

# The Ecodesign Toolbox for the Development of Green Product Concepts - First Steps for Product Improvement

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## Abstract

In order to enable enterprises to find essential environmental improvement aspects of their products the ECODESIGN Assistant, an easy to apply tool for classifying a product, has been developed at the Institute for Engineering Design of the Technical University of Vienna (VUT). To be able to fulfill stakeholder requirements, especially the two directives WEEE and RoHS, a practical tool has been developed, the so called 'Electric and Electronic Equipment-PILOT' (EEE-PILOT). This tool gives first information about the framework of the directives, i.e. target groups are mentioned as well as validity and deadlines for required reports are given. The EEE-PILOT is a software tool which helps product developers to find suitable strategies and tasks in order to improve a product in such a way that they fulfill the requirements of the WEEE and the RoHS directive. Both tools, the Assistant and the EEE-PILOT, are integrated in the actual project 'ECODESIGN Toolbox for the Development of Green Product Concepts'.

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## 1 Introduction

This paper describes the first step of a project carried out at the Institute for Engineering Design of the Vienna University of Technology. The project aims at developing a method for sustainable product design and is called 'ECODESIGN Toolbox for Green Product Concepts'. Innovative product concepts will be developed during this project in cooperation with partners from the industry. Two cases will be addressed on electronic products. This project is funded by the Federal Ministry of Transport, Innovation and Technology and the Austrian Research Promotion Agency. The project is still in progress and will be finished in August 2007.

## 2 Objective

The objective of this paper is to describe how environmental analysis of a product and how specific stakeholder requirements from legislations such as the European WEEE directive [1] and the RoHS directive [3] as well as the new EuP directive [2] in the can be integrated in the ECODESIGN Toolbox for Green Product Concepts (see Figure 1). The ECODESIGN Toolbox for Green Product Concepts as shown in Figure 1 comprises of a six step process procedure. The Toolbox will comprise of different tools for sustainable product development which will be tested and applied by the product design teams of three industrial project partners. The ECODESIGN Toolbox for Green Product Concepts supports product designers in improving the environmental performance of their products in two aspects: (i) environmental analysis and (ii) analysis of the stakeholder requirements. In the environmental analysis part the product is evaluated with the ECODESIGN PILOT (Product Investigation, Learn and Optimization Tool) [4] and the Assistant ([www.ecodesign.at/pilot](http://www.ecodesign.at/pilot)). The stakeholder requirements are derived from customer and market requirements as well as from existing and upcoming environmental laws and directives. For achieving legal compliance with

the EU-directives a special software tool has been developed - the so called 'Electric and Electronic Equipment-PILOT' The EEE-PILOT will be implemented in the ECODESIGN Toolbox to consider stakeholder requirements of the mentioned EU regulations for electronic products. As a case study, a digital voice recorder has been chosen. Further, it will be demonstrated how to obtain support in improving this product environmentally and achieving legal compliance by applying the new EEE-PILOT and the adapted version of the ECODESIGN Assistant.

### **3 Product Analysis by Applying the Ecodesign Assistant**

#### *3.1 Introduction*

The Assistant is an add-on to the ECODESIGN PILOT, which helps to classify products and which enables to apply Life Cycle Thinking. The Assistant helps to find the life phase with the most environmental impact. Based on this classification it suggests appropriate ECODESIGN strategies for product improvement. The Assistant asks for product specific data with the help of six forms. For each of the life cycle phases, i.e. raw materials, manufacturing, distribution, use and end of life, data can be entered in a separate form. The first form collects general data about the product such as the product life time or the definition of the functional unit, see Figure 2. With the entered data the Assistant is able to identify the product type. There are five different product types depending on which life cycle phase contributes most to the environmental impact of the product, e.g. raw material intensive product if the life cycle phase 'raw materials' including the processes needed to extract the raw materials for the product contributes most to the environmental impact. Based on the product data input the ECODESIGN Assistant identifies the special characteristics and critical aspects of the product. Further, the ECODESIGN Assistant recommends strategies for the improvement of the product. The strategies are divided into strategies which should be realized

with a high priority since they lead to a significant product improvement and additional and recommended strategies which can be realized at a later time. The corresponding checklists are derived from the ECODESIGN PILOT and can be used to improve the product. In the mentioned project the Assistant will be further developed to fit the requirements of the project. First the database will be updated with additional data for materials and processes. Second the results gained by the Assistant should be, among the ECODESIGN checklists for further improvements, visualized in a graph with quantified data. In this graph the energy values per life cycle phase of a product are displayed and the type of product can be identified as well.

### *3.2 Results gained with the Assistant*

The voice recorder is classified as a use intensive product which means that the product has its most environmental impact during its use phase. It has to be mentioned that the achieved result for the voice recorder depends on the considered use scenario as well as the energy management of the device. In the analysis above it is assumed that the recorder is used for 4 hours a day and 250 times a year over 4 years. The energy needed is supplied by alkaline batteries. The voice recorder needs 800 batteries for its entire life.

The suggested main strategies for the improvement of the voice recorder are:

- Reduce consumption at use stage
- Avoidance of waste at use stage
- Ensuring environmental safety performance

An approach for realizing the first suggested strategy is to use rechargeable batteries instead. This approach would lead to a reduction of the environmental impact of the use phase but also to relative increase of the raw

materials phase. Additionally the following improvement strategies for the voice recorder are derived from the Assistant:

- Optimizing product functionality
- Improving maintenance

These strategies are linked to the PILOT and lead together with the ECODESIGN checklists to improvement ideas listed in chapter 5.

## **4 The EEE-PILOT applied on a voice recorder**

### *4.1 Introduction*

The EEE-PILOT is a sector specific adaptation of the ECODESIGN PILOT. A generic web based version of this software tool is available under: [www.ecodesign.at/pilot](http://www.ecodesign.at/pilot) and has been published in [5]. The new EEE-PILOT is the result of a joint research project between the Technical University of Vienna and the Austrian Center of Excellence Electronic and Environment. The EEE-PILOT supports engineers in product development in the following four main areas:

- Directives validity check: Is the product or the company affected by the RoHS or WEEE directives?
- Obligations: What environmental requirements have to be fulfilled by the product?
- Timetable: When is the deadline for compliance with the requirements of the WEEE directive?

- Implementation: How to realize the new requirements in an environmentally improved product?

The environmental requirements of the EU-directives have been summarized in an easy understandable way. Further, design support for the implementation of the directives is provided through ECODESIGN checklists which are tailor made for electrical and electronic products, see Figure 4.

#### *4.2 Validity Check - WHO*

In the area 'WHO' it is checked whether the product (or in general the company) is affected by the WEEE or RoHS directive. To give answer to that question, the EEE-PILOT's 'Validity Check' can be used. The user is guided through the relevant legal requirements by simply worded questions (e.g. Does the product require electromagnetic fields in order to function?) concerning the product, the company and relevant exceptions from the WEEE and RoHS directive. By answering the multiple choice questions the EEE-PILOT can indicate the relevance of the directives. Online help is available in case additional explanation is needed. Applying the Validity Check to the example of the voice recorder shows that the requirements of both directives, the WEEE and the RoHS, are relevant to this product

#### *4.3 Legal compliance - WHAT*

The Legal Compliance area - What deals with the question which environmental requirements have to be fulfilled by the product? The content of the directives is prepared and presented in an easily understandable form. For good usability of the tool the requirements are divided into the product categories, according to the WEEE directive, e.g. large household appliances or consumer equipment, see Figure 5.

To prevent uncertainties in assigning products to product categories an exemplary list and a detailed list of products for each category is provided. For each of the product categories a set of requirements arise which have to be fulfilled in the early product development process. The voice recorder can be allocated to the category of IT and telecommunications equipments. For this product category the minimum rate of recovery is 75% and the minimum rate of reuse and recycling is 65% of the average weight per equipment. Additionally, the EEE-PILOT provides information about which materials can be recycled or which can be incinerated, see Figure 6.

Furthermore the following requirements have been set up for IT and telecommunications equipment:

- Marking of electrical and electronics devices
- Selective treatment: Removing of liquids or components containing dangerous materials
- Product conception: Make reuse possible by changing the design characteristics
- Information for users and treatment facilities

#### 4.4 *Timetable - WHEN*

In this section deadlines for activities and demanded reports from the WEEE and RoHS directives are presented (see Figure 7). The deadlines and the demanded reports are categorized and divided into three groups:

- Single obligations and first reporting
- Annually repetitive reporting
- Important times for implementation of the WEEE and RoHS directives

For products, which are put on the market after the 13th August of 2005, each producer is responsible for the financing of the collection, treatment, recovery and environmental sound disposal of WEEE from private households. Furthermore the restriction of using lead from the RoHS directive comes into force after 1st July 2006.

#### *4.5 Design support - HOW*

The Legal Compliance section gives a list of requirements of the two EU-directives [1] and [3]. The product developer gets answers to the question of implementation - How can the new requirements be realized in an environmentally improved product? With the formulated strategies and guidelines the requirements of the EU directives and the national directives can be fulfilled. This area contains strategies of a Secure Take-back to strategies for a Disassembly-friendly product conception, see Figure 8. For each strategy one checklist is available. The checklists contain the assigned guidelines for the realization of the strategy. On the one hand the checklists can be used for evaluating the product design and on the other hand they can be used to stimulate product improvements by asking specific questions and giving improvement examples. The evaluation is an examination to what extent the product or its parts already fulfill the formulated requirements in the checklists. The additional questions point out the surrounding field of the evaluation question and place them into a larger context, see Figure 9. The procedure for product improvements for existing products consists of the following steps:

1. Relevance: In the EEE-PILOT the relevance is set to 'very important' because the requirements of the directives are required by legislation.
2. Fulfillment: Estimate the current fulfillment of the assessment questions (yes / rather yes / rather no / no).
3. The priority of the strategy will then be calculated automatically through multiplication of the relevance (R) and the fulfillment (F). With this

calculation those guidelines which are on the one hand 'very important' and on the other hand 'not fulfilled' can be found systematically. The guidelines with a high priority (which score 30 and 40) should be considered for realization first.

4. Idea for Realization: Finding ideas to realize the ECODESIGN tasks.

## **5 Improvement Ideas**

Design support has been given to the design team of the voice recorder using ECODESIGN checklists by performing two workshops. In Table 1, Table 2 and Table 3 selected strategies and the guidelines with high priority are listed together with the derived improvement ideas for the voice recorder.

## **6 Summary and Outlook**

The case study performed so far in the project showed that finding improvement options works very well using the checklists of the EEE-PILOT and the guided support of the Assistant. Both tools will be integrated into the methodology of the ECODESIGN Toolbox for Green Product Concept in order to have one consistent approach for improving products regarding environmental aspects and stakeholder requirements. The Toolbox will be available latest in spring 2007. The databases of the Assistant will be further developed during the project to provide additional material and process data. The further development of the tool will comprise also updates according to the new EuP directive [2].

## **References**

- [1] Directive 2002/96/EC of the European parliament and of the council of 27 January 2003 on waste electrical and electronic equipment (WEEE).

- [2] Directive 2005/32/EC of the European Parliament and of the council of 6 July 2005 establishing a framework for the setting of Ecodesign requirements for energy-using products. Technical report.
- [3] Directive 2002/95/EC Of The European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS). 2003.
- [4] W. Wimmer and R. Züst. *Ecodesign Pilot: Product-Investigation-, Learning-and Optimization-Tool for Sustainable Product Development*. Kluwer Academic Publishers, 2003.
- [5] W. Wimmer, R. Züst, and K.M. Lee. *ECODESIGN implementation: A Systematic Guidance on Integrating Environmental Considerations into Product Development*. Springer, 2004.

<b>Selected Strategies &amp; Guidelines</b>	<b>Improvement ideas - What to do</b>
<b>Assistant</b>	
<b>Reducing consumption use stage</b>	
Minimize energy consumption at use stage by increasing efficiency of product	Redesign of the electronics
Make possible use of renewable energy resources at use stage	Energy supply for the basis station using photovoltaic
<b>Avoidance of waste at use stage</b>	
Avoid and/or minimize waste at use stage	No batteries / accumulator
etc.	etc.
<b>RoHS</b>	
<b>Restriction of using lead</b>	
Usage of product parts free of lead	Certifications from subcontractors for parts (resistors, printed circuit boards, etc) free of lead have been obtained.
Investigation of the existing soldering machine on lead-free usage	Investigation of the soldering machine on lead-free production

Table 1: Identified guidelines and improvement ideas

<b>Selected Strategies &amp; Guidelines</b>	<b>Improvement ideas - What to do</b>
<b>WEEE</b>	
<b>Secure Take-Back, Collection and Treatment</b>	
Participation in an existing collecting and utilization system	Joining a collection system; In Austria this would be: (i)Umweltforum Haushalt (UFH), (ii) European Recycling Platform (ERP), (iii)Elektro Recycling Austria GmbH (ERA), (iv)Erfassen und Verwerten von Altstoffen GmbH (EVA)
Registration of the collection and utilization system	Registration in Austria at: <a href="http://edm.umweltbundesamt.at">http://edm.umweltbundesamt.at</a>
Secure orderly treatment	Joining a collection system
<b>Supply of information for users and treatment facilities</b>	
Proper marking	Print crossed-out wheeled bin on the packaging, on the instructions for use, on the warranty and on the product
Prepare information for the treatment facilities	Providing a CD-ROM containing information of components, materials and location of the accumulator.
Prepare information for the user to animate for separate collection take-back of WEEE	(a) not to dispose WEEE as unsorted municipal waste and to collect such WEEE separately; (b) the return and collection systems available to them; (c) their role in contributing to reuse, recycling and other forms of recovery of WEEE; (d) the potential effects on the environment and human health as a result of the presence of hazardous substances in electrical and electronic equipment; (e) the meaning of the crossed-out wheeled bin

<b>Selected Strategies &amp; Guidelines</b>	<b>Improvement ideas - What to do</b>
<b>Recovery-friendly product conception - material choice</b>	
Reduction of materials used	Shell technique - use just one material for the outer parts
Ensure that materials are suitable for recycling	Use PS, ABS and PP which can be recycled with a rate of nearly 100%
etc.	etc.

Table 3: Identified guidelines and improvement ideas

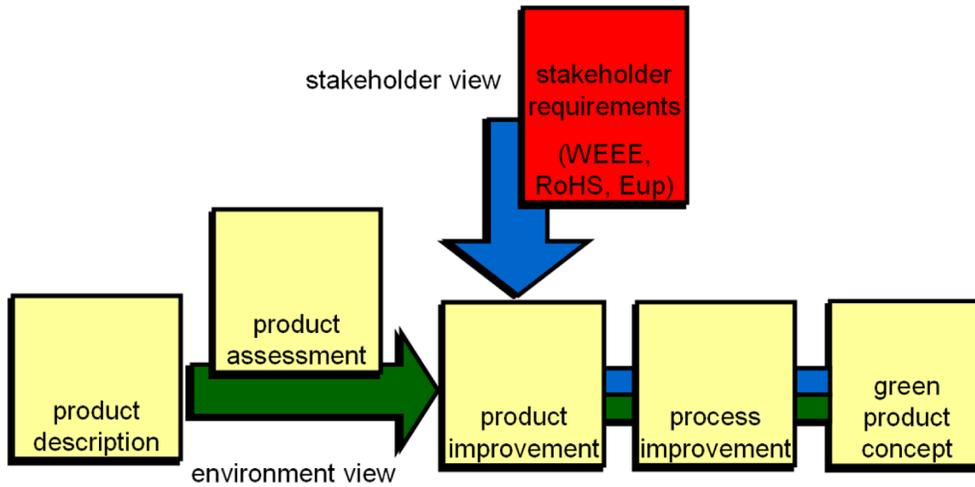


Figure 1: Six steps of the ECODESIGN Toolbox

The screenshot shows the ECODESIGN Assistant web interface. The header includes the logo 'ECODESIGN online PILOT' and navigation tabs for 'INTRODUCTION', 'PILOT', and 'ASSISTANT'. The main content area is titled 'Assistant' and has a 'Description' tab selected. The form contains the following fields:

- Product Name:** Voice Recorder
- Product Life Time:** 4 years
- Functional Unit:** 1 h dictation time, 4 h per day, 250 days per year

A 'goto next form' button is located at the bottom of the form. The interface also includes a navigation bar with 'Raw Material', 'Manufacture', 'Distribution', 'Product Use', 'End of Life', and 'Result' tabs.

Figure 2: First form of the ECODESIGN Assistant

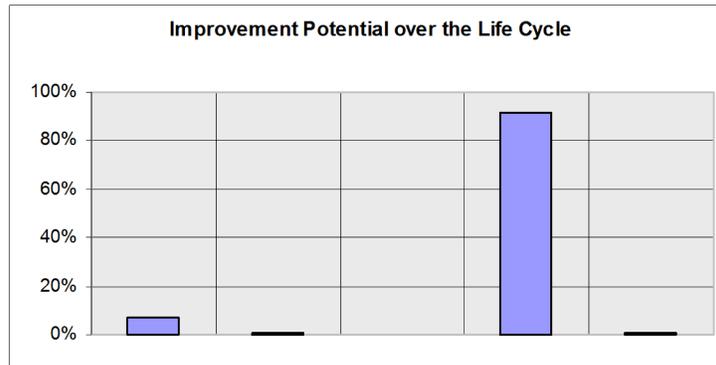


Figure 3: Result graph of the Assistant for the voice recorder



Figure 4: Four main areas of the EEE-PILOT

Product categories	Product examples
→ Large household appliances	refrigerators, washing machines, ...
→ Small household appliances	toasters, kitchen scales, ...
→ IT and telecommunications equipment	notebooks, printers, ...
→ Consumer equipment	radio sets, TV sets, ...
→ Lighting equipment	fluorescent lamps, discharge lamps, ...
→ Electrical and electronic tools	saws, drilling machines, ...
→ Toys, leisure and sports	electric model railroads, computerized home

Figure 5: WEEE - Legal Compliance - WHAT - area

**Meeting set recovery rates for IT and telecommunications equipment**

Article 7 of the WEEE Directive sets the recovery rate for **category 3** devices to an overall 75% of average weight per appliance. This is to be interpreted as the recovery of any type of material or energy. The mandatory reuse and recycling rate for components, materials and substances is set to 65% of a device's average weight.

Different materials are varyingly reusable and recyclable. Furthermore, components as e.g. the coatings of computer screens may contain additives, such as flame retardants and stabilizers, which impede the recovery of substances and cause emissions which are harmful to the environment.

Figure 6: Legal compliance-product category



Figure 7: WEEE timetable

**ECODESIGN**  
EEG PILOT

INFORMATION | RoHS | WEEE

@ :home :up :down

LEARN

## Design Support, "HOW"

### WEEE-Directive ←

**Make intensive use of resources**

- **Secure Take-back, Collection and Treatment**
- **Supply of information for users and treatment facilities**
- **Recovery-friendly product conception - material choice**
- **Disassembly-friendly product conception - connection techniques**
- **Selective treatment - depollution**

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Figure 8: Obligatory strategies

Is it possible to extract components which contain harmful substances entirely and without residues?

Does the product contain components with harmful substances? Are such components easily accessible? Is it rather time-consuming or easy to remove the components and substances in question? How can they be separated?

Relevance (R)	Fulfillment (F)	Priority (P)
<input checked="" type="radio"/> very important (10)	<input type="radio"/> yes (1)	<input type="text"/> $P = R * F$
<input type="radio"/> less important (5)	<input type="radio"/> rather yes (2)	
<input type="radio"/> not relevant (0)	<input type="radio"/> rather no (3)	
	<input type="radio"/> no (4)	

Measure	Providing for an easy removal of components which contain hazardous substances <a href="#">LEARN</a>
Idea for Realization	<input type="text"/>

Figure 9: Element of a checklist