

# Putting Ecology Back into Design

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The first article in our series on sustainable design defined sustainability as being “...about sustaining the natural systems that support human life.” The reason for this is that natural systems provide a wide variety of ecosystem services that we and other living creatures depend on, such as soil formation, water supply, food production, climate regulation, nutrient cycling, pollination, erosion control, waste treatment, and many more. Although these services are provided by Mother Nature free of charge, they have great value. A 1997 article in *Nature* magazine conservatively valued nature’s services at \$33 trillion per year, compared with the total human economy that totaled about \$25 trillion. The analysis was based on estimated costs of replacing the services nature provides with equivalent services provided by human infrastructure alone. (1) In this second article in our series, we will briefly explore some ways that engineers are already incorporating, or might consider, natural systems in design.

## Process

The ecosphere — defined here as the biosphere plus the atmosphere that protects life on our planet - in which we live is a highly complex, ever-changing, adaptive system. Ecosystem services don’t occur in isolation from one another, but in relationships knitted together through biogeochemical mechanisms. Therefore, design to protect or restore ecological functions requires a holistic or systems approach rather than a focus on one, isolated component. We see this already occurring in integrated water management plans and watershed approaches to water management where public and private organizations join forces to create multidisciplinary and multijurisdictional partnerships to focus on water management.

If our goal is to maintain or restore ecological function, then when beginning a new project, the first step is establish aggressive environmental performance goals and related metrics. Environmental goals might include that the project: is carbon balanced, maintains pre-development hydrological function, provides wildlife habitat, etc. Ecological performance standards are regularly developed for ecosystem restoration projects and can also be developed for engineering projects. A couple of great resources for sustainability goals and indicators are:

- [Project Sustainability Management Guidelines](#): FIDIC, International Federation of Consulting Engineers
- *Sustainability Criteria for Water Resource Systems*: Task Committee on Sustainability Criteria, Water Resources Planning and Management Division, ASCE and the Working Group of UNESCO/IHP IV Project M-4.3, D.P. Loucks, chmn. Reston, VA: ASCE, 0-7844-0331-7, 1998, 253 pp. (unfortunately, this one is out of print).

Once goals and metrics are established, a sustainable design process will consider a wide range of alternatives. Tapping into a wide range of disciplines, as well as looking to nature and to other industries will often identify innovative solutions that do more with greater positive impacts. A great resource for discovering nature’s design strategies is the recently unveiled free [Ask Nature](#) online database that

accesses biological strategies by design function. In other words, you can ask Nature how to ‘regulate temperature’, or ‘clean water’. (Tip: The Browse function works better than the Search function at this point in time!)

Doing things in the right order is also important — preventing damage is typically more cost effective than remediating later. So first, you might consider ways to reduce impacts to the site to the extent possible through protecting portions from development, not channelizing waterways, etc. Next, you might improve ecological function of disturbed areas by using native landscaping, using rainwater harvesting and low impact development techniques to maintain local hydrological function, etc.

### Tool & Frameworks

- Natural systems are embedded in several widely used sustainability tools, including [The Natural Step Framework](#), the [Ecological Footprint](#), [Natural Capitalism](#), and [Cradle to Cradle](#).
- The Nature Conservancy has developed a [methodology and tools](#) to integrate environmental flow considerations into water management planning. Tools are available for application at individual project as well as at river basing or regional scale. Environmental flows refer the quantity, quality, and timing of water flows needed to sustain healthy freshwater ecosystems.
- [Life Cycle Assessment](#) (LCA) is a generally accepted, structured framework for assessing the environmental effects of a product or process over its entire life cycle (raw materials extraction, construction, use, maintenance, and final disposal).

### A Final Note

What better way to integrate natural systems into engineering design than to study those systems and emulate their deep design principles? Ecological engineers design solutions that incorporate the self-organizing and self-maintaining processes of the environment. Applications include designing ecosystems to process wastes, such as constructed wetlands, and restoring heavily altered landscapes such as the Everglades and those created by surface mining operations.

[Biomimicry](#) is an emerging discipline that studies and emulates nature’s remarkably effective designs to solve human challenges. It can be used as a tool for innovation to develop or redesign products and processes. One example is PAX Scientific, an industrial design firm that has developed [fans](#) and [mixers](#), based on the spiral geometries found in natural fluid flow. Depending on application, the resulting designs reduce energy usage by a staggering 10-85% over conventional rotors, and noise by up to 75%. At a deeper level, engineers can use ‘Life’s Design Principles’ as sustainable design criteria for their own projects... after all life has 3.8 billion years of experience with what works here on Earth! Perhaps the best place to start integrating ecological systems into our work is by looking to nature as teacher rather than merely as a supply of resources, and asking, “How would Nature...?”

What questions do you have about ecosystems? Send them to Helene Hilger, Chair, Sustainability Task Committee, at [hhilger@uncc.edu](mailto:hhilger@uncc.edu).

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(1) Costanza et al. The value of the world’s ecosystem services and natural capital. *Nature* 387:253-260 (1997).