1.10: Green Products and Services- Design for Sustainability

Green products use relatively smaller amounts of material and energy and throughout their life cycles from manufacture to disposal minimize exposure of humans and the environment to hazardous substances, pollutants, and wastes. A **green service** fulfills these criteria in providing a service. A hybrid fuel/electric automobile with a capability of recharging its battery from the electrical grid has minimum environmental and sustainability impact so it is a green product. The function of such an automobile can be replaced by a green service consisting of efficient rail and bus transportation.

Green products have several characteristics in common. One is high durability so long as it does not pose undue disposal problems. Another characteristic is low potential for exposure to toxic substances. A green product comes with minimal, recyclable packaging and is generally reusable, repairable, and capable of being remanufactured. Green materials used in consumer applications are relatively more concentrated with minimum inert ingredients so that they are economical to transport (a concentrated liquid laundry detergent compared to detergent in a granular formulation containing a lot of filler). Business and governmental practices and infrastructures can determine product sustainability. For example, a sustainable product requires that it be easily repaired and that repair parts are readily available. The sustainability of electrical batteries requires dropoff points and infrastructure for recycling of the materials in the batteries. A good example is the need for facilities to reclaim and recycle the lithium in lithium ion batteries as these sources of electrical energy storage become more popular in a world where sources of lithium are limited. Efforts have been made in some countries to require product take-back to enforce recycling components and materials in spent products.

The practices of design **for environment and design for sustainability are** key aspects of eco-efficiency.[10]In the practice of design for environment, environmental performance and potential environmental impacts are given priority consideration in the earliest stages of product development including raw materials acquisition, manufacturing, packaging, distribution, installation, operation, and ultimate fate at the end of the useful product lifetime. Design for sustainability does much the same thing with emphasis upon minimizing impact upon Earth's natural capital.

The following is a list of some specific design characteristics that go into design for environment and design for sustainability:

- Material substitution to use readily available materials from renewable sources that require relatively less energy for processing and that are recyclable,nontoxic, and environmentally friendly
- Minimize packaging
- Products with long lifetimes
- Promote recycling and reuse with products designed for separability, disassembly, reuse, remanufacture and recyclability.
- Consumptive materials should be biodegradable or capable of being burned for energy without emitting harmful byproducts (avoid bound halogens and heavy metals in plastics)

LITERATURE CITED

1. “World Commission on Environment and Development,”*Our Common Future*, Oxford University Press, New York, 1987.
2. Owen, David, Green Metropolis: Why Living Smaller, Living Closer, and Driving Less are the Keys to Sustainability, Riverhead Hardcover, 2009, New York.
3. Raven, Peter H., Linda R. Berg, and David M. Hassenzahl, *Environment*, 6th ed.,Wiley, 2008.
4. Carson, Rachel, *Silent Spring*, Fawcett Crest, New York, 1964.
5. “The Tragedy of the Commons,” Garrett Hardin, *Science*, **162**, 1243, (1968).
6. Duncan, Dayton,*Miles from Nowhere*, Viking, New York, 1994, p. 145.
7. Baum, Rudy M., “Sustainability: Learning to Live Off the Sun in Real Time,”*Chemical and Engineering News*, **86**, 42-46 (2008).
8. Anastas, Paul, Irvin J. Levy, and Kathryn E. Parent, *Green Chemistry Education: Changing the Course of Chemistry*, Oxford University Press, Oxford, UK, 2009.
9. Anastas, Paul T., and John C. Warner, *Green Chemistry: Theory and Practice*, Oxford University Press, Oxford, UK, 2009.
10. Jasch, Christine, *Environmental and Material Flow Cost Accounting: Principles and Procedures (Eco-Efficiency in Industry and Science)*, Springer, Berlin, 2008.