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LIFE CYCLE DESIGN - DEVELOPMENT OF METHODS AND GUIDELINES FOR ENVIRONMENTALLY SOUND DESIGN OF COMPLEX PRODUCTS

SUMMARY FINAL REPORT

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I. OBJECTIVES

Life-Cycle Design is the environmentally sound design of products based on the whole lifecycle starting from exploitation and processing of raw materials, preproduction, production, distribution, to use and returning materials back into the industrial cycles.
Although some successful ´Ecodesign´ demonstration projects have been carried out in the last few years, many companies lack the experience to systematically include environmental considerations in their product design processes. Several design strategies and principles have been published in various manuals and other publications. However, especially for designers of complex products, there is a lack of information and practical tools. The main aim of the project was therefore to develop a manual with practical tools which enables designers in medium sized companies to include environmental considerations into the design process. According to this, the manual focuses on principles and criteria which help the designer to find environmentally sound solutions at various steps in the product design process.

II. METHODOLOGY

On the basis of existing knowledge and experiences a systematic stock-taking and weak spot analysis of the environmental relevance of complex products was carried out.
An analysis of the existing concepts for an environmentally sound product design was carried out. Actual national and international initiatives for standardisation of design criteria for an environment-friendly product design were systematically analysed and evaluated, completed by interviews with experts from companies, consumer and counselling institutes, administrations, associations of companies focusing on methods, criteria, principles and procedures for the environmentally sound product design and the experiences made in this field.
On the basis of the obtained information previous approaches were evaluated.
On the basis of the weak spot analysis, the interviews with experts and the evaluation of other concepts, a catalogue of criteria for design and evaluation of environmentally sound products was put together. The overall context of environmental and disposal problems during the whole life cycle of a product from design to the use of recycled substances and waste disposal was treated. An environmentally desirable product design, based on the careful treatment of resources and the prevention of waste and harmful substances and allowing closed cycles for as many substances as possible had the highest priority. Requirements for establishing closed cycles or the minimising of certain harmful substances were formulated for product design. In order to make environmental product design operational, the catalogue was developed as a criteria checklist. An ABC-scheme was integrated in the checklist, enabling designers to quickly reveal weak spots.
The catalogue was specified and tested in co-operation with participating companies in practical application to different complex products in case studies. The case studies form the empirical basis of the manual.

II.MAIN RESULTS

Stock-taking and analysis of environmental problems

The stock-taking and analysis of environmental problems showed that especially the complexity itself, the broad variety of materials used, the electronic components and the use of problematic materials were responsible for the negative environmental effects caused by complex products. Furthermore, environmental problems are provoked by the shortening of the life-span of products and insufficient collection, return and reuse logistics.
Besides, the number and composition of complex products were investigated and frequently used materials, additives and operational materials were assigned to specific components. Substances with a noxious potential as well as their location in the products were identified.
Based on this analysis a look on current state of recycling processes for complex products was taken. The present design of the products is leading to several problems and showing up limits within the recycling processes:

- recycling processes often lead to a product downgrading
- for the recycling of compound materials additional energy is needed, rendering the recycling in certain circumstances uneconomic and ecologically questionable
- potential pollution with unknown harmful substances.

Evaluation of existing approaches

Additionally a survey of approaches of environmentally sound product design was carried out showing that most approaches lack detailed criteria for environmentally sound product design. They only concentrate on one single criteria and do not take the whole life cycle into account.

The focus of the existing concepts is on a limited number of strategies such as the various aspects of recycling, the reduction in energy consumption during use and the substitution of certain materials posing a danger to health, such as halogenated flame retardents, mercury or PCB. Strategies for reuse and refurbishment, an increase in durability, the use of renewable resources as well as the development of new user concepts (for example eco-leasing) have so far received only little attention in the product development.

Development of scientifically based methods

Based on these results a catalogue of principles and criteria in order to make ecologic design operational was drawn up, including the following ecological principles (P):

- Ecologic efficiency/Optimal function
- Save resources
- Use renewable and sufficiently available resources
- Increase product durability
- Design for product reuse
- Design for material recycling
- Design for disassembly
- Minimise harmful substances
- Produce in an environment-friendly manner
- Minimise environmental impact during product use
- Use of environment-friendly packaging
- Dispose of non-recyclable materials in an environment-friendly way
- Implementing environment-friendly logistics

This list of requirements can be used to check whether or not the design team has explored the entire range of environmental product development. In order to facilitate the realisation of the principles, a number of criteria have been formulated and examples given, putting the principles into concrete terms, offering the planner, designer and engineer an overview of practice in Life Cycle Design. It is based on experience gained in the Life Cycle Design so far. There is, however, no such thing as a homogeneous solution for the ecological product. The rules are intended to be used for a systematic development of ecologically sound design products. In practice, the main objective will be the implementation of as many criteria as possible in agreement with the demands on functionality, quality, design and cost of the product as well as the consumers' claims.

The checklists are based upon a simple "ABC-scheme", enabling the user to quickly reveal weak spots of a specific product: A indicates that the criterion has fully been taken into account, B shows a fair degree of implementation and C indicates an urgent need for a change, so new and better solutions should be generated (see figure).

Criteria for Increasing Product Durability	relevant for the product	Characteristics	Rating (Tick off Characteristics) A	B	C	No data available
Reliability	☐	Above average	☐			☐
		Average		☐		
		Below average			☐	
Wear	☐	Low (with normal use), restricted to easily exchangeable components	☐			☐
		Medium wear, affected components exchangeable		☐		
		High wear without exchangeability of components			☐	
Timeless design	☐	Timeless design	☐			☐
		Contemporary design		☐		
		Fashionable short-lived design			☐	
Use of modules	☐	Modular structure	☐			☐
		Partial modular structure		☐		
		Complex structure			☐	
Future technical developments	☐	System design adaptable to future developments	☐			☐
		System adption possible		☐		
		No system adaptation possible			☐	
Cleaning-friendly	☐	Cleaning easily possible	☐			☐
		Acceptable expenditure for cleaning		☐		
		Cleaning not possible			☐	
Maintenance-friendly	☐	Maintanance-free	☐			☐
		Low expenditure for maintanance		☐		
		High expenditure for maintanance			☐	
Repair-friendly	☐	Easy to repair	☐			☐
		Acceptable expenditure for repair		☐		
		Repair not possible			☐	
guarantee period	☐	> 5 years	☐			☐
		< 5 years		☐		
		< 1 year			☐	

Evaluation

A = Ideal situation

B = Acceptable situation

C = Urgent need for action

LCD

Summing up the criteria in checklists offers a practical method. They are easy to integrate into the normal planning and design process. Every design step can easily be checked against the lists, showing whether or not all relevant criteria have been taken into account. This way, the designer is automatically involved in all important environmental aspects of the LCD and thus receives suggestions with regard to better solutions.

Specification and application of the criteria in case studies

A further specification and more concrete application of the developed criteria and the ABC evaluation method was obtained through case-studies in companies. Some of the originally intended co-operations was not

completed. But new companies were found for a co-operation instead.
The methods developed (guidelines, checklists, short ecobalance) were applied to the following products and tested :

- Telephones
- Vacuum cleaners
- Videotape recorder
- Swivel chairs
- Lightning systems,
- Cables
- Electronic ignition
- Equipment for electrical installations

With regard to the case studies concerning the electronic ignition and the equipment for electrical installations the current state is reported as the work carried out by the companies was not completed during the project.

IV. SCIENTIFIC INTEREST AND POLICY RELEVANCE

(i) scientific interest and novelty
Scientific improvement is to be expected basically through the development of scientifically based methods for Life Cycle Design. The tried and tested principles and criteria offer, especially for small and medium-sized companies, a tool for environmental product design, that they would otherwise not easily have at hand, as the necessary R&D capacities often do not exist. The manual can partly be seen as a substitute for external expertise or as a means to facilitate internal education.
(ii) policy relevance
Profit can be realised, both for companies and for the environment when in design processes of products environmental considerations are integrated. Life Cycle Design of products can lead to better usage of raw materials and energy, improvement of product efficiency, higher product quality and better working conditions. It can also lead to less generation of waste and emissions, less pollution control and waste treatment costs as well as less environmental administration costs.
The project also offered an innovative and relevant contribution to an ecological structural change in Europe.
A contribution to more equal competition aspects with regard to environmental product policies within the EC could be achieved and an increased competitive advantage against companies from Japan and the USA secured. Furthermore, the international co-operation within the project will lead to a prenormative contribution of European standardisation of construction and evaluation methods for complex products.