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Water and Other Natural Resources

In this chapter, we take a closer look at how the use of water and other natural resources impacts product design. Let's start with the simple, undeniable fact that we're running out of lots of natural resources—both renewable and nonrenewable. A nonrenewable natural resource is one that cannot be remade, regrown, or regenerated on a scale comparative to its consumption. Often, fossil fuels, such as coal, petroleum, and natural gas, are considered nonrenewable resources, as they do not naturally re-form at a rate that makes the way we use them sustainable.

A renewable resource differs in that it may be used but not used up. Fresh water is one example. Other examples include natural resources such as timber, which regrows naturally and can, in theory, be harvested sustainably at a constant rate without depleting the existing resource pool, and resources such as metals, which, although they are not replenished, are not destroyed when used and can be recycled.

Social Considerations

From a societal perspective, every time we use a natural resource we're shrinking the pool for everyone. The immediate and obvious result for consumers is higher prices, but the impact goes far deeper. Beyond depleting the common supply, the process of obtaining these resources from their natural setting can damage the environment. Anyone who's seen the results of a strip-mining operation or clear-cutting in forests can attest to that. The costs of finding more of the scarce resource can be staggering—just ask any oil company executive. Less obvious but equally important is the fact that depletion of natural resources eventually draws the attention of regulatory agencies, and companies are increasingly required to report on their use of these resources (see the "water footprint" discussion later in this chapter). In other cases, these resources come from countries or regions that may not fully comply with accepted employment standards—unfair wages, unsafe working conditions, underage workers, and so on.

Business Considerations

It doesn't take an economics degree to understand that nonrenewable resources will get more expensive as the available supply decreases. And since new products are being created all the time, there's no guarantee that a resource that seems abundant today will remain so in the future. Furthermore, civil unrest and wars can threaten supply.

Since products are often in design for years before going into production, understanding the potential impacts of price changes for your raw materials is vital. It's useful to look at historical price trends, but also to run through some scenarios where a market shock sends prices above their historical trends. This may increase the urgency with which you pursue alternative approaches.

Calculating the Water Footprint

How many liters of water does it take to make a cup of coffee? Sounds like the setup for a joke. Actually, it's an interesting way to envision the **water footprint** of products. In fact, according to Waterfootprint.org, it takes 140 liters of water to make a cup of coffee; it takes 900 liters of water to produce a kilogram of corn; and it takes 16,000 liters of water to produce a kilogram of beef. You get the idea. Studying the water footprint over the lifecycle of a product or service is the only way to get a clear picture of how much total water is embodied in each product or service we design.

The water footprint calculation is fairly straightforward, but with a couple of twists that you won't encounter in calculating embodied energy or greenhouse gas (GHG) emissions.

The water footprint of a product includes the total volume of fresh water used directly or indirectly over the product's lifecycle, and consists of three components: the water use in the producer's supply chain (indirect water use), the direct water use by the producer (for producing/manufacturing or for supporting activities), and the water use inherently associated with the consumption of the producer's products by others.

The lifecycle water footprint further breaks down into three categories: the blue, green, and gray water footprints.

- The **blue** water footprint is the volume of fresh water that evaporated from the global blue water resources (surface water and ground water) to produce the goods and services.
- The **green** water footprint is the volume of water evaporated from the global green water resources (rainwater stored in the soil as soil moisture).
- The **gray** water footprint is the volume of polluted water that associates with the production of all goods and services for the individual or community.

It is relevant to know the ratio of green to blue water use, because the impacts on the hydrological cycle are different. Evaporated water and polluted water are both "lost" (unavailable for other uses).

Trading Virtual Water

Since almost all products and services contain embodied water, when goods and services are exchanged, so is virtual water. For example, when a country imports a ton of wheat instead of producing it domestically, it is saving about 1,300 cubic meters of real indigenous water. The water that is "saved" can be used by the importing country for other purposes. That is why water-scarce countries such as Israel discourage the export of oranges (relatively heavy water guzzlers)—because that in effect prevents large quantities of water from being exported to different parts of the world.

In recent years, the concept of virtual water trade has gained weight in the scientific community and has become the subject of political debate. Trade in real water between nations or companies remains impractical because of the distances and associated costs, but trade in water-intensive products is feasible.

The notion is still is its embryonic stages, but as an analytical concept virtual water trade provides a way to analyze the impacts of consumption patterns on water use.[1] As a politically induced strategy, the questions are whether virtual water trade can be implemented in a sustainable way, whether the implementation can be managed in a social, economical, and ecological fashion, and for what countries the concept offers a meaningful alternative.

Other Natural Resources

There is now clear scientific evidence that humanity is living unsustainably by consuming the Earth's limited natural resources more rapidly than they are being replaced by nature.[2] Many excellent books and articles discuss natural resource usage and sustainability; we recommend that you visit the Appropedia Wiki at www.appropedia.org for an overview of key considerations and recent engineering community insights.

One important consideration pertaining to natural resource usage is often overlooked, however: hidden impacts or unintended consequences. An article posted on Yahoo.com[3] underscores the problem, explaining how coltan, a rare, unrefined metallic ore used in the manufacture of video game consoles, may have fueled violence in the Democratic Republic of Congo:

> *Allegedly, the demand for coltan prompted Rwandan military groups and western mining companies to plunder hundreds of millions of dollars worth of the rare metal, often by forcing prisoners-of-war and even children to work in the country's coltan mines. "Kids in Congo were being sent down mines to die so that kids in Europe and America could kill imaginary aliens in their living rooms," said Ex-British Parliament Member Oona King.*

It's not always possible to foresee every consequence and impact of the natural resources used in the products we design and manufacture, and worldwide supply-and-demand conditions for specific resources are not within an engineer's control. But to the extent possible, think through the short-term and long-term implications of the material selections you make. And if you have concerns, speak up. An ounce of prevention is still worth a pound of cure.