Sustainable Minds™

Design greener products right – from the start

Learn, assess, design, model, visualize and report

www.sustainableminds.com
Twitter : @sustainablemnds

Overview

- Introduction
- Key LCA concepts
- LCA Example
- Ecodesign strategies
- Ecodesign example
- Features of Sustainable Minds
- Demo

Ecodesign (new ideas) + **LCA** (metrics and measurement) =  (truly greener products)

Innovation +  = 

Scenario: 2 digital prototypes* for hardware packaging solution

Design goals: greener than current packaging

Questions:

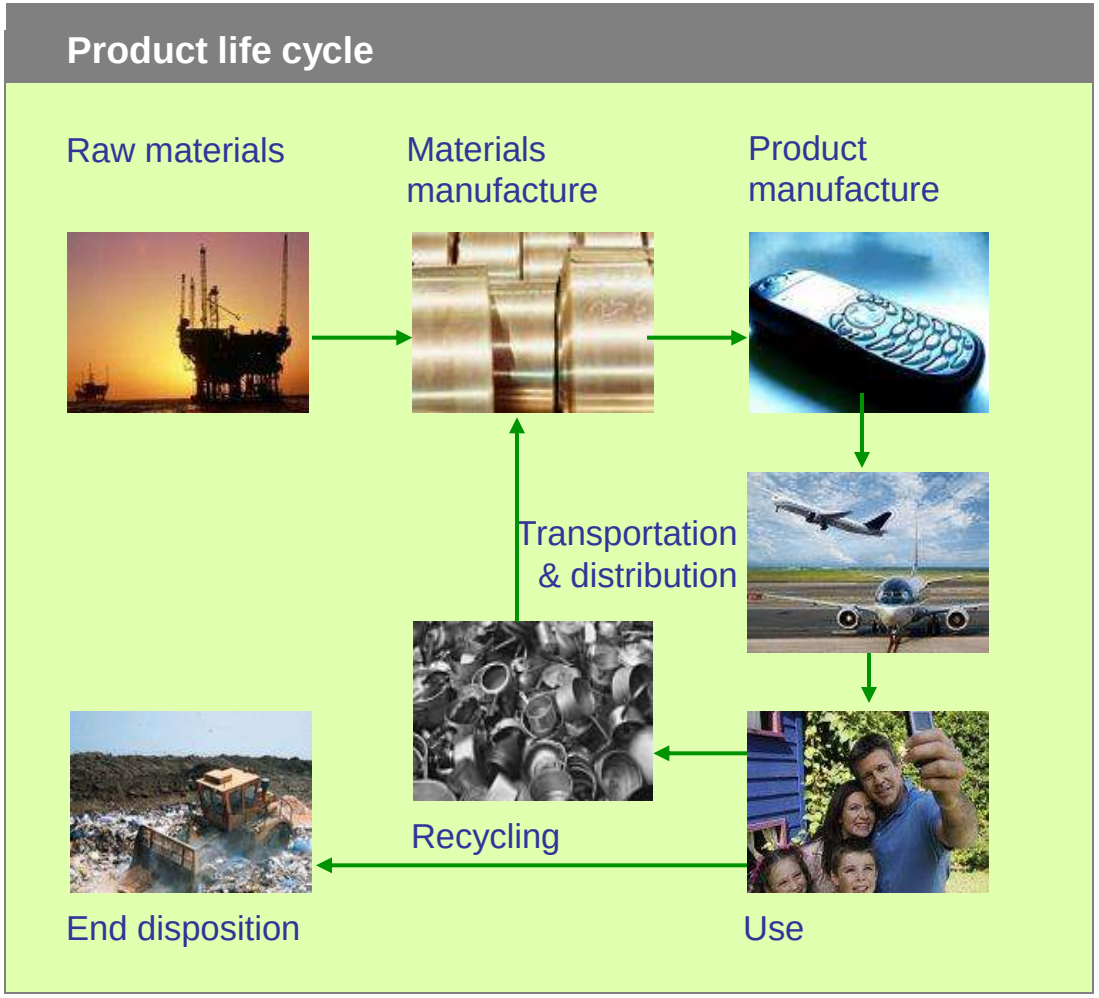
- Which has better environmental performance?
- What quantitative data supports options for management decision?

Option 1: Recycled cardboard

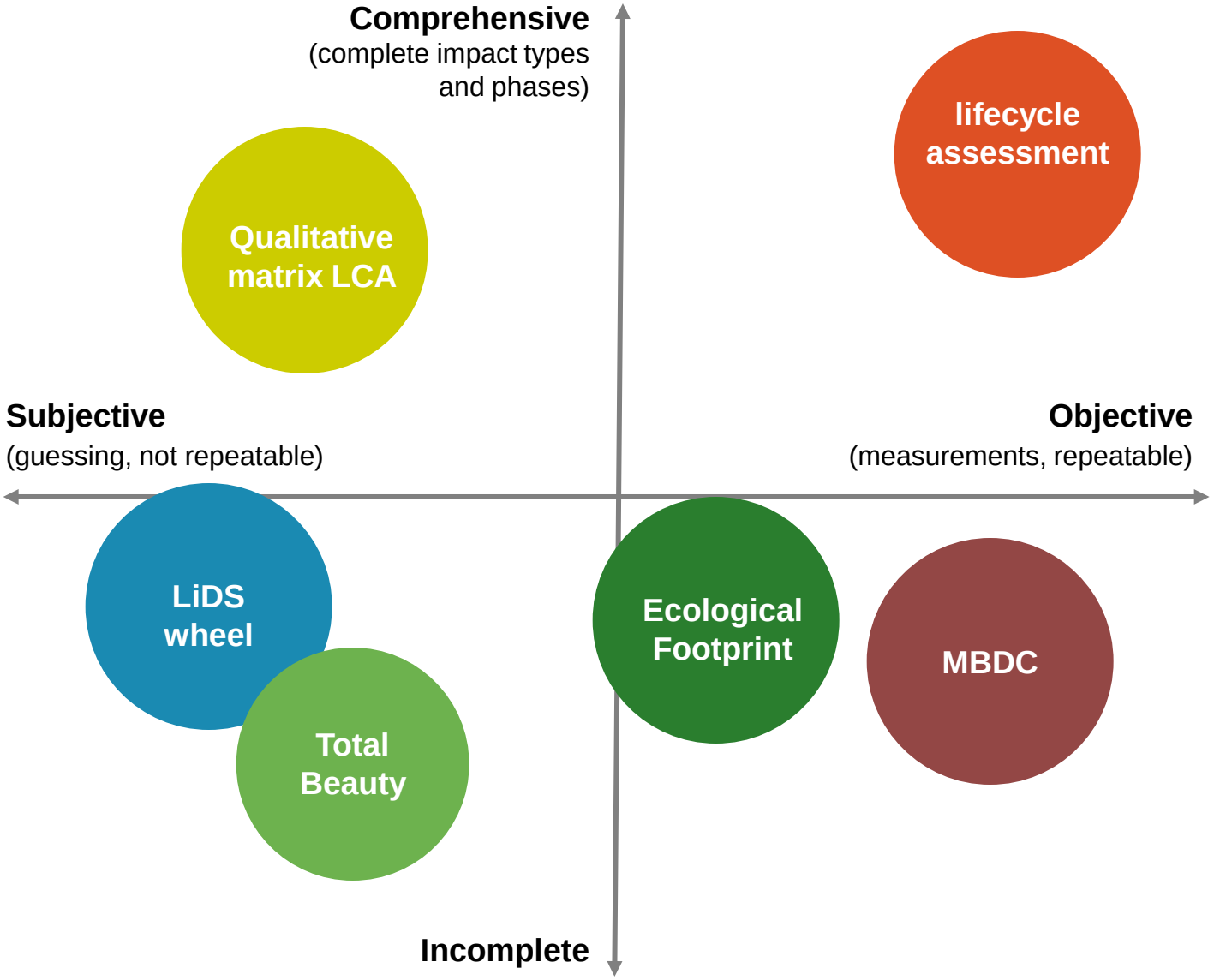
Option 2: Reusable HDPE case

Key LCA Concepts

To shift to environmentally sustainable design, life cycle mindsets must be adopted and incorporated during *conceptual design.*



Environmental impact assessment methods



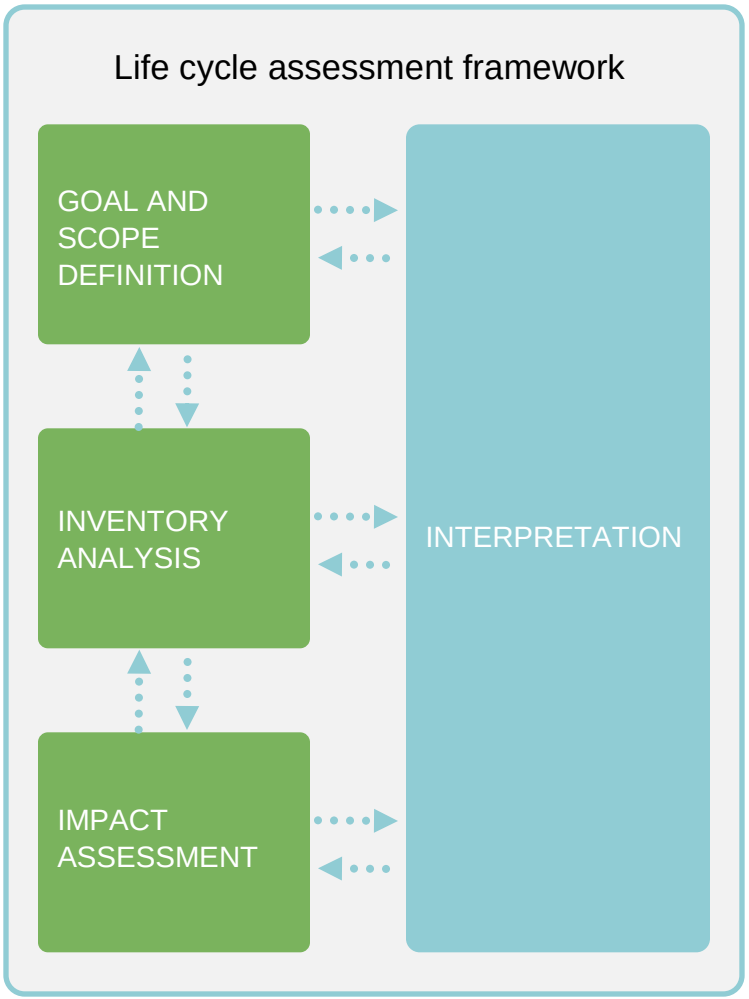
Life cycle impact assessment (LCA)

LCA is both **objective**, based on quantified measurements, and **comprehensive** including the entire lifecycle of the system and including most impacts categories.

LCA is an internationally recognized method.

Its practice is guided by international standards,
ISO 14040 LCA series.

ISO 14040 framework

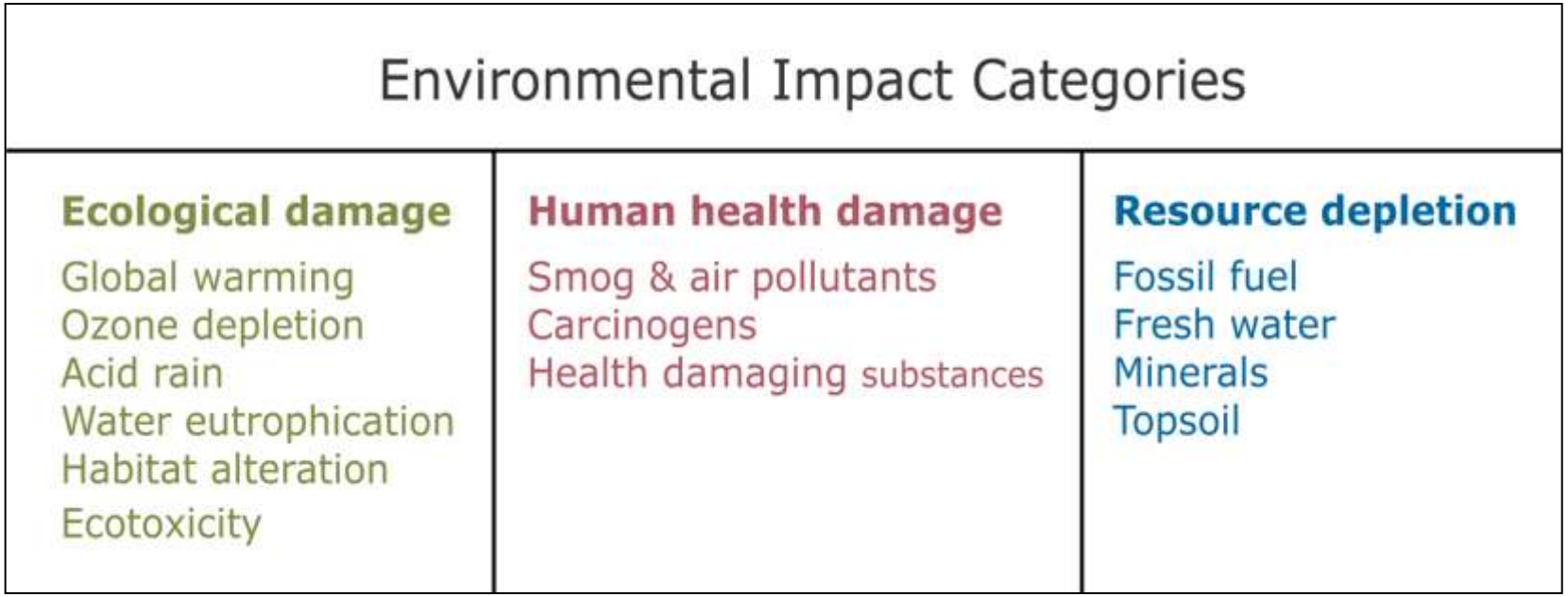


Source: ISO 14040

Ecological & environmental impacts

A single product can create many different kinds of environmental damage. Environmental impacts are typically grouped into three general groups: ecological damage, human health damage and resource depletion.

Although some impacts create both ecological damage and human health damage, they are categorized according to their primary impact group.



Ecological damage:

Water eutrophication

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.

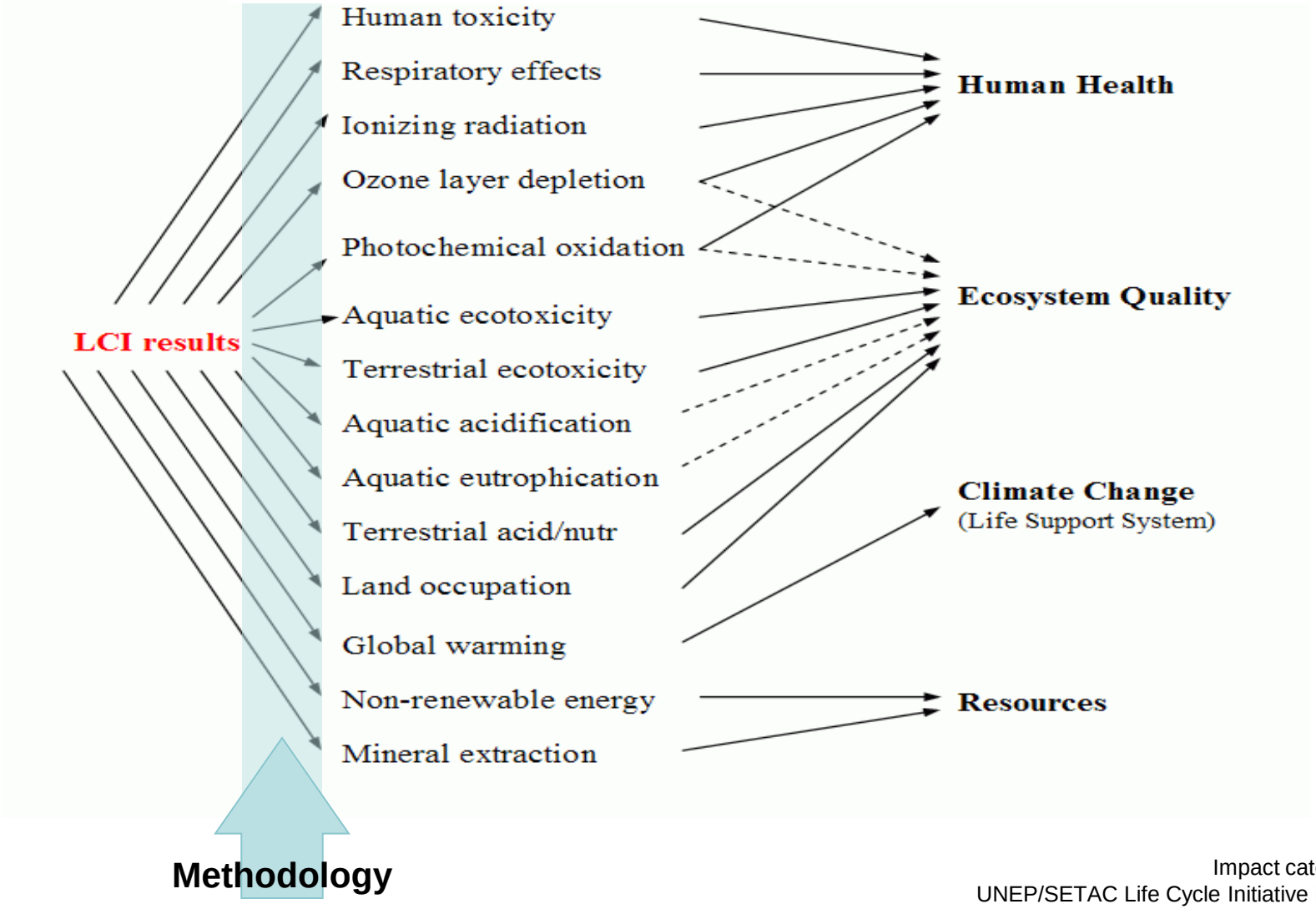
This results in algal blooms that lower the quantity of dissolved oxygen.

Eutrophication removes the oxygen from the water, killing fish and other aquatic organisms.

Process inventory data
Emissions, land use and depletion data

Midpoint categories
Impact characterization

Endpoint categories
Damage assessment



Impact categories
UNEP/SETAC Life Cycle Initiative in 2003
Source: Int J of LCA 9(6) 2004

The LCA process from the product development perspective

1 → Bill-of-materials

Materials, processes, energy used, transport, end-of-life

Length of list depends on the product

2 → LCI data

Emissions, resource depletion, and land-use

Can be hundreds of data points per material

3 → Characterization

Environmental impacts: global warming, carcinogens, ecotoxicity, etc.

Typically 8-12 categories, via scientific, peer reviewed formulae

4 → Normalization

Scales impacts by average impacts of a person in a continental area

North American or European normalization available

5 Weighting

Scales Impacts according to socially defined significance

Normalization and weighting are not required by ISO 14040 LCA standards, but are allowed as they deliver a useful single-figure score.

Single-figure LCA

All steps combined in one factor

Inventory Characterization Normalization Weighting

Single-figure indicators combine inventory and subsequent steps in one multiplication impact factor.

Impact factors incorporate **existing inventory data, often from averaged processes**. They report a single figure score per material or process.

Product Developers can use single-figure factors to quickly model the overall impacts of products.

LCA Example

Why LCA? Raw product data can be difficult to understand

Product property	Incandescent lamp	Fluorescent lamp
power consumption	60 W	18 W
life span	1000 hr	5000 hr
mass	30 g	540 g
mercury content	0 mg	2 mg
etc	…	…

Phase 3: Impact assessment: weighting

Example of a weighted environmental index

Weighed index	**Incandescent lamp**	**Fluorescent lamp**
Weighted index	8.5×10^{-10} points /100,000 lumen-hours	1.4×10^{-10} points/ 100,000 lumen-hours

The results are summed here after weighting.

EcoDesign Strategies

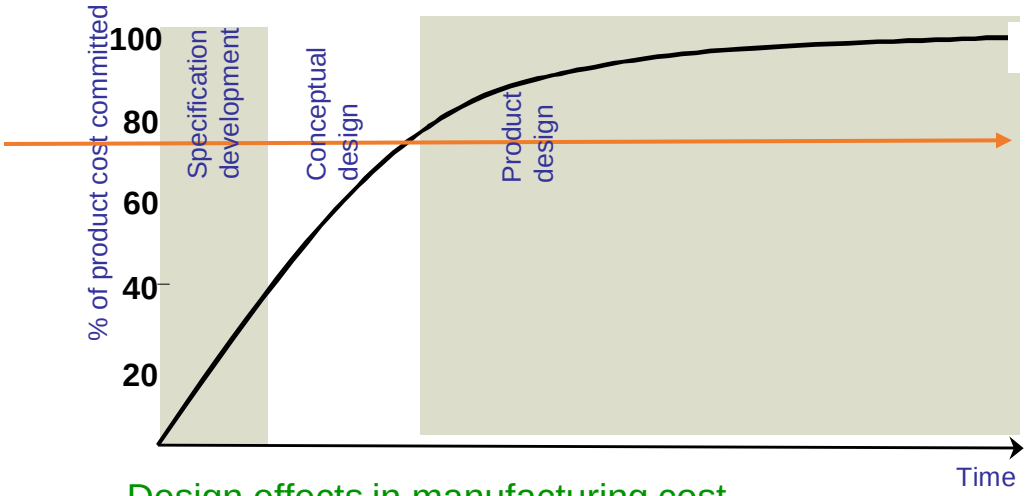
Whole product systems approach

For the shift to environmentally sustainable design to happen, life cycle mindsets must be adopted and incorporated during *the conceptual design stage.*

Why it's important to assess impact early?

75% of manufacturing costs are committed by the end of the concept phase.

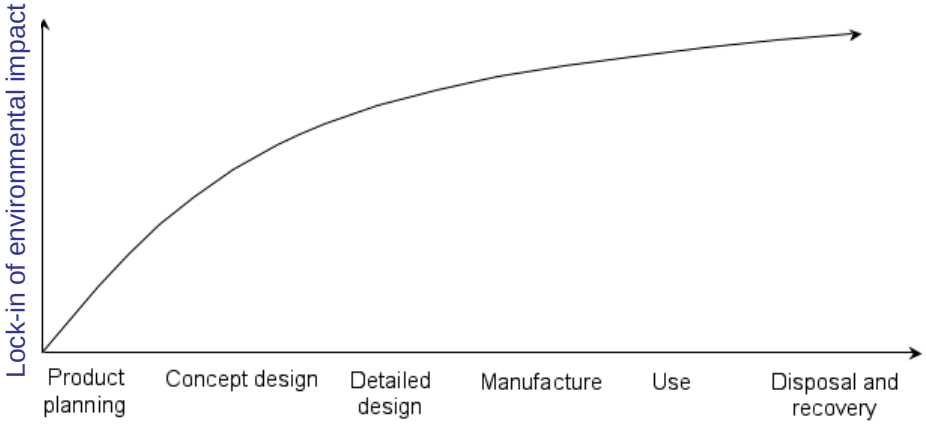
Decisions after this point can determine less than 25% of manufacturing costs.



Design effects in manufacturing cost

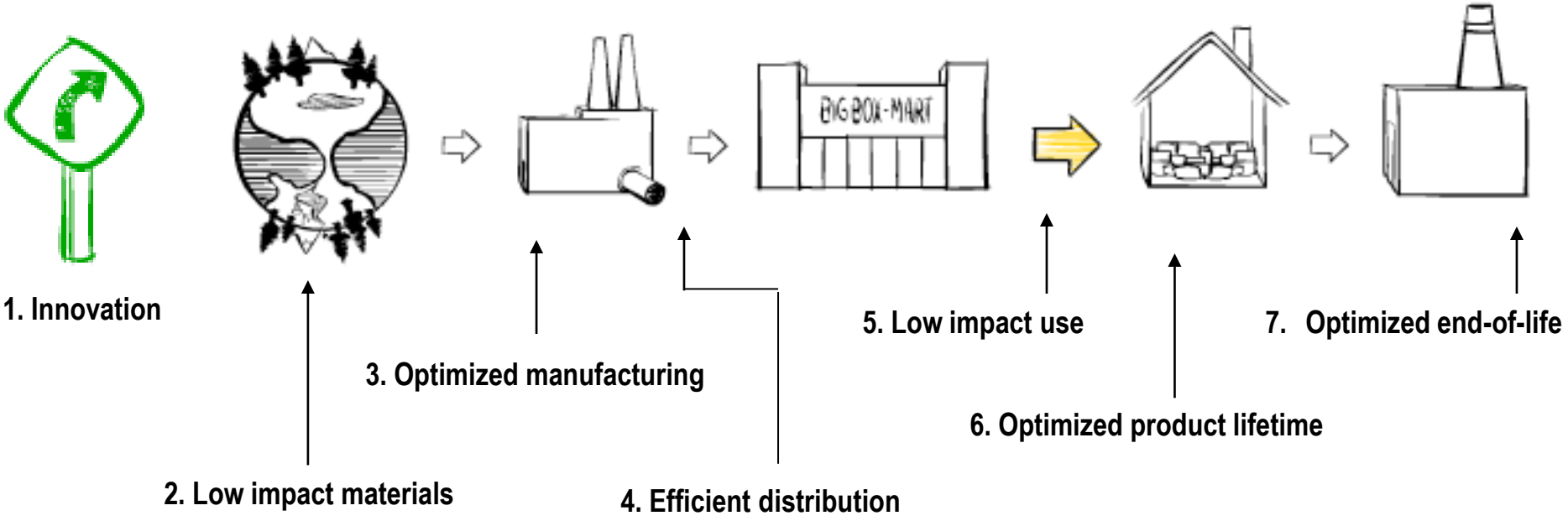
Likewise, the environmental performance of a product is locked-in early.

Early stage decisions on materials, energy requirements, recyclability & longevity impact environmental performance.



'Lock-in' of environmental performance over product development process and life cycle

Source: Approximate Life Cycle Assessment using Learning Systems, Ines Sousa, PhD Thesis Dissertation, 2002 -- Adapted from "The Mechanical Design Process", David G. Ullman, McGraw-Hill 1992; and "Design + Environment – a Global Guide to Designing Greener Goods", Lewis, H., Gertsakis, J., Grant, T., Morelli, N.,& Sweatman, A., New York: Greenleaf Publishing 2001



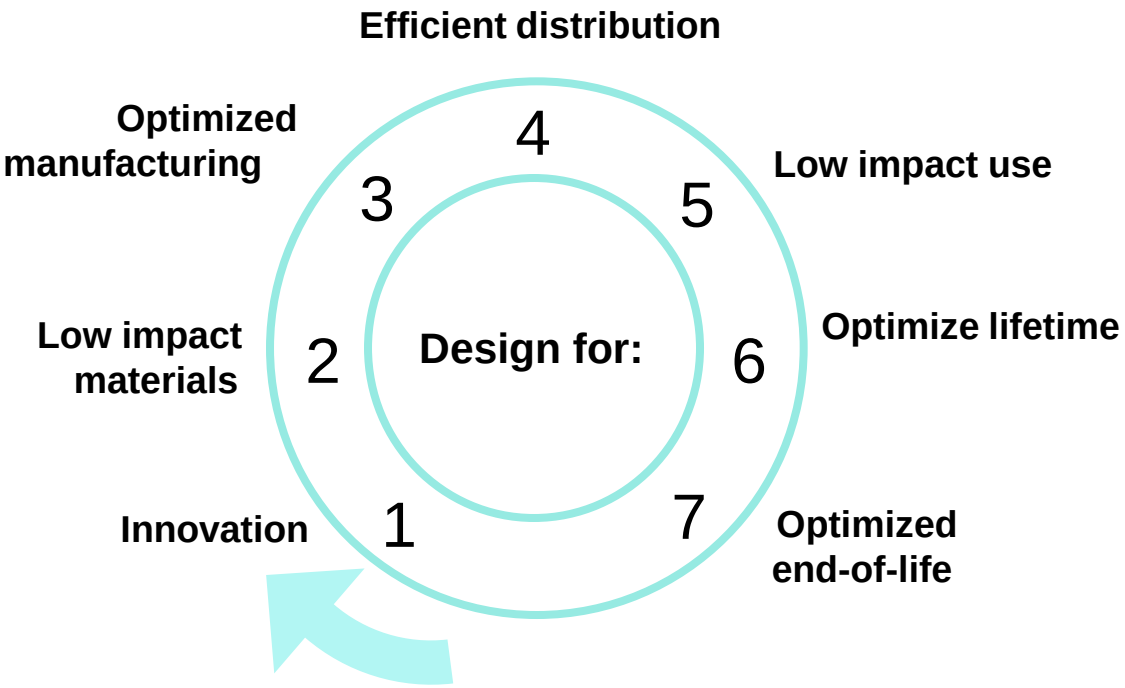
There are many points of intervention, and opportunities for innovation.

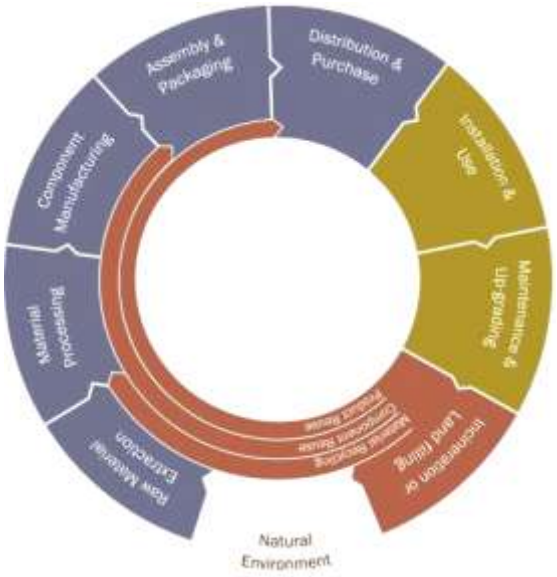
Okala; modified from the LiDs Wheel, Han Brezet, et al., PROMISE manual, Delft University of Technology, 1996| Image source: Storyofstuff.com

Phases in a product's lifecycle

Raw material extraction	**Wood from forest, oil from well, metal ore from mine…**
Material processing	**Wood to paper, oil to plastic, ores to metal alloys…**
Component manufacturing	**Paper printed, plastic molded, alloys into circuitry…**
Assembly & packaging	**Assembly and packaging with documentation**
Distribution & purchase	**Distribution, marketing and purchasing**
Installation & use	**Energy and additional materials used**
Maintenance & upgrading	**Product cleaned, parts replaced or upgraded**
Transport (among all phases)	**Via train, truck, automobile, sea vessel or airplane**
Reuse, recycling, composting	**Product or component reuse or material recycling**
Incineration or landfilling	**Burned or buried in landfill**

Ecodesign strategy wheel





Strategies for lifecycle design modified from the LiDs wheel by Hans Brezet et. al., TU Delft

Amended from the LIDS wheel
Han Brezet, TU Delft, Promise Manual 1998

4. Efficient distribution

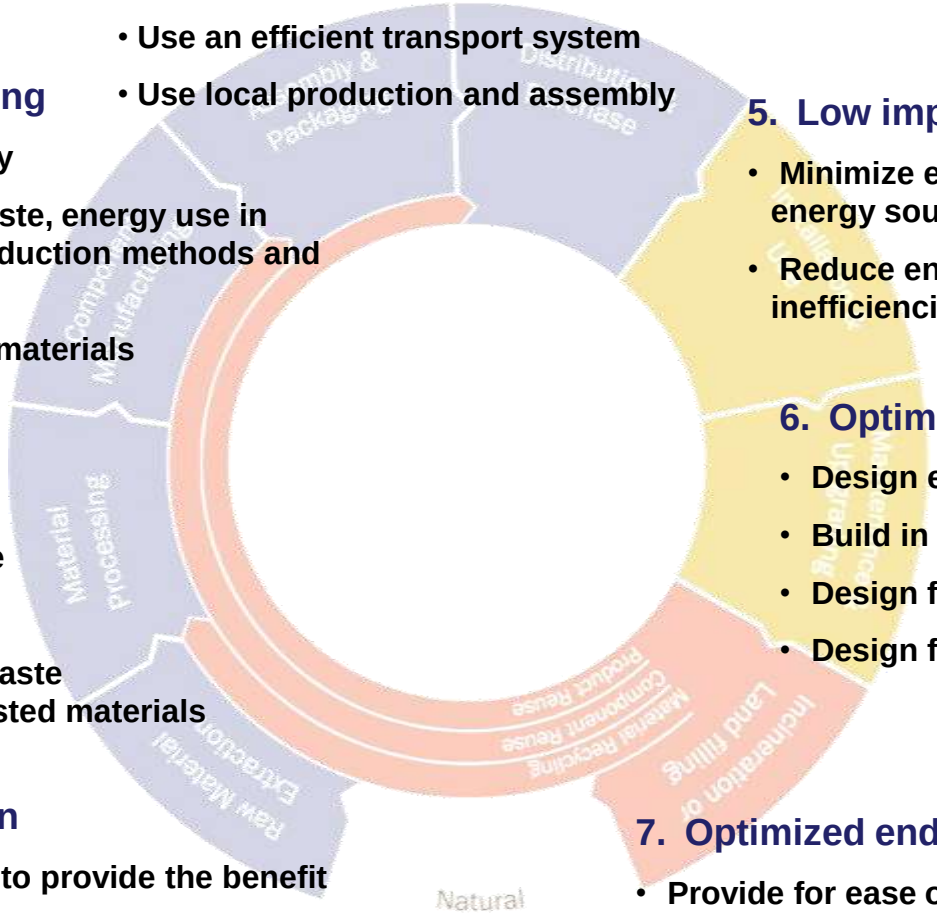
- Reduce product and packaging weight
- Use reusable or recyclable packaging
- Use an efficient transport system
- Use local production and assembly

3. Optimized manufacturing

- Ease of production & quality
- Minimize manufacturing waste, energy use in production & number of production methods and operations
- Minimize number of parts / materials

5. Low impact use

- Minimize emissions / Integrate *cleaner* energy sources
- Reduce energy, water use & material inefficiencies



6. Optimized lifetime

- Design easy product take-back programs
- Build in durability
- Design for maintenance and easy repair
- Design for upgrades & second life

2. Low impact materials

- Avoid materials that damage
- Minimize materials
- Use renewable resources, waste byproducts & thoroughly tested materials

1. Innovation

- Rethink how to provide the benefit
- Provide needs provided by associated products
- User sharing & upgradability
- Design to mimic nature

7. Optimized end-of-life

- Provide for ease of disassembly, recycling, downcycling reuse, or second life
- Provide for reuse of components
- Provide ability to biodegradability &safe disposal

EcoDesign Examples

2. Design with low-impact materials

Avoid materials that impact human health, ecological health, and resource depletion.

Use minimal materials

Use readily renewable resources

Use reused or recycled materials

Use waste byproducts

Use more thoroughly tested materials

Leg Over

By Sebastian Bergne

Uses simple materials and assembly. Colorful, circular polypropylene seat clips over the steel frame.

7. Design for optimized end-of-life

Provide/integrate methods for product collection

Provide for ease of disassembly

Provide for recycling or downcycling of materials

Design for closed-loop recycling

Design reuse, or “next life of product”

Provide for reuse of components

Provide ability to biodegrade

Provide for safe disposal

Sloppy Joe shoe

Simple shoes

Made from leather, biodegradable glues and plant fibers, this shoe can be safely composted.

The ecodesign strategy wheel helps generate new ideas; it does not guarantee that new ideas will have superior environmental performance than previous products.

Environmental performance of the new concept can be measured with Sustainable Minds.

Features of Sustainable Minds

Based on science from trusted sources:

- **EPA's TRACI Impact categories**
- **NIST Normalization & weighing**

550+ impact factors and CO_2 equivalent values

- **EcoInvent & NREL process inventory data**

Quantifiable comparisons!

- Quantifiable estimates of environmental performance
- For non-experts to integrate LCA & product development
- Standardized system for credibility & comparison
- Easy to interpret & share graphical results

Sustainable Minds' benefits to professionals:

Product design professionals

- Enables differentiation through 'greener' product development skills
- Gives credibility and substantiation for new solutions

Manufacturers

- Increases revenues from innovative, ecologically superior products
- Bolsters brand value by credibly marketing 'greenness'
- Improves employee satisfaction

Educators

- Adds new curriculum, attracts new students
- Empowers faculty to gain new knowledge & skills to keep current with industry and professional demands

700+ users since alpha, R1 launched 11.09

Manufacturers

EMC² where information lives
hp
MAC
Celestica
MOTOROLA
xerox
GE
CROWN
Whirlpool
YAKIMA

Product consultancies

LUNAR
CONTINUUM
IDEO
Moto
MAGNET Manufacturing Advocacy & Growth Network
frog design
LOGIC
farm
SMART DESIGN
BRESSLER group

Education

risd rhode island school of design
UCLA
STANFORD UNIVERSITY
PRESIDIO GRADUATE SCHOOL
PARSONS THE NEW SCHOOL FOR DESIGN
KEENE STATE
MINNEAPOLIS COLLEGE OF ART AND DESIGN
CCA CALIFORNIA COLLEGE OF THE ARTS

Software Demo

Toaster Redesign

Sustainable Minds™

Thank you!

kimi@sustainableminds.com

twitter : @sustainablemnds