Module-18

Economic, Environmental, and Social issues of material usage

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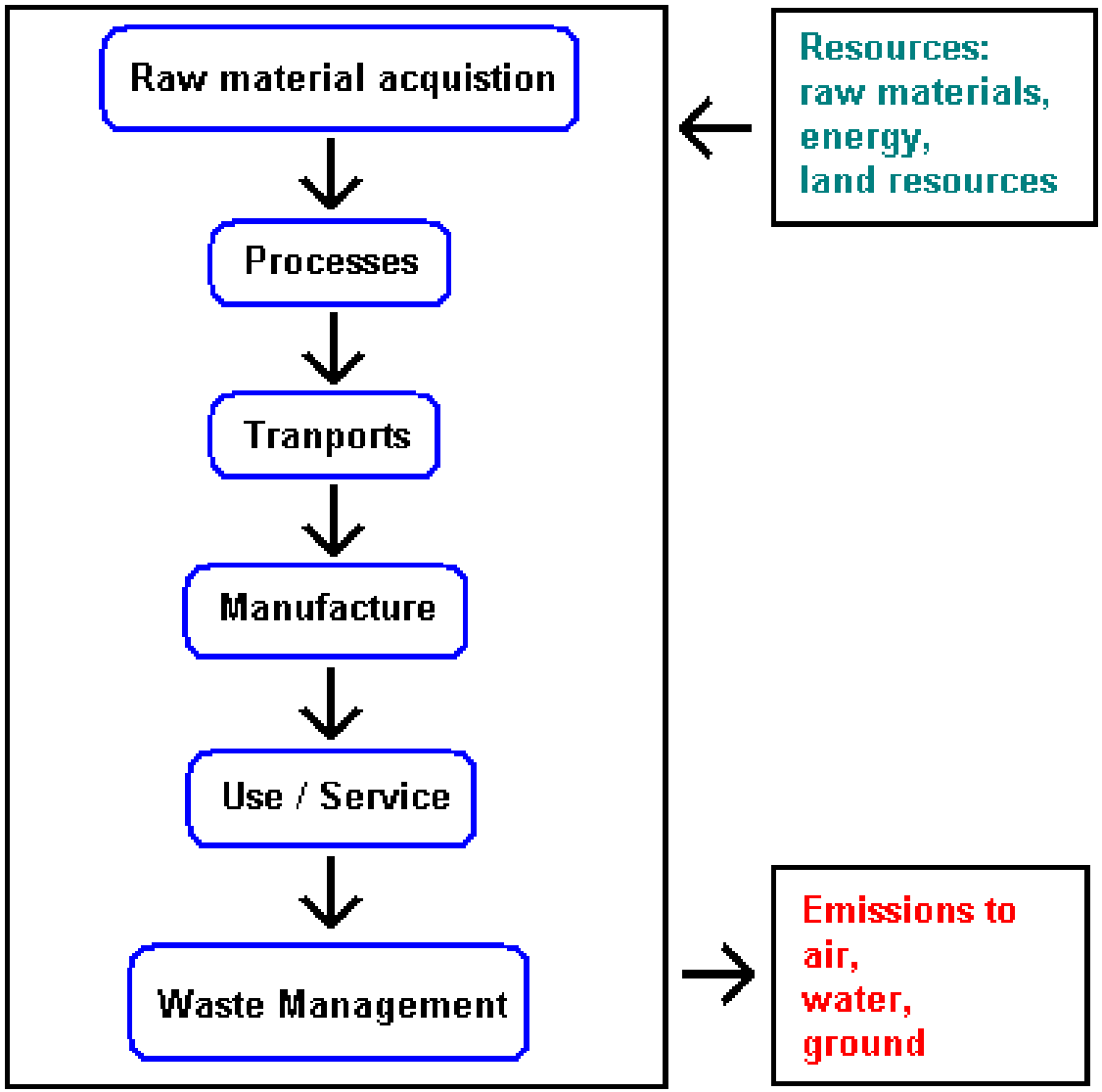
Economic considerations

- Economics of engineering a component / system depends on three factors: component design, material usage, and manufacturing costs.
- All these three factors are inter-related i.e. one or two might influence the choice of others.
- Manufacturing of a component starts from conception, design, material selection.
- Material life starts from extraction, forming into a component, service, and disposal.
- Inspection, packing, and transportation adds onto the increase the cost of a product.

Environmental considerations

- Manufacturing of a product does have impact on environment in many ways.
- This is because resources required to produce a product comes from different parts of the world.
- Along with these, detrimental effects of industrialization also spread its wings to various parts of the world.
- A material used to produce a product goes through number of stages / phases.
- These include extraction of raw materials from natural resources through production, use during the service, and finally its disposal. It is some times known as *cradle-to-grave life cycle* of a material.

Life cycle model



Material life cycle

- Raw materials are first extracted from natural earthy resources through drilling, mining, etc.
- Later-on these are subjected to purification, refining to convert them into metals, ceramics, rubber, fuel, etc.
- These primary products are further processed to obtain engineered materials like metallic alloy, glass, plastics, semi-conductors, etc.
- Now the engineered materials are shaped, heat treated to make components which are assembled into products, devices that are ready for use by society.
- During the service, products become old, out fashioned, break down, or may not serve the purpose efficiently. So they are discarded. This competes the life cycle.

Social issues

- Raw materials and energy are prime components for manufacturing a product.
- However, they are limited in nature!
- Hence, materials and energy need to conserved.
- Material life cycle involves interactions and exchanges among materials, energy and the environment including the society.
- Social issues of material usage relates to weather distribution, and safe waste disposal.
- Products are needed to be designed and manufactured such that they are environmentally friendly, and easy to recycle. In case of disposal into environment, products need to be bio-degradable.

Recycling issues

- Metals and alloys tend to get corroded up to some extent i.e. bio-degradable. However, some of them are toxic. On the other hand, most metals and alloys are recyclable.
- Ceramics / glasses are, however, are hardly recycled. It is because their raw materials are inexpensive, and recycling process is time consuming and expensive.
- Plastics are mostly recycled, and just disposed through land-fills. Thermo-plastic polymers are easily recycled up on heating to higher temperatures. On the other hand, recycling of thermo-set plastics is much more difficult. Hence these are usually disposed. Thus, there is a trend to use alternative materials which are recyclable. Ex.: thermo-plastic elastomers in place of traditions rubber.

Life Cycle Analysis

- Industrial approach to assess the environmental performance of products is termed as *life cycle analysis / assessment* (LCA).
- The complex interaction between a product and the environment is dealt with in the Life Cycle Assessment (LCA) method. It is also known *Ecobalance*.
- One important reason for undertaking an LCA study is that there are growing concerns about a variety of environmental issues as expressed by public opinion, political bodies, and industry.
- LCA systematically describes and assesses all flows to and from nature, from a cradle to grave perspective.
- LCA is not only product-orientated; it is also quantitative and thus seemingly objective. Thus, it was no longer necessary to reply on simple rules of thumb.

LCA use in design

- LCA is a technique for assessing the environmental aspects and potential impacts associated with a product by

- complaining an inventory of relevant inputs and outputs of a product system;
- evaluating the potential environmental impacts associated with those inputs and outputs;
- interpreting the results of the inventory analysis and impact assessment phases in relation to the objectives of the study.

- With respect to product design, there is a need to understand how a product impacts on the environment. To develop truly sustainable products, it must be possible to assess which design solution is environmentally preferable. LCA tools can help in this difficult area of *eco-design*.