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GREEN PRINCIPLES

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The paper deals with the interrelationship of the machine-human-environment cycle. It analysis what the designer should keep in front of the '*green*' eye during the conceptual design process. According to the environmentally friendly and ergonomics guidelines the paper offers a suggestion for collecting tips of conceptual design process, including *green tips*, that are of course in connection with the eco-design, and are suitable for a software that is written for helping the designers work during the conceptual design process.

1. Environmentally friendly design

It is not easy to shortly define environmentally friendly design. According to the several components it has, it is quite a complex process. According to Zilahy [1] environmentally friendly design systematically concentrates to the environmentally impacts that are potentially coming in the fore during the whole life-cycle of products and services, and to reduce or eliminate these expectable impacts still in the design process.

Orbán [2] defines DFE as a design, that minimalizes the undesired impacts for the nature (DFE = design for environment). DFE is the necessity of the developed product causes the less harmful impact on the environment that is an ever-growing claim of today.

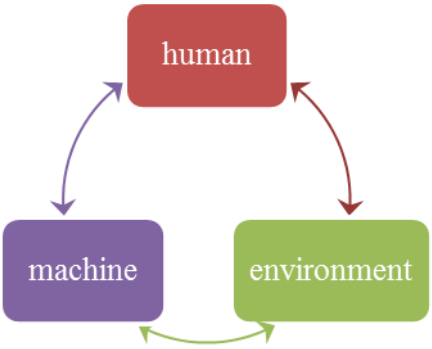


Figure 1: Machine-human-environment cycle

Due to the literature of the field *environmentally friendly design* or *DFE* or *Green design* or *eco design* mean only the protection of the nature do not pay any attention to the protection of the human that is a component of the green environment, only indirectly referring to it. It is essential to notice that the man only as a designer but also as the part of the green environment appears in the machine-human-environment cycle. The elements of the cycle are interrelationship continuously, as Figure 1 shows. So the human designs for

itself and for the environment as well. Machine has the effect for the human and for the environment too. The environment also has the impact for the human and for the machine. So environment means not only the nature over the office, the factory, but the direct environment of the human where it works, so the workplace. As for the further researches it would be practical to mention and analyse ergonomics as the element of the environmentally friendly design.

2. The tools of DFE

2.1. DFE elements

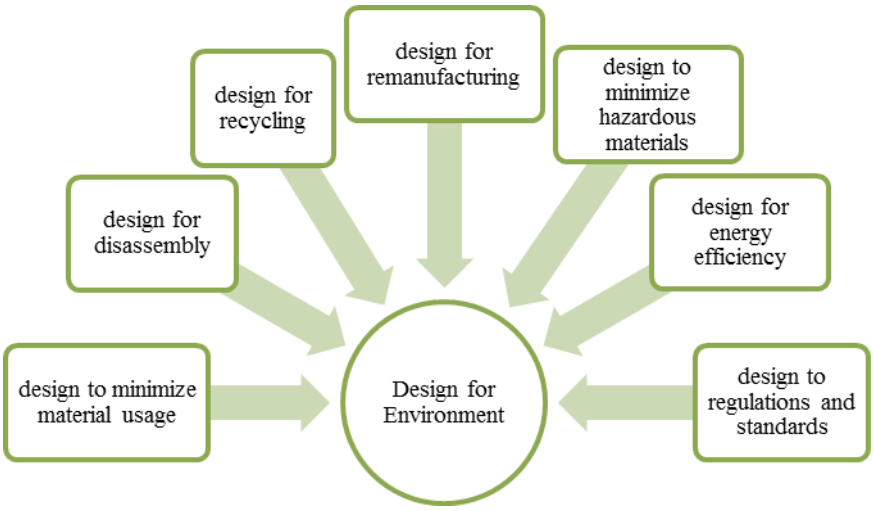


Figure 2: Design for the Environment [4]

Dfx, or design according to a given viewpoint [5] can be any formal period of the design process, or any important aspect that can be followed during the whole design activity as the main principle. Dfx is an enormous set of design principles that is really hard to describe, because this set is increasing day-by-day. Scientists define more and more principles, and for those principles methods are also created. These methods denote or can denote the adaption of Dfx techniques to computer. DfE, that is Design for the Environment is collecting the aspects of environmentally friendly design. As it is shown in Figure 2 it consists of seven essential areas. According to different aspects these can be divided into other different principles. This figure also confirms why it is so complicated to collect all the Dfx techniques and to group them.

2.2. 3R, 4R and 6R philosophies

3R philosophy means nothing else but not accumulating used or consumed materials as waste, but recycling them to the product-market. Reduce means to lower the quantity of the waste, reuse means using again the waste, recycling means using waste for creating new raw material. This cycle is shown in Figure 3.

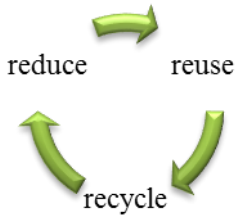


Figure 3: 3R philosophy

There are several versions for 4R. Usually recover, rethink and replace are mentioned as the 4th R. Elements of 6R are introduced in Figure 4 by a pyramid. Colures of the figure refer to the green factor of the given notion.



Figure 4: The 6R philosophy

Rethinking a product can lead to an absolute green product, for instance using biodegradable materials. Of course it determines and might lower the life-time of the product (e.g.: plant-a-tree box, as a packaging carton box, patent no.: US20080046277A1). But this way the effect on the environment can be reduced the most. *Reducing* the waste cannot be the best solution, as even though making the quantity of the waste less, it still has the impact on the environment. During *redesign* certain assemblies can be changed by less harmful ones. *Repairing* a product that is out of order its lifetime gets longer, so less new product is needed. It is sure that this possibility is not proper for the manufacturers. *Reusing* a product is significant for the environment. Due to recycling less natural raw materials have to be extracted. The recycled raw material has no impact on the environment as waste, but the recycling procedure might be dangerous for the environment. It does not mean to be worst than extracting the natural materials.

2.3. Valdez or CERES principles

There are several principles that were defined to make the industry understand and deal with the effects of producing for the environment. For example Valdez principles that were published in the Financial Times 27th March 1991. These principles later had been renamed for CERES principles. Coalition for Environmentally Responsible Economies had been established by Joan Bavaria in 1989 that is the abbreviation for CERES, who was the Roman goddess for fertility and agriculture. After the Exxon Valdez oil spill in the same year of establishing, CERES determined its 10 point principles. These help factories producing with the highest environmentally efficiency. Many industries keep CERES principles in front of the eye nowadays, General Motors among others. Principles are the following:

- Protecting the biosphere.
- Sustainable use of natural resources.
- Reducing and disposing waste.
- Wise use of energy.
- Risk reduction.
- Marketing of safe (green) products and services.
- Damage compensation.
- Disclosure.
- Environmental directors and managers.
- Assessment and audit.

2.4. Ten Golden Rules

Ten golden rules were carried out by Luttropp and Lagerstedt [3]. The rules are the summary of those principles that are used by different industries, and suggested by hand books. Ten golden rules are quite general; each industry should carry out product and industry specific rules. Golden rules are the following without any importance order:

- Limit the use of hazardous substances and arrange closed loops if necessary.
- Minimize energy and resource consumption in production and transport through housekeeping.
- Minimize energy and resource consumption in the usage phase especially for products with most significant aspects in the usage phase.
- Promote repair and upgrading especially for long lasting and system dependent products.
- Assist long lifetime for products especially for those ones that have significant effect on the environment out of usage phase.
- Use structural features and high quality materials to minimize weight (e.g.: metal foam [8]) if not interfering with necessary flexibility, impact strength or functional properties.
- Use better materials, surface treatments or structural arrangements to protect products for dirt, corrosion and wear.
- Prepare for upgrading, maintenance and recycling through information, labelling, modularization and accessibility.

- Prepare for upgrading, maintenance and recycling, by using few, simple, recycled, not blended materials and avoid alloys.
- Use as few joining elements as it is possible and promote intelligent geometric solutions.

3. Ergonomics

MacLeod [6, 7] defined twelve principles that can help the designer's work during the design process to create a machine, tool, equipment or product that ensures comfortable work for the user. These principles are general, but give significant help during design. MacLeod's principles are the following:

- Work in neutral postures!
- Reduce excessive force!
- Keep everything close!
- Work at proper heights!
- Reduce excessive motions!
- Reduce fatigue and static load!
- Reduce pressure points!
- Ensure free motions!
- Move, exercise, strength!
- Secure comfortable environment!
- Controls and displays should be clear!
- Improve work organisation!

David Ridyard determined five main territories within he declared several design principles for neutral postures. The aim is to ensure these normal positions. These main territories are the following:

- General work station
- Repetitive hand and wrist work
- Hand tool use and selection
- Lifting and lowering
- Carrying tasks

4. Summary

Principles were introduced above are the tools of the environmentally friendly design. Ergonomics is mentioned as an independent field of science by the literature, but as for the environment human should not be forgotten, as it is a component of the nature. So during environmentally friendly design designers should pay attention to human and due to its comfort to health. This way ergonomics is also practical to be mentioned among the tools of green design.

Above mentioned principles have to be examined, how designers can take them into consideration during conceptual design phase, this very early stage of the whole design process. Further task is to create a list on the basis of the introduced principles that gives 'green' tips for the designers during the conceptual design. Adapting this tip-list to computer is another task. This computer adapted tip-list would give tips while defining functional subassemblies while using an already existing concept generator software.

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