Okala

learning ecological design

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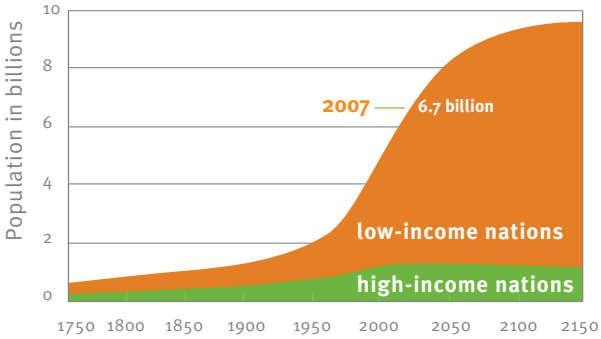
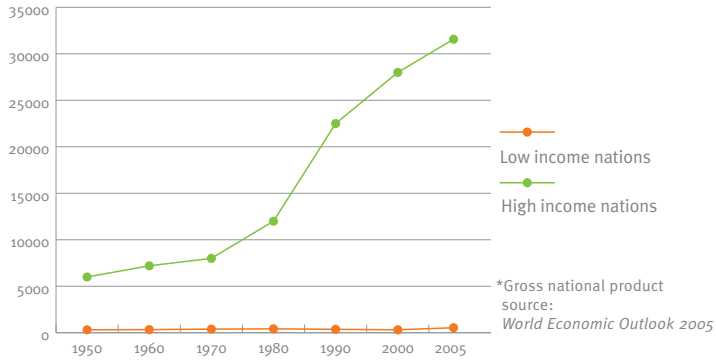
High-income versus low-income populations

Most population growth occurs in the low income nations, as graph A illustrates. Per person income is greater and per person resource consumption and per person resource depletion are proportionately greater in the high income nations (graph B).

graph A: Projected Human Population Growth



graph B: Global per person GDP* in $US



Sustainable development

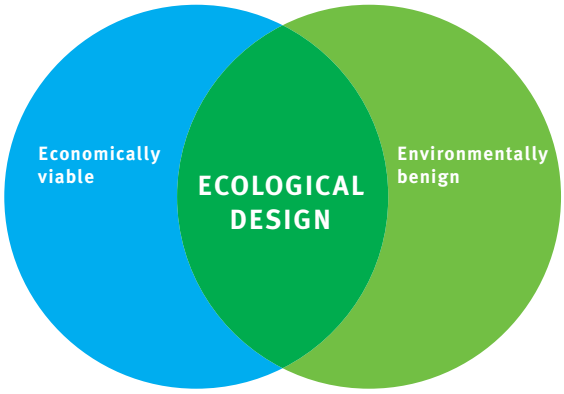
"Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development is about making life better for everyone. This should not involve recklessly destroying our natural resources, nor should it involve polluting the environment."

The United Nations Commission on Environment and Development (the Bruntland Commission) 1987

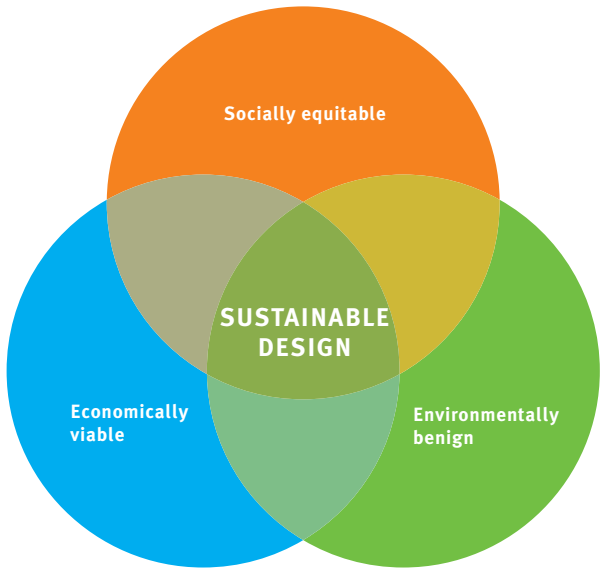
The sustainable economy

A sustainable economy would use only the net available solar energy. Such a system would consume a fixed and non-growing amount of physical resources, like biological systems. In such a steady-state system, the term "sustainable economic growth" is a contradiction.

Source: *VALUING THE EARTH: Economics, Ecology, Ethics*, Herman E. Daly and Kenneth N. Townsend, 1993



ECOLOGICAL DESIGN is environmentally benign and economically viable.



SUSTAINABLE DESIGN is environmental benign, economically viable and socially equitable.

Environmental impact categories

These impact categories encompass a broad range of real and potential damage, and include most of the impacts that are monitored and modeled by current scientific methods.

Ecological Damage

- Global warming
- Ozone depletion
- Acid rain
- Water eutrophication
- Habitat alteration
- Ecotoxicity

Human Health Damage

- Photochemical smog & air pollutants
- Health damaging substances
- Carcinogens

Resource Depletion

- Fossil fuels
- Fresh water
- Minerals
- Topsoil

Ecological Damage

Global warming

Global warming (or climate change) results from the addition of gases to the atmosphere through burning fossil fuels, agricultural practices and industrial practices that raise the temperature of the Earth's atmosphere. Rising temperature accelerates: incidence of storms, desertification, range of tropical diseases, melting glaciers and polar ice, changes in marine ecologies and possible changes to ocean currents. Climate change could cause the extinction of quarter the species of plants and animals on Earth in the next 50 years. The cost to humanity, in wealth, environmental security, and quality of life will be extreme.

Ozone depletion

Stratospheric ozone depletion is caused by emissions of chlorinated fluorocarbons (CFC's) such as Freon and related compounds. Ozone in the upper atmosphere is destroyed, leading to "ozone holes" above the North and South poles. Ozone loss increases the ultraviolet (UV) light falling on the Earth, leading to cancers and cataracts in animals and humans. The UV light also reduces the productivity of plants, affects marine algae and affects the life forms in high latitudes. The 1992 Montreal Protocol banned use of 42 ozone-depleting chemicals internationally.

Acid rain

Acid rain (acid precipitation) is caused by the release of acidic gases, primarily from burning fossil fuels. The acids dissolve aluminum and other metals from soils to the level at which they become toxic to plants and to aquatic organisms. Acidic rain dissolves cement and minerals in the built environment.

Water eutrophication

Eutrophication is caused by the addition of excess nutrients to water leading to reduction of available oxygen. Nitrogen and phosphorous compounds from municipal wastewater and agriculture pollute surface waters. This results in algal blooms that lower the quantity of dissolved oxygen that kills fish and other aquatic organisms.

Habitat alteration

Habitat alteration (also referred to as land-use) is the physical modification or destruction of natural habitats. Ecosystems are destroyed to provide for agriculture, roads and urban growth. Habitat alteration is the primary cause of the loss of biodiversity on the planet.

Ecotoxicity-

Ecotoxicity is the effect of toxic substances on plants, animals and other biota in the natural environment. The range of possible effects is large and methods of assessing these impacts are still developing.

MODULE 7

Challenging our beliefs

SUGGESTED READING

Ishmael: An Adventure of the Mind and Spirit, by Daniel Quinn, pub. Bantam books, 1995
Readings #1–3 on following pages

Many of the questions we face about the environment today are challenging. One of the most difficult and perhaps most salient is the question of why: Why are humans, with our extraordinary capacity for reflection and intelligence, soiling our nest? In answering this question we might come to grips with the underlying belief systems that determine how we treat the natural world, and—more importantly—create new beliefs that invite different behaviors toward the environment. This essay provides an overview of several areas of research that may challenge some of our belief systems. Much of this research and discussion is located under the umbrella of Environmental Ethics, a branch of philosophy that examines the relationship between nature and humanity.

Environmental ethicists ask whether the environment might have moral rights that contravene the notion that human beings can use nature for our own benefit. If this sounds absurd, consider that throughout the 20th century, our culture's perception of moral rights has changed again and again. At one time, it was considered acceptable to own slaves, it was taken for granted that African Americans should be segregated, and it was presumed that women did not have sufficient intelligence to vote. These modes of thought were considered normal in their day, and yet with the passing of time they now appear ridiculous. Might it some day be that way with respect to the rights of nature? How different would our handling of the natural world be as a result?

Historian Donald Hughes writes that the modern ecological crisis was made possible by our view of the natural world as something to be freely used. Hughes claims that by contrast, the animist religions of ancient cultures held nature to be sacred, on a plane equal to mankind.[1] This belief limited what cultures felt able to "take" from nature, as described in Daniel Quinn's fable Ishmael[2]. Several late stone-age cultures (including Egyptian, Judaic and its descendent Christian) replaced animism with a monotheistic belief that placed humans in a superior position to nature, and encouraged its exploitation[3]. The subsequent changes that took place through Roman times, (nature pillaged) and Medieval times (nature ignored) take us to the industrial revolution and the modern age, where a common belief is that science and technology prevail over everything: religion and nature included. Many people hope blindly that technology will offer us easy solutions to the ecological crisis. Hughes' overview offers an opportunity to question our assumptions: Is humanity separate from, and more important than nature? Does nature exist only to be of service to humankind? Is Capitalism yet another implicit belief system, one that is particularly relevant to industrial designers who measure success according to the number of units sold?

In recent history, a handful of radical thinkers called for a new view of nature. Rachel Carson sounded the alarm about the dangers of DDT and other bioaccumulative toxins[4] in 1962, and Arne Naess challenged environmentalists as being motivated by a shallow desire to maintain the wealth of developed countries[5].By the end of the 1970's, many people began to study the ethical questions around our use of natural resources, and to discuss the abuse of nature that stemmed from our culture's prevailing sense of entitlement as higher beings (also known as Anthropocentrism). By

Ecodesign Strategy examples

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a The body raft uses local elm wood and contributes to the local economy. If it is sold outside of the region, the lightweight chair is inexpensively shipped. David Trunbridge, New Zealand
4 efficient distribution

b The Celle chair by Herman Miller uses fewer material types, reduces production costs and enables easy disassembly for recycling.
3 optimized manufacturing and #7 end of life

c Dyson developed bagless vacuum technology for the Dual Cyclone cleaner.
5 low-impact use

d This iron pot's aesthetic and material quality references both the past and the future. By Timo Sarpaneva, Finland
5 optimized lifetime

e The IXI bike is a compact urban vehicle that encourages pedal-powered trips and mass transit, thereby reducing CO_2 emissions and traffic congestion.
5 low-impact use

f The Karcher power washer uses few types of material and easy disassembly for recycling.
7 optimized end-of-life

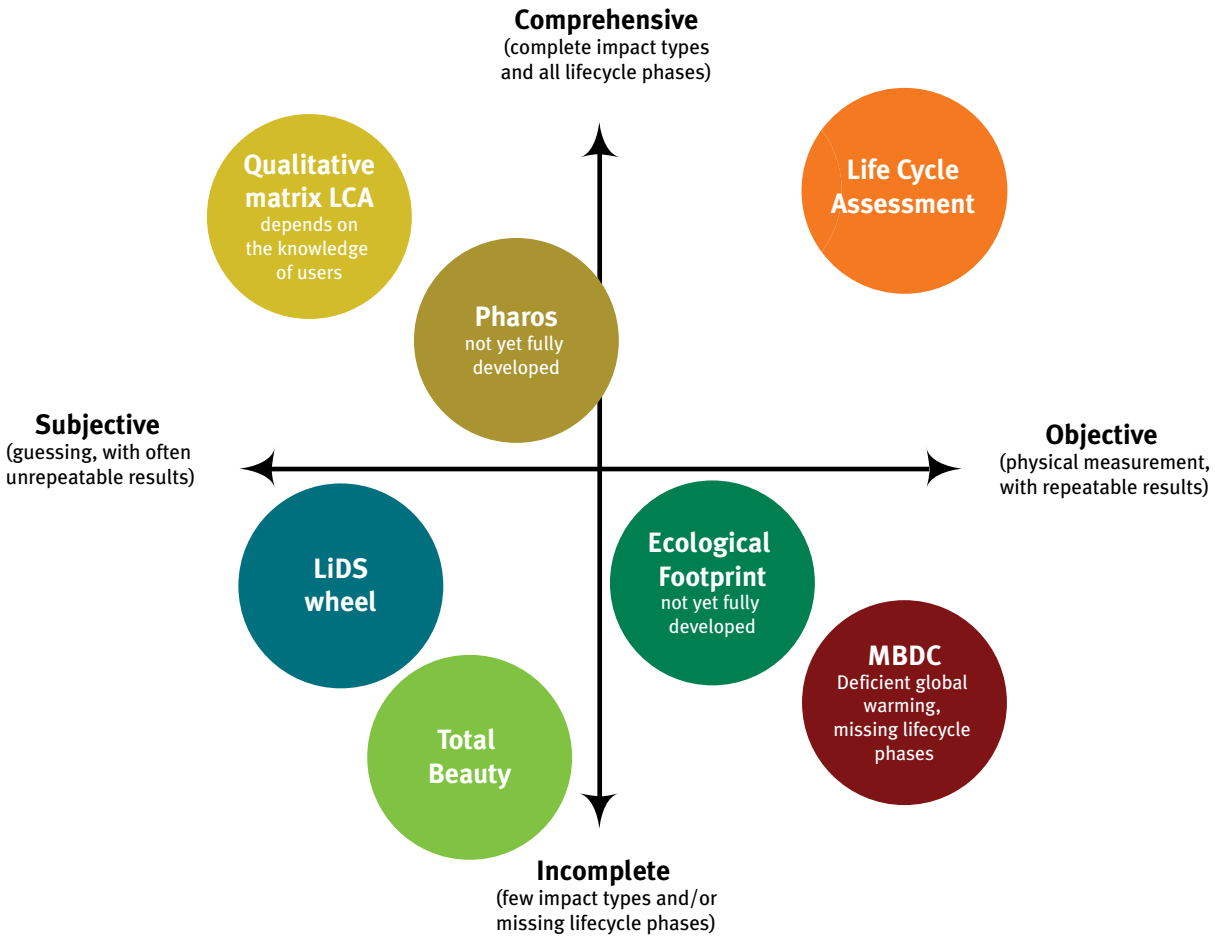
g MP3 technology (such as the Apple Ipod) affords efficient distribution of digital content, eliminating impacts from packaging and shipping.
1 innovation and 4 efficient distribution

MODULE 14

Life Cycle Impact Assessment

SUGGESTED READING

Design + Environment, Lewis & Gertsakis, Environmental Assessment Tools, Chapter 3
available at: www.idsa.org, eco-design section



Environmental Impact Assessment Methods

MODULE 15

Impact factors

OVERVIEW

Some of the Okala impact factor values follow common sense, while some of them contradict preconceived notions.

The Okala Impact Factors each contain impacts from the ten impact categories outlined in Table H. The 2007 impact categories are specified by the TRACI impact assessment method, which was developed by the US EPA. Normalization values per person per year for the US as outlined in the table I. The Okala Impact factors also used the draft weighting values specified by the US National Institute for Standards and Technology (NIST) in 2006. Together, these values yielded the individual Okala Impact Factors 2007 on the following pages.

Table H
TRACI Impact categories included in Okala Impact Factors

Acidification
Ecotoxicity
Fossil fuel depletion
Global warming (climate change)
Human cancer
Human respiratory
Human toxicity
Ozone layer depletion
Photochemical smog
Water eutrophication

Polymers and elastomers

Designers can discern much about the environmental performance of materials and processes from the Okala impact factors. For instance, secondary (recycled) polymers values are lower than primary (virgin) polymer values, because refining the raw petroleum into plastic makes more emissions than the plastic recycling process. Secondary plastic factors assume that other substances have not contaminated the plastic.

Metals

The range of impacts among metals is larger than the range among plastics. Stainless steel is more damaging per unit than regular steel, and precious metals have extremely high impacts. Like plastics, secondary (recycled) metals have lower impacts than primary (virgin) metals because primary metals require large amounts of ore to be processed and smelted.

Energy and transportation

Photovoltaic (solar) electricity (excluding storage batteries) has lower impacts per kilowatt-hour than typical electricity from the wall plug. Wind derived electricity is even better. Air transport is much more damaging than road transport, while rail and water transport are the least ecologically damaging. Nuclear fission derived electricity demonstrates low environmental impacts, but nuclear fuels can be made into weapons of mass destruction and are therefore not advisable.

Landfill and incineration

Landfills are the destination for the vast majority of products in North America. Okala landfill factors are based on year 2000 Swiss eco-invent data from sealed landfills that release few emissions to air or water. These values do not apply to regions where unsealed landfills leak into groundwater and surrounding soil. Incineration is rare in North America, but common other parts of our planet. Incineration values are also based on year 2000 Swiss data; they do not apply to regions where products are burned in the open air. Sadly, we lack essential landfill and incineration data for many common substances. If you know that the product will be disposed of in an open pit landfill or that it will be burned in the open air, you should multiply the landfill or incineration impact factors by 100.

Data uncertainties

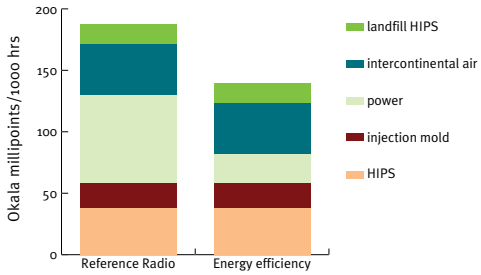
People in different locations use differing methods to collect inventory data for LCAs. Uncertainty about the thoroughness and consistency of the data are unavoidable. Among data from similar types of materials and from the same data collector, uncertainties should be negligible. Uncertainties among data from different collectors and among different types of material are larger. Assessment results are not more precise than two significant figures.

"METAL, POLYMER and OTHER SUBSTANCES" refer to the impacts resulting from the extraction of raw materials from nature and the processing of the raw materials to deliver these materials. Likewise "METAL PROCESSING and POLYMER PROCESSING" refer to the impacts from an additional manufacturing process applied to the material.

Example B. Increase energy efficiency

By changing the electronics to a much more efficient system, we reduce the electrical energy use from 6 kW-hrs to 2 kW-hrs, and we reduce the overall impact from 188 to 140 millipoints, a 26% reduction.

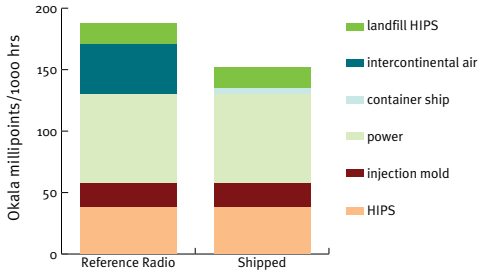
ENERGY EFFICIENCY			Impact factor	Impact
HIPS	2	lbs	19	38
injection mold	2	lbs	10	20
power	2	kW-hrs	12	24
intercontinental air	1.82	ton-mi	23	41
landfill HIPS	2	lbs	8.4	16.8
		Okala millipoints per 1000 hrs:		**140**



Example C. Efficient transport

By changing the mode of transport from intercontinental airfreight to container ship, we reduce the overall impact from 171 to 148 millipoints, a 21% reduction.

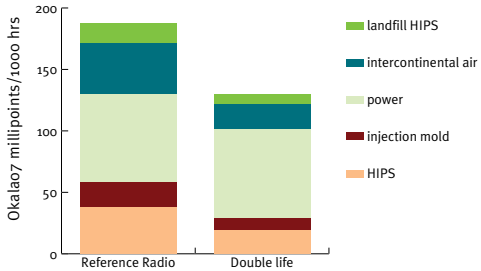
EFFICIENT TRANSPORT			Impact factor	Impact
HIPS	2	lbs	19	38
injection mold	2	lbs	10	20
power	6	kW-hrs	12	72
container ship	2	ton-mi	2.5	5
landfill HIPS	2	lbs	8.4	16.8
		Okala millipoints per 1000 hrs:		**148**



Example D. Extend product life

By doubling the functional life to 2000 hours, the energy use per unit time stays constant, but the other factors decrease by 50%. Overall, we reduce impact per 1000 hours from 188 to 130 millipoints, a 31% reduction.

EXTENDED LIFE			Impact factor	Impact
HIPS	2	lbs	19	38
injection mold	2	lbs	10	20
power	12	kW-hrs	12	144
intercontinental air	1.82	ton-mi	23	41
landfill HIPS	2	lbs	8.4	16.8
		Okala millipoints per 2000 hrs:		**260**
		per 1000 hrs:		**130**



Example E. Design for disassembly and recycling

Credit for recycling materials currently goes to the secondary (recycled) material. LCA practitioners strive to avoid "double counting," but we want to encourage recycling. We allow half of the value of difference between the primary and the secondary materials to be subtracted if the product has been designed for fast disassembly and recycling. In this case, the value of the recycled HIPS is 19 – ((19 – 14)/2) = 16.5. We also eliminate landfill impacts. This drops the overall impacts from 188 to 166 millipoints, a 12% reduction.

DESIGN FOR RECYCLING			impact factor	impact
HIPS	2	lbs	16.5	33
injection mold	2	lbs	10	20
power	6	KW-hrs	12	72
intercontinental air	1.82	ton-mi	23	41
		Okala millipoints per 1000 hrs:		**166**