Ecodesign of Electronic Devices

UNIT 6: Lifecycle of electronic devices

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Lifecycle

- Ecodesign of electronic devices is intended for development of electronic products in a way that we decrease environmental effects through the whole lifecycle. This means that ecodesign is based on the evaluation of the device lifecycle.
- The effect that the device has on the environment has to be studied and decreased in all lifecycle phases. These phases include the gathering of resources, production, marketing, distribution, use and final disposal of the product, as shown in image 1.

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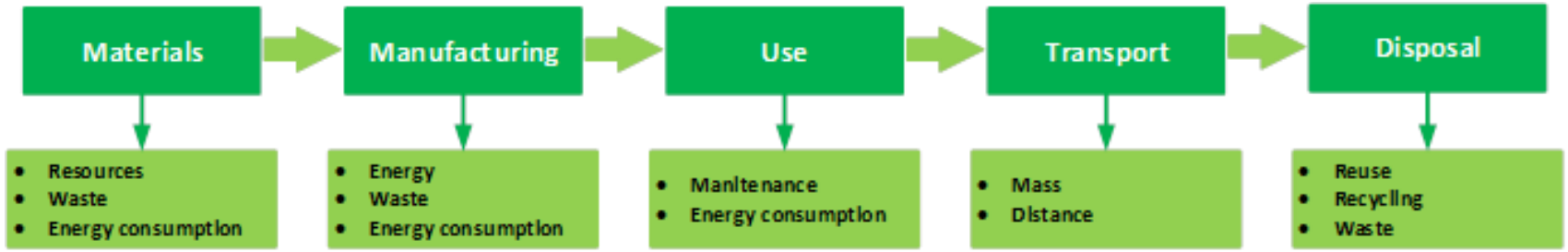
Lifecycle

- The most important phases of electronic device lifecycle.



- Environmental effects in each phase are:
  - **Input:** used energy, resources.
  - **Output:** Emissions to earth and air.
  - **Production of solid waste.**
  - **Issues with occupational diseases and safety.**

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Ecodesign and lifecycle evaluation

- Ecodesign can be presented in multiple ways. Each company has a different environmental problem, related to their products and services. The company can come closer to ecodesign by using different strategies and considering laws and directives.
- External factors, such as compliance with the newest environmental laws. These can define a strategic agenda for environmentally suitable design.
- Internal factors, such as energy use also have the leading role in determining the priority tasks for environmentally suitable design.

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Ecodesign and lifecycle evaluation

- For designing an ecological electronic product. The following general strategies can be used:
  - **New development concept.**
  - **Physical optimization.**
  - **Choice of material.**
  - **Product optimization.**
  - **Optimizing operations.**
  - **Disposal and recycling of the product.**

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Optimal design throughout the entire life cycle

- The designer must not only designer “green” products that are ecological when in use, but the design has to be lead in a way that included the whole device lifecycle. This means that the concept “from cradle to grave” or “from cradle to cradle” have to be considered.
- Physical optimization is a strategy of product design with the intention to increase reliability and improve functions that would improve the ecological profile of the device.
  - **The increase of lifetime and product reliability**
  - **Optimization and integration of functions.**
  - **Simple maintenance and repairing**

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Materials selection

- Choice of suitable materials in Ecodesign can decrease environmental effects related to depletion of resources and lifetime management. The key goals of this strategy are prolongation of lifetime, reduction of material consumption and general use of materials with smaller environmental effects.
- Choice of material characterizes the product characteristics and its lifetime.
  - **Material recycling.** Recycling can be a very efficient solution for resource management.
  - **Renewable materials.** Renewable materials are those that can easily regenerate themselves in the environment.

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Materials selection

- **Use of less material.** Designers should in Ecodesign strive for reduced use of resources in the development of new products. Reduced use of resources and energy sources means lower production costs and less waste that needs to be recycled or disposed after product lifecycle.
- **Materials with lower energy value.** This strategy refers to the use of materials that are produced with minimal energy for extraction, processing, and purification.
- **Use of materials with lower environmental effects.** Hazardous materials can directly or indirectly cause a larger problem during their use or when the device is treated as waste.

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Selection of Production process

- Production processes need to be optimized to decrease use of materials, energy consumption and waste production. This can be achieved by reshaping the existing processes or removal of unnecessary production steps. Important steps in process optimization are:
  - **Alternative production processes.** Processes that cause extensive environmental effects need to be replaced by alternatives. However, the effects of these changed on costs and performance need to be evaluated beforehand. Designer has to be notified on the best available technologies and equipment for completion of the processing process, preparation of alternatives need to be evaluated within lifecycle in order to provide a reduction of all effects.
  - **Fewer production steps.** Process optimization includes reduction of production steps and improves the production process and its efficiency. Reduction of production steps is often linked to the introduction of new technological solutions and processes.

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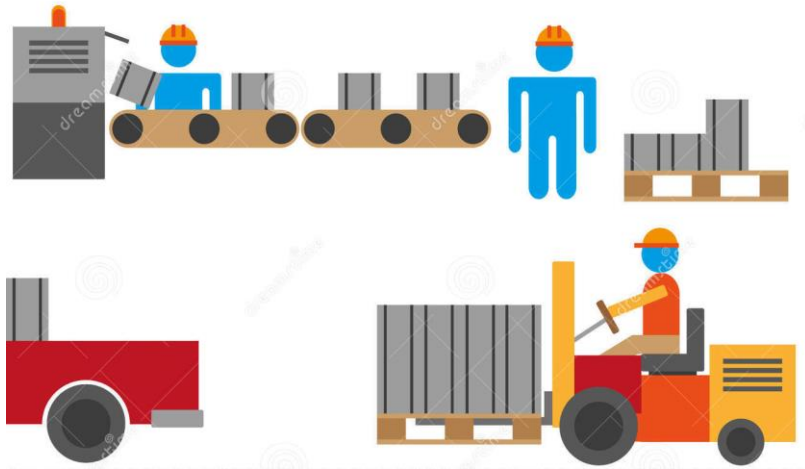
Selection of Production process

- **Controlling production process.** Control systems are integral parts of planning processes. Well designed process control can decrease pollution and save the resources. Production of products that are in the same area can cause the creation of large quantities of waste. Determination of suitable deviations improves precision and directly decreases environmental effects.
- **Production with low energy consumption.** Energy consumption can be decreased with process planning. We can save with energy with the use of more efficient processing equipment, for example with highly efficient engines and fans that are highly efficient. Appropriate maintenance and equipment use can also significantly influence energy consumption.
- **Less waste.** Optimization of processes decreases waste production. This way we can achieve more efficient use of materials which results in less waste on landfill.
- **Incorporation of renewable resources.** Solar and heat systems can be used in heating processes in lower and middle-temperature range. With these measures, the use of fossil energy sources can positively influence the environment. Unlike conventional energy system, the use of solar energy, in the beginning, requires relatively high investment.



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Disposal and recycling of electronic devices

- The environmentally designed product is the main factor in the implementation of environmentally friendly strategy at the end of product lifecycle.
  - **Reuse**. Products have to be designed in a way that enables quick and easy to disassemble. Separate components should be suitable for reuse in the production of other product.
  - **Rebuilding.** Rebuilding includes collecting of products by sorts and types, then follows cleaning and examination for repairs and reuse. Rebuilt products are assembled using the reused and new parts, where needed.

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Disposal and recycling of electronic devices

- **Designing for disassembly.** Designing for disassembly guarantees that the product and its parts can be reused, rebuilt or recycled after the lifetime.
- **Material recycling.** Recycling is the process of gathering the materials that can be reused in new products. Separation of different materials increases the value of recycled materials if we remove the contaminants and hazardous materials.
- **Safe disposal.** If disposal is the only possibility that the consumer has, the designer has to do the following: Avoids the use of toxic or dangerous substances, provides instructions on safe disposal, uses biodegradable materials where this is possible.

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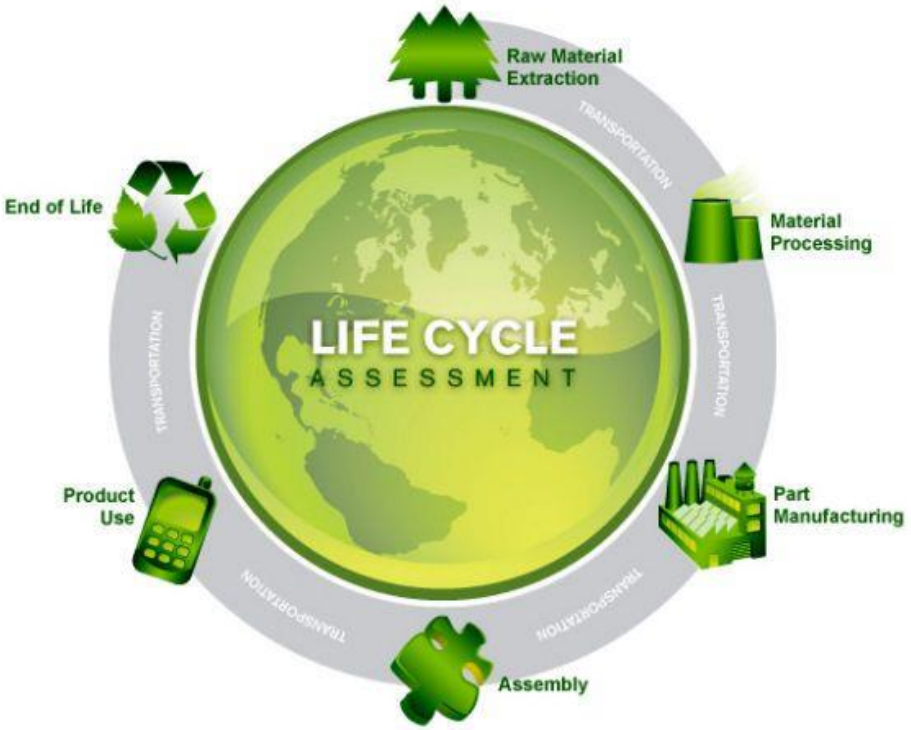
Methods of evaluating device lifecycle

- A useful tool for evaluating device's impact on the environment is a method of lifecycle evaluation. This approach examines the complete product lifecycle (LCA – Life Cycle Assesment). The LCA process analyzes the device from the design start to decomposition, recycling or disposal at the landfill.
- The LCA methodology evaluates all lifetime phases in terms of interdependence meaning one operation leads to another and so on.
- LCA enables evaluation of cumulative environmental effects that originate from all phases of the product lifecycle.



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Methods of evaluating device lifecycle

- By considering the effects through the whole product lifecycle, LCA provides a complete overview of an environmental characteristic of a product or process
- The method of lifecycle assessment uses device or system modeling and different databases that evaluate the environmental effects of certain materials or components.
- Often LCA is connected to use of complex scientific methods that demand an advanced understanding of risky natural science and technical areas, such as mathematics, chemistry, biology, and physics.

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Benefits of using lifecycle evaluation for electronic devices

- The method of lifecycle evaluation provides many benefits and possibilities for use.
  - **Improved device design.** Method LCA can be used as help in design and redesign. Companies can use LCA for comparison of environmental effects of the device and evaluation of different design possibilities. With this evaluation, the company can see if the device has environmental benefits or weaknesses.
  - **Providing environmental information.** With the increased use of lifecycle method in the whole supply chain, the companies can share their data on environmental effects of their products to others in the chain. LCA quantifies input and output data of all phases of the lifecycle of production and the device.

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Benefits of using lifecycle evaluation for electronic devices

- **Marketing.** LCA can be used as a marketing tool. It is used in product development which shows that the product is improved from the ecological perspective. Use of LCA tool could be the driving force for the consumers who want to use environmentally friendlier products.
- **Financial benefits.** As previously mentioned, LCA evaluates the product's lifecycle and determines where the main environmental effects occur. These effects can be reduced by increasing device efficiency, using suitable materials and by different production technologies. The increase of resource use efficiency will lower the quantities of used resources. Consequently, less waste will be made, and the costs will be decreased.

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Use of lifecycle evaluation method for electronic devices

- LCA is a technique that evaluates the environmental effects and potential effects related to the product or service. This is an analytical method that can help the company to evaluate all inputs and outputs of their production process.
  - First is the preparation of a list of suitable energy inputs, materials and environmental outputs (for example emissions, disposal of solid waste, separation of wastewater).
  - Evaluation of possible environmental effects related to the defined inputs and outputs.
  - Interpretation of results as the basis for decision-making.

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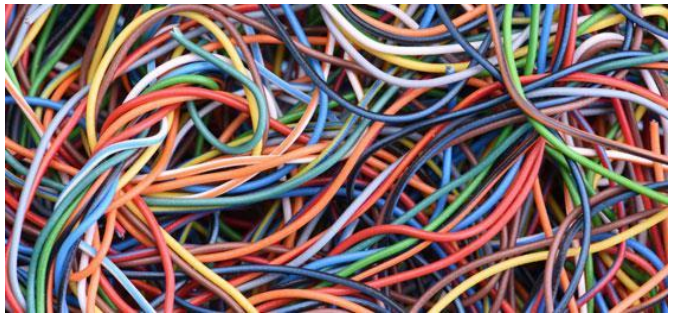
Use of lifecycle evaluation method for electronic devices

- Main areas of LCA are:
  - The examination of the problem source, related to the product or service.
  - Evaluation and analysis of possibilities for product or service improvement.
  - Design of new devices and possibility to compare the product with other similar products.



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Use of lifecycle evaluation method for electronic devices

- Environmental policy is oriented on the device production and guides the companies to use of lifecycle analysis method.
- By describing the product lifecycle from cradle to grave it is possible to analyze all effects, consequences, and participants in the whole life chain. This way, it is easier to accept certain solutions and determine optimal design and use of the given product.
- Environmental management system EMS , such as ISO 14000 or EMAS work on achieving environmental goals of the company and determine the criteria when the goals are achieved.
- LCA solely evaluates the consequences to the environment on all phases of device's lifetime
- LCA also significantly contributes to the scientific and transparent basis for determining ecological criteria for the Europen ecological labeling.

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An example of using LCA in a company

- The table presents an example of LCA use in a company.

Application	Example
Establishment of Environmental Focus	Identification of areas for improvement. Product-oriented Environmental Policy Environmental Management.
Design Choice	Concept Selection. Component Selection. Material Selection. Process Selection.
Environmental Documentation	ISO 14000 Certification. Eco-labels.

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