodesign with PILOT (Wimmer, W., Züst, R.)

The tool increases awareness on sustainable product development by presenting information on Ecodesign and stimulating additional interest in environment-related product innovation. Furthermore, PILOT gives clear advice and shows product examples. PILOT provides working documents in form of individually generated checklists containing step-by-step instructions on the implementation of Ecodesign for daily design work in companies.

For the establishment of the PILOT knowledge base, all possible Ecodesign aspects during the product life cycle were addressed (see Figure 3).

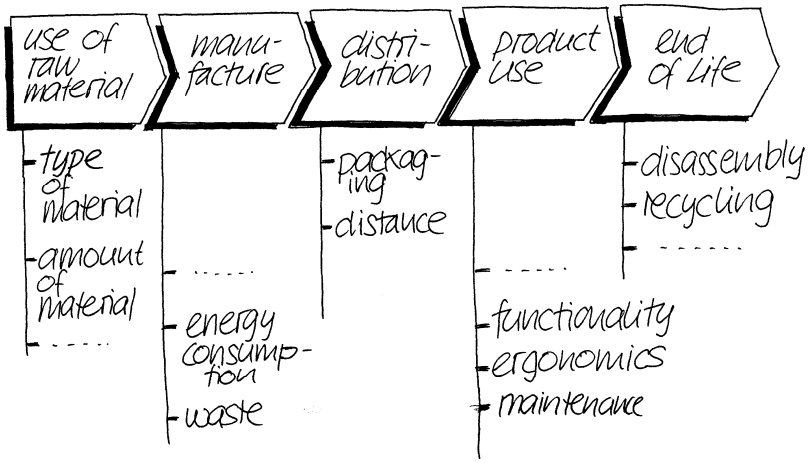
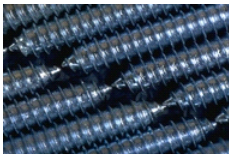


Figure 3: Life cycle phases and Ecodesign aspects (Wimmer, W., Züst, R.)

For each aspect, so-called guidelines were defined. Altogether around 150 detailed guidelines were integrated into this tool. The complete list of Ecodesign aspects included



in PILOT is provided in Table 2.

Life cycle	Ecodesign aspects
Raw Material	Type of material Amount of material Origin of material
Manufacture	Production technology Energy demand for production Auxiliary and process materials for production Production waste and emissions External parts and components Assembly
Distribution	Packaging of product Transportation of product
Use	Functionality of product Service life User behaviour at use stage Product ergonomics Environmental safety at use stage Energy demand during operation Auxiliary and process materials during operation General conditions of use Waste/emissions during use Maintenance of the product Repair of the product
End of life	Product return Disassembly Refurbishing of the product Reuse of parts Recycling of material Disposal of unusable parts of the product

Table 2: List of Ecodesign aspects from PILOT (Wimmer, W., Züst, R.)

The Ecodesign guidelines assigned to each aspect consist of a *how-to-do instruction*, the *environmental background*, the *interdependence* with other guidelines (internally related) as well as an *example* in the form of a picture or drawing, an *assessment question* and *general questions* helping to carry out a design assessment. Furthermore, *additional information* is provided (available externally from the Internet). These elements were integrated in so-called "knowledge pages" enabling the user to learn everything about environmentally relevant measures including checklists for product development (see Figure 4).

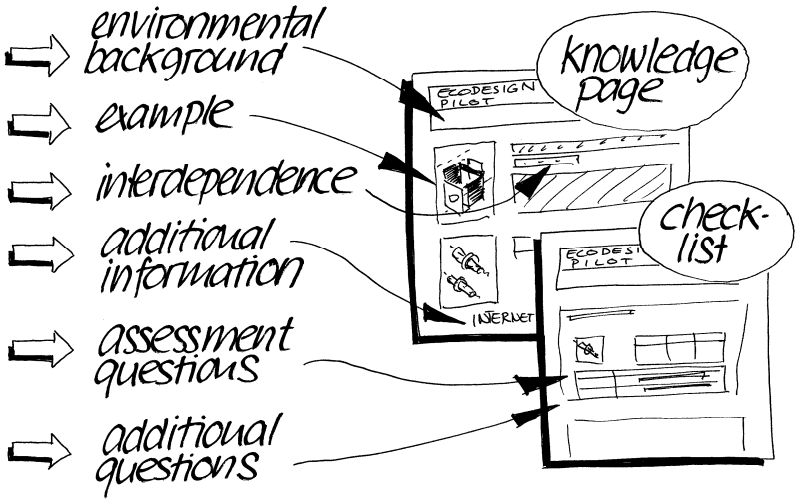


Figure 4: Elements of the Ecodesign guidelines of PILOT (Wimmer, W., Züst, R.)

4 How to redesign a product?

For the redesign process it is important to identify those Ecodesign measures that are most relevant to an effective product improvement. The first step consists in identifying the phase of the product life cycle causing the largest environmental impact (identifying the *basic type* as explained in chapter 4.1). Then Ecodesign strategies can be identified and, as a next step, appropriate Ecodesign measures are selected and adapted to the redesign of a product (see Figure 5).

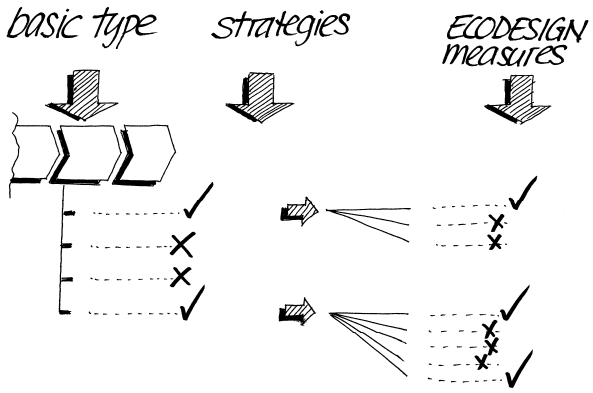


Figure 5: Steps to an improved product with Ecodesign PILOT (Wimmer, W., Züst, R.)

Applying Ecodesign PILOT to specific products consists of a six-step procedure which is explained in the following chapter.

4.1. Life cycle thinking

Life Cycle Thinking (LCT) identifies phases and processes within the product life cycles (see Figure 6) which have or could have significant environmental impacts.

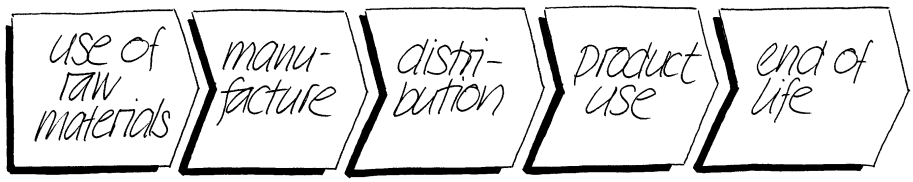


Figure 6: Phases of the product life (Wimmer, W., Züst, R.)

As a result of this environmental evaluation a specific description of the product is generated. Ecodesign PILOT divides products into the following *basic types*:

- Basic type A: raw material-intensive product;
- Basic type B: manufacture-intensive product;
- Basic type C: transportation-intensive product;
- Basic type D: use-intensive product;
- Basic type E: disposal-intensive product.

Life cycle thinking itself can be performed using the following methods:

- A full life cycle assessment (time and cost intensive);
- An abridged LCA in form of indicators (limited availability of indicators);
- An evaluation of the energy and material consumption over the whole life cycle of the product (limited focus of analysis);
- The Ecodesign PILOT Assistant under: http://www.ecodesign.at/assist.

The Ecodesign PILOT Assistant provides support in classifying the product according to the five basic types mentioned above and suggests, on the basis of the provided product data, appropriate improvement strategies for the individual products. The resulting improvement strategies are then directly linked to Ecodesign PILOT. For each improvement strategy, a checklist is available which facilitates the working out of detailed design changes for the analysed product.

As an example, a water kettle was analysed with the PILOT Assistant (see Figure 7). The water kettle consists of an injection-moulded PP housing, a heating element made from high-alloy steel and a regular electric cable. The total weight of the kettle is 0.87 kg; the packaging weighs 0.2 kg and consists of cardboard.

The assumption made for the use phase was that half a litre of water is boiled three times a day. The total service life of the kettle was estimated at three years.

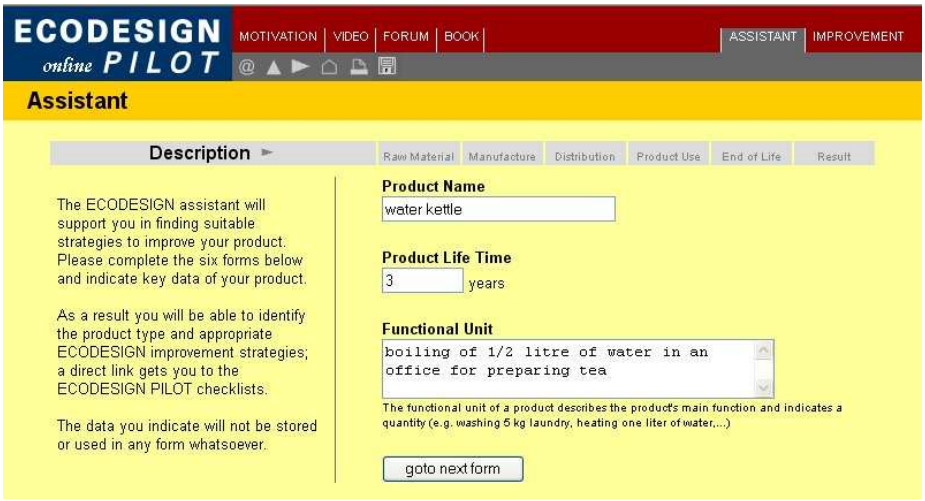


Figure 7: Interface of the Ecodesign Assistant (www.ecodesign.at/assist)

The result of this LCT is shown in Figure 8. The water kettle was classified as basic type D: *use-intensive product*.

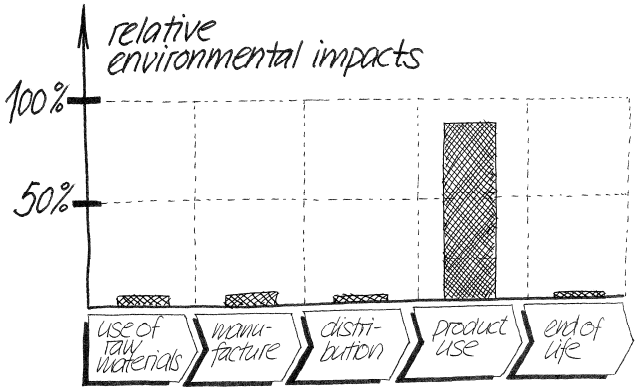
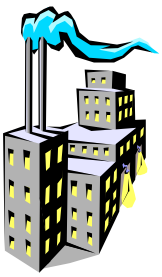


Figure 8: LCT - profile of a water kettle (Wimmer, W., Züst, R.)

4.2. Selecting objectives and strategies for improvement



Before the appropriate strategy for a certain product type can be determined, different improvement objectives have to be evaluated. The improvement objectives are discussed in a cross-functional team (CFT) and several options are developed. Next, the options are analysed in view of their feasibility. Several reasons might influence this decision-making process, such as customer requirements, company policy or technological reasons.

After the LCT step, it is important to find and define effective improvement strategies. The following list shows the improvement strategies included in Ecodesign PILOT:

- Reducing material inputs;
- Reducing energy consumption in the production process;
- Optimizing type and amount of process materials;
- Avoiding waste in the production process;
- Ecological procurement of external components;
- Reducing packaging;
- Reducing transportation;
- Optimizing product functionality;
- Improving maintenance;
- Ensuring environmentally safe performance;
- Reducing consumption at the use stage;
- Avoiding waste at the use stage;
- Increasing product durability;
- Improving reparability;
- Improving disassembly;
- Reusing product parts;
- Recycling materials.

The discussion for the water kettle showed that "*Reduce energy and material input at the use stage*" was clearly pointed out by the cross-functional team and was recommended after analysing the product with the Assistant.

4.3. Identifying Ecodesign guidelines with checklists

With the help of the checklists, appropriate Ecodesign measures for a product improvement can be identified. Each checklist contains a strategy-related cluster of Ecodesign guidelines enabling the user to check, if the product or product parts fulfil the Ecodesign requirements.

The checklists include an assessment question for each Ecodesign solution (see Figure 9), which aims at a potential improvement measure and therefore must be answered.

Not all assessment questions are of equal importance for a given product. An ecology-oriented three-step prioritization will help to implement the selection:

1) Weighting (W):

The relative importance of the individual assessment questions for a given product has to be determined. A rating of 10 points means "very important for my product", 5 points "less important for my product" and 0 points "not relevant to my product".

2) Assessment (A):

The assessment question has to be answered by one of the four possible answers. Here, 1 point stands for "yes, has been fulfilled", 2 points for "rather yes, partly fulfilled", 3 points for "rather no, partly not fulfilled" and 4 points for "no, not fulfilled".

3) Priority (P) of Ecodesign measures:

The priority value P is calculated by multiplying the weighting value W by the assessment value A. Therefore, possible values for P are 40, 30, 20, 15, 10 and 0.

The most promising Ecodesign solutions are characterized by a high priority value P. Activities should focus on these solutions because they have a high improvement potential for the product in question.

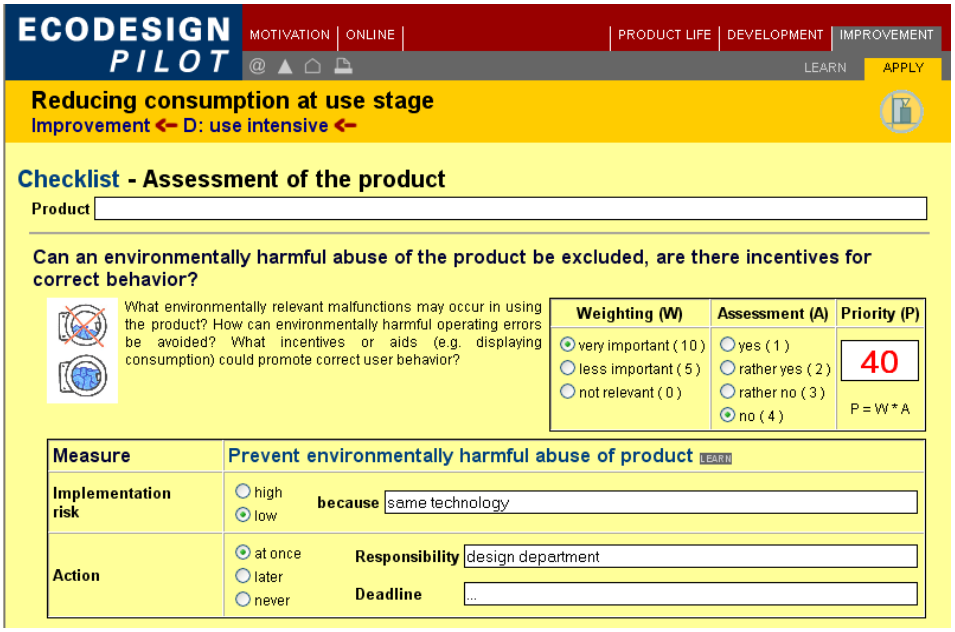


Figure 9: Checklist element of Ecodesign PILOT (www.ecodesign.at/pilot)

An extract of the result obtained from the checklist is shown in Table 3, including the priority determined for each measure.

Identified improvement measures	**Priority**
Prevent environmentally harmful use of the product	High
Indicate consumption of product along the use stage	High
Minimize energy consumption at use stage by increasing the efficiency of product	High
…	

Table 3: Improvement measures for the water kettle

4.4. Transforming Ecodesign solutions into product design changes

The transformation from the generally formulated Ecodesign solutions into product-related measures requires experience and creativity as well as methodical support. A brainwriting session, for instance, could have generated the detailed design changes shown in Table 4.

Improvement measures	Detailed design changes
• Prevent the environmentally harmful use of the product; • Indicate the consumption of the product during the use stage; • Minimize the energy consumption at the use stage by increasing the efficiency of the product.	• Avoid re-boiling by insulation of the pot; • Temperature adjustment to hold the desired temperature; • Installation of a lamp or signal to indicate that the water is ready; • Instructions for the correct amount of water; • Reducing the lag time of the switch-off sensor; • Improving the efficiency of the heater.

Table 4: Ecodesign PILOT improvement measures transformed into design changes

4.5. Evaluating and implementing design decisions

In the course of the evaluation, the potential improvements and related risks expected from the implementation of an Ecodesign measure are compared. This evaluation should be carried out by a cross-functional team, who should also decide which Ecodesign measures could be implemented.

4.6. Organizing the evaluated design decisions

As a last step, a time frame for the implementation of the design decisions is set and the responsibility for this process is assigned to a person or department. Thus the evaluated ECODESIGN measures can be integrated in the managing process of an Environmental Management System (EMS). An EMS according to ISO 14001 is part of an interdisciplinary management system including the organizational structure, planning activities, responsibilities, methods, actions, processes and resources for the development, implementation, fulfilment and evaluation of the environmental policy. All these measures ensure the continuous improvement process in an EMS (see Figure 10).

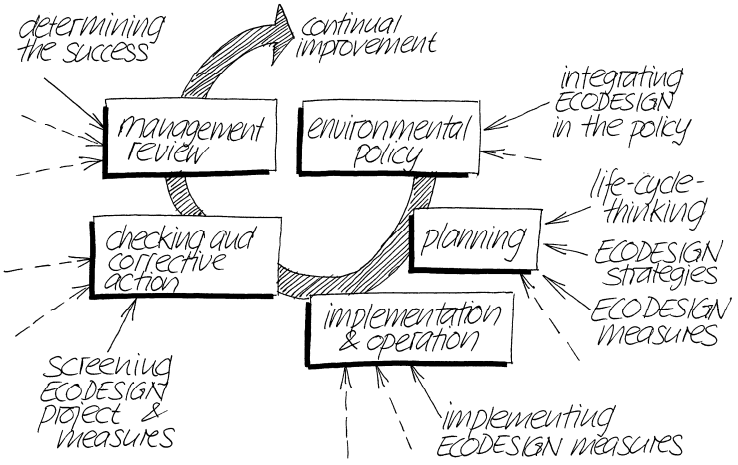


Figure 10: Structure of an EMS and the corresponding links to Ecodesign (Wimmer, W., Züst, R.)

5 Conclusion

Experience from various case studies has shown that Ecodesign is a multidisciplinary task and requires an adequate learning environment and creativity techniques. Moreover Ecodesign presents the following advantages:

- Ecodesign PILOT has the potential to transform the term "environment" from a vague notion into detailed step-by-step guidelines in the language of product development.
- The Ecodesign methodology is easy to understand for most people (also for persons without design engineering background).
- Users of PILOT can identify successful strategies and measures within short time.
- The combination with general methods is a very useful tool for finding detailed design changes.

Ecodesign PILOT points out the potential for eco-innovation in product design and development. Environmental issues in product development can be addressed and the target groups can be motivated to promote the implementation of Ecodesign in their companies. Ecodesign PILOT has the potential to develop new ideas for better products.

6 Further information on Ecodesign

Ecodesign PILOT, book and CD-ROM:

Wimmer, W., Züst, R., Ecodesign PILOT, Product Investigation, Learning and Optimization Tool for Sustainable Product Development, with CD-ROM, Alliance for Global Sustainability Series Vol. 3, Kluwer Academic Publisher, Dordrecht, Boston, London, 2003 (ISBN 1-4020-1090-7)

Ecodesign PILOT – online:

Currently available in five languages.

www.ecodesign.at/pilot

Ecodesign PILOT Assistant:

www.ecodesign.at/assist