



Product Design for Environmental Sustainability

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Preparation Assignment

- Think about the environmental impact of the products and services we use.
- Identify a product or service with reduced environmental impact.
- Be prepared to describe the product or service tomorrow in class.

Dunlop Recycled Wellington Boots



Dunlop Wellington boots are made from polyurethane, PVC, and rubber.

Dunlop developed a line of recycled boots.

Dunlop takes back used Wellingtons from customers. Old boots are re-ground and re-manufactured into new boots.

This helps to reduce production of new PVC and keeps it out of the waste stream.

Source: www.biothinking.com

Freitag Bags



Freitag reuses

- truck tarps
- inner tubes
- seat belts

www.freitag.ch

Stokke Tripp Trapp Chair



Peter Opsvik (for Stokke, 1972) designed the award-winning Tripp Trapp chair to grow with the child, increasing the effective lifetime of the chair.

www.stokke.com

STOKKE[®]

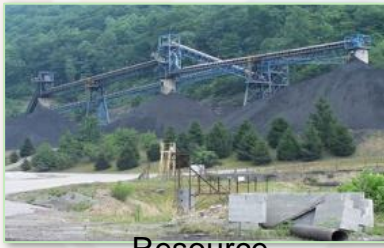


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Environmental Impacts



Global Warming



Resource depletion



Solid waste



Water pollution



Air pollution



Land degradation

www.buildbabybuild.com
www.co.rockingham.nc.us

[www.flickr.com Ben Rad](http://www.flickr.com/BenRad)
commons.wikimedia.org

www.wonkroom.thinkprogress.org
www.adb.org

Is this ...

a **legacy** problem?

a **materials** problem?

a **solvable** problem?

YES!

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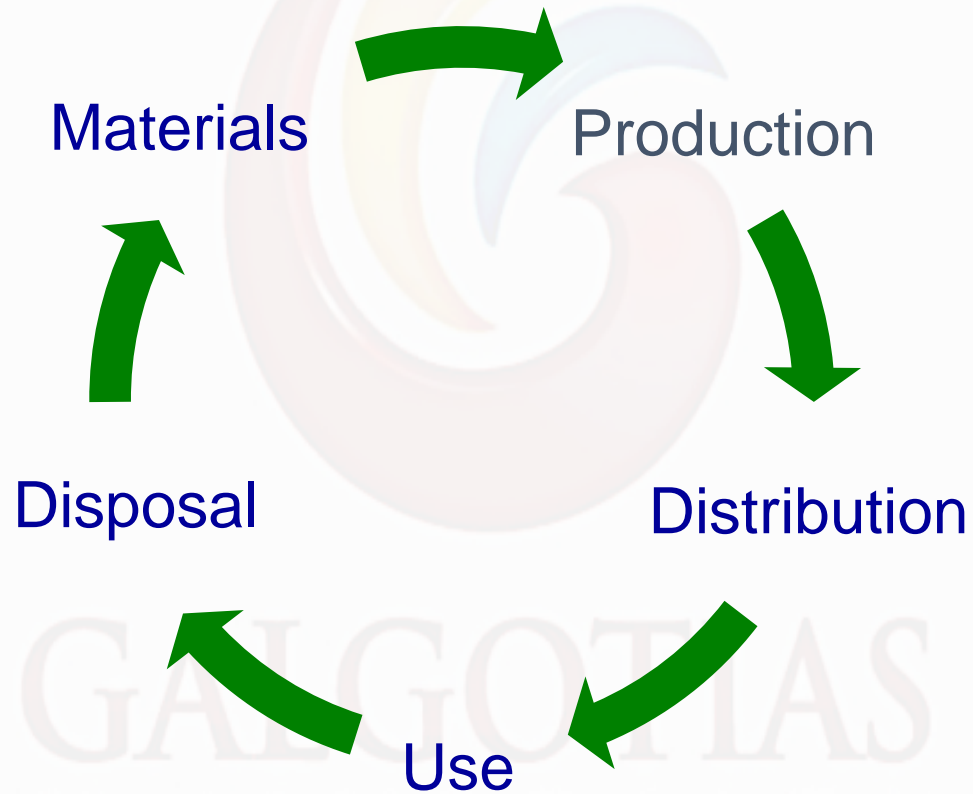
Design for Environment (DFE)

Design for Environment (DFE) is a method to minimize or eliminate environmental impacts of a product over its life cycle.

Effective DFE practice maintains or improves product quality and cost while reducing environmental impacts.

DFE expands the traditional manufacturer's focus on production and distribution of its products to a closed-loop life cycle.

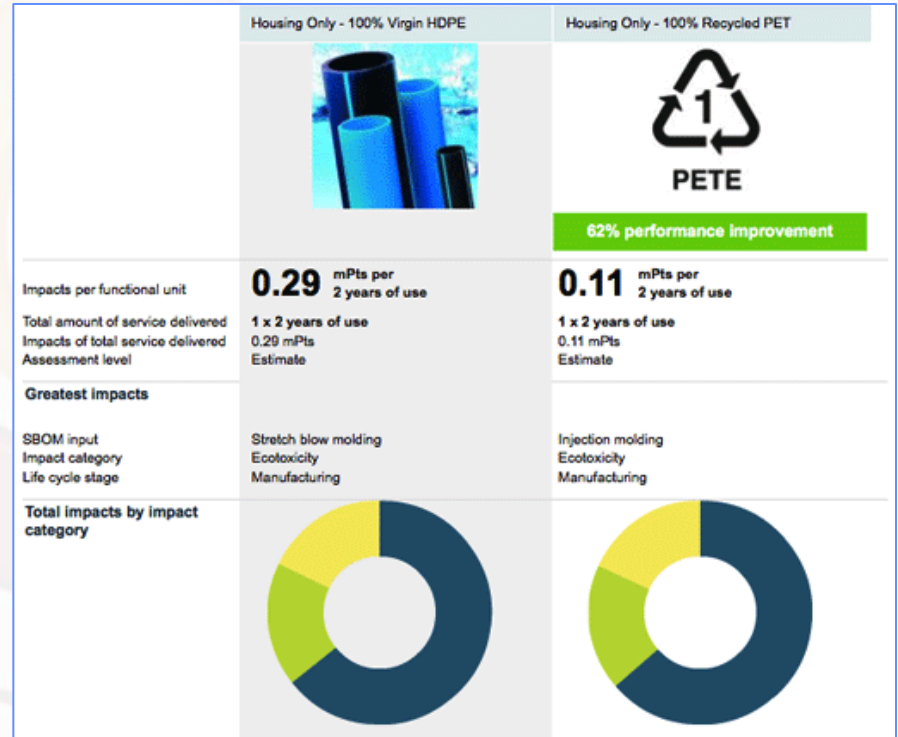
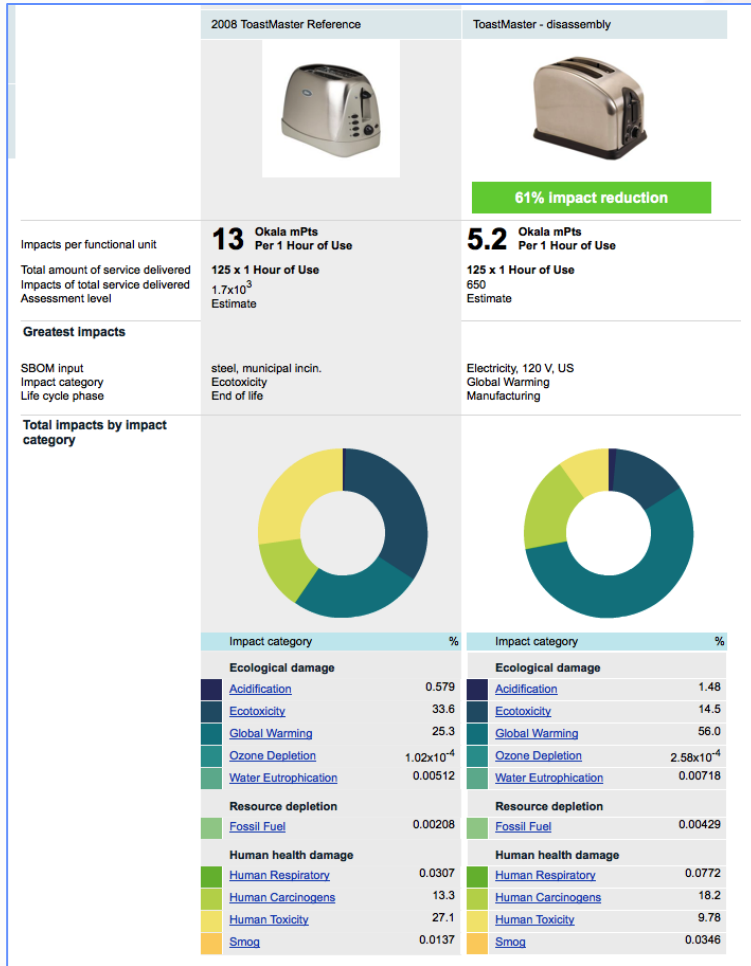
Product Life Cycle



Life-Cycle Assessment (LCA)

- Quantifies environmental impact over product life cycle
- Steps in LCA analysis:
 1. Prepare proposed design options
 2. Identify life cycle, including recycling and disposal
 3. Identify all materials and energy sources used
 4. Identify outputs and waste streams
 5. Quantify impacts of each material, energy, waste
 6. Aggregate impact into categories for comparison
- Requires specialized LCA software and training
- Commercial LCA software growing in capability
 - SimaPro, GaBi, OpenLCA, Sustainable Minds, ...

Sustainable Minds LCA Software



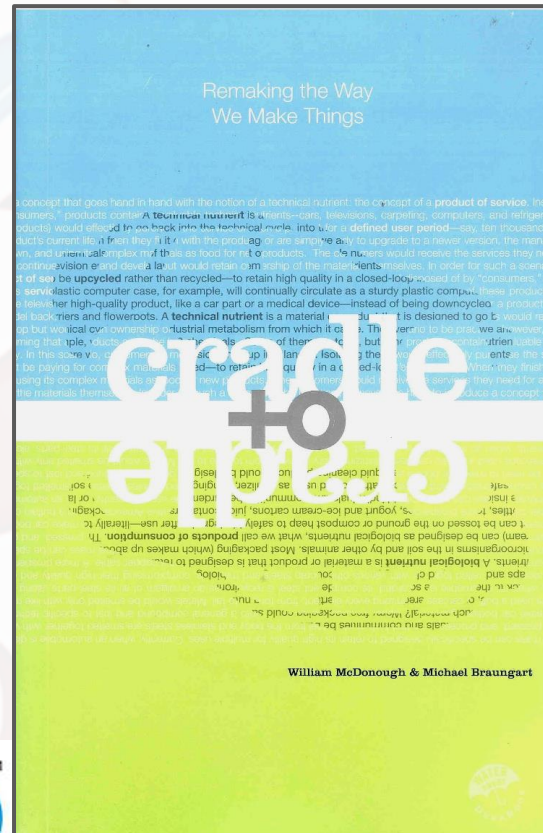
Source: www.sustainableminds.com

Cradle to Cradle

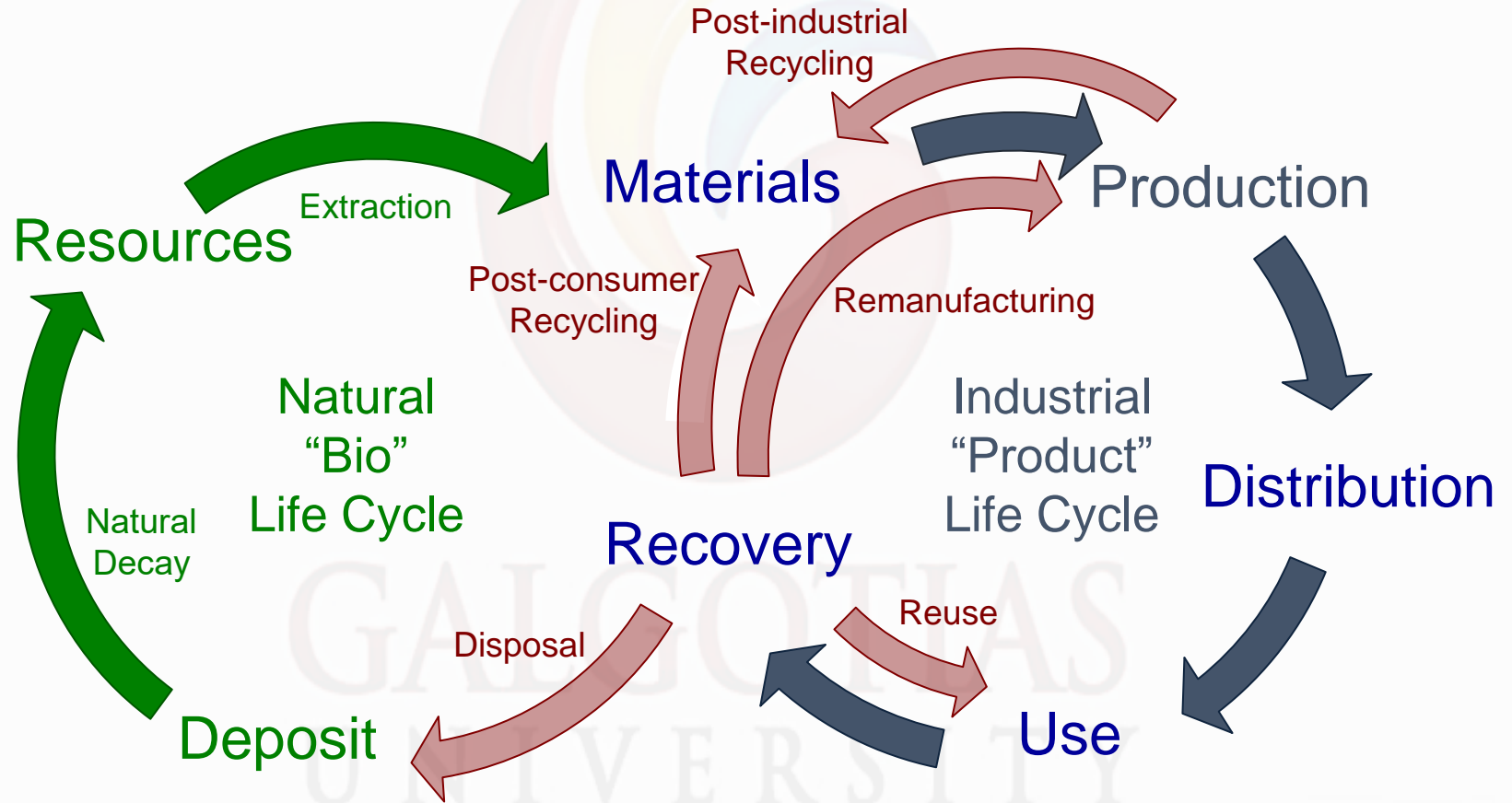
Cradle to Cradle (C2C) is a DFE method emphasizing renewable resources and sustainable life cycles.

William McDonough and Michael Braungart, *Cradle to Cradle: Remaking the Way We Make Things*, 2002.

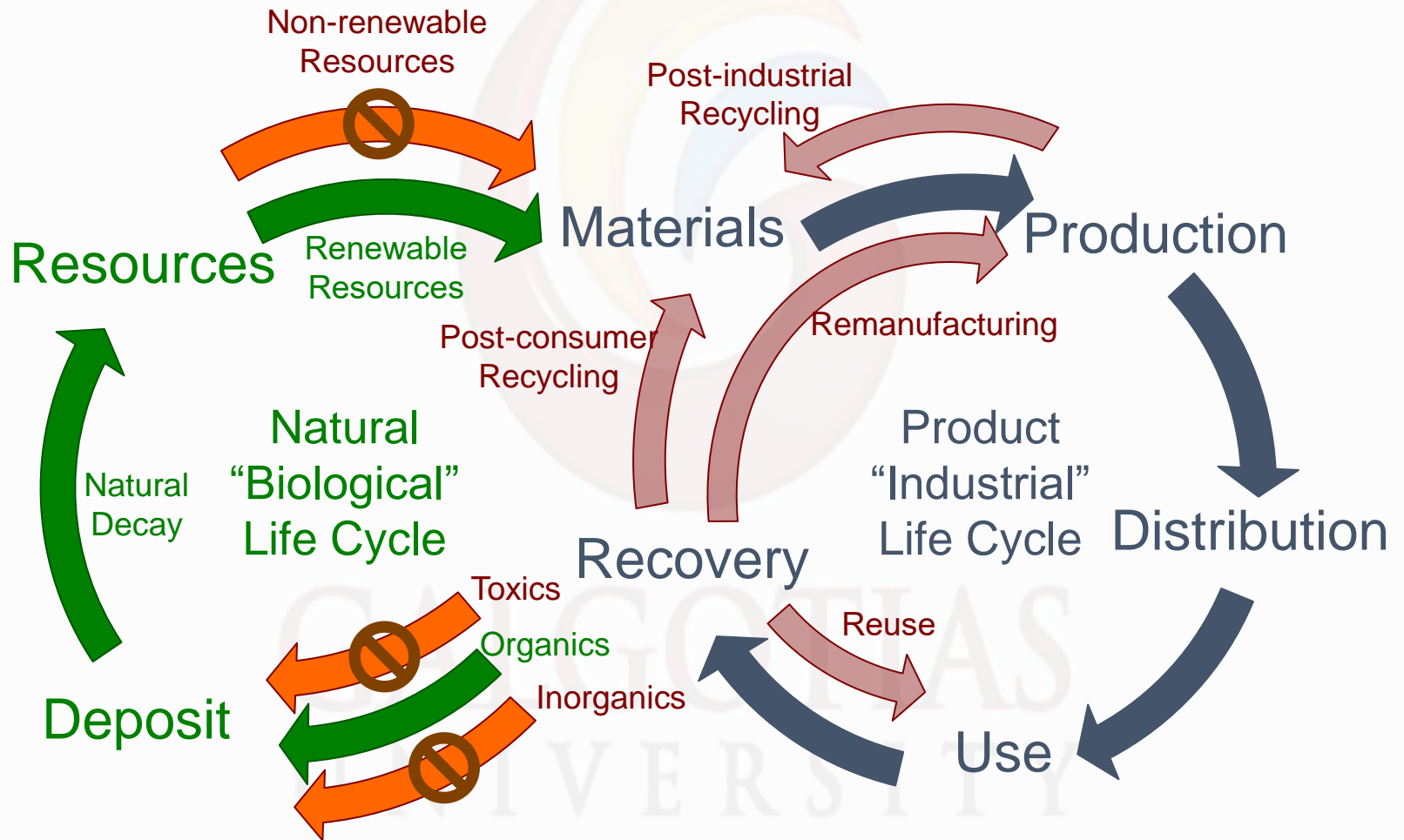
McDonough Braungart Design Chemistry (MBDC) works with companies to select the safest materials for product design.



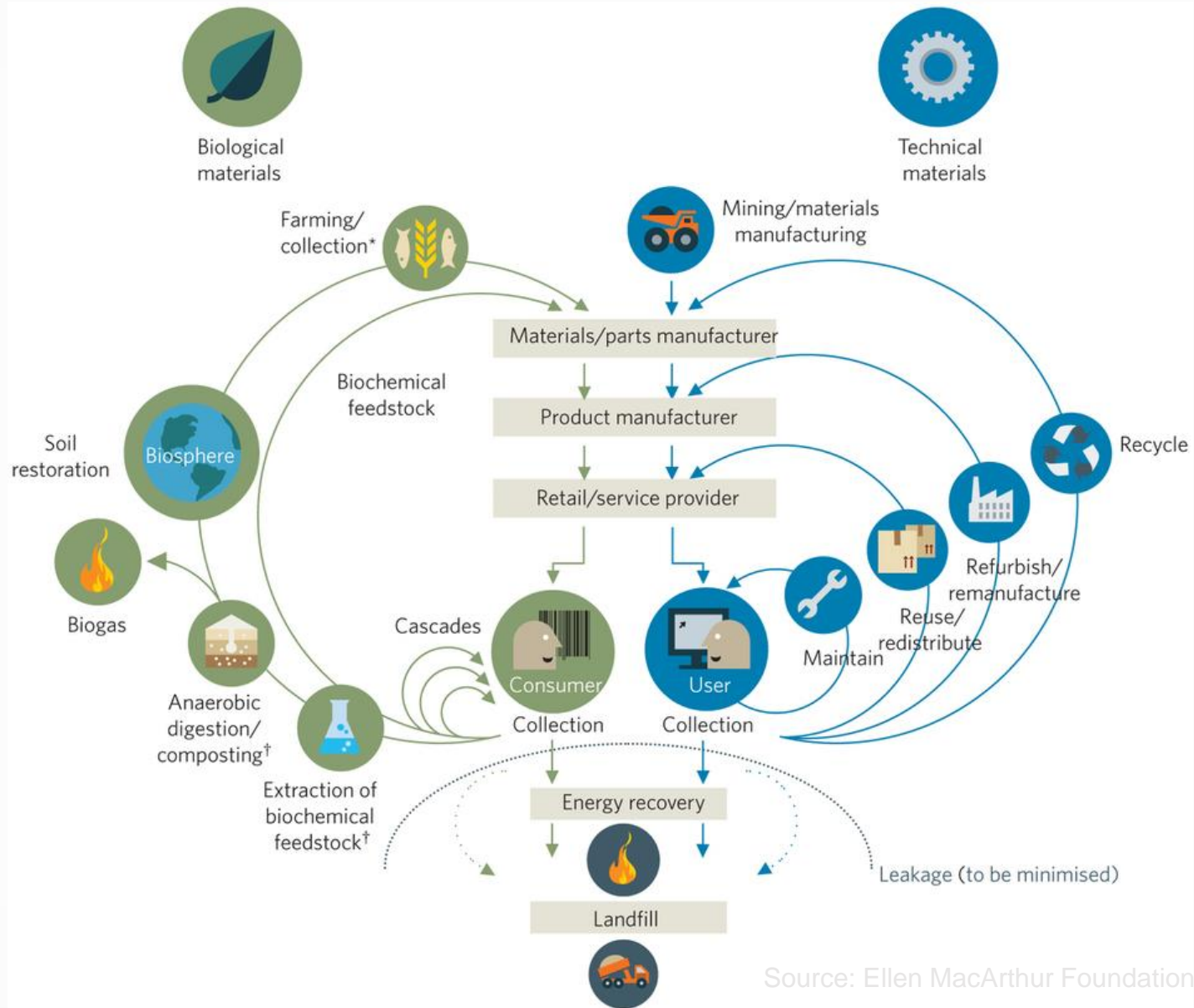
Two Life Cycles



Two Life Cycles



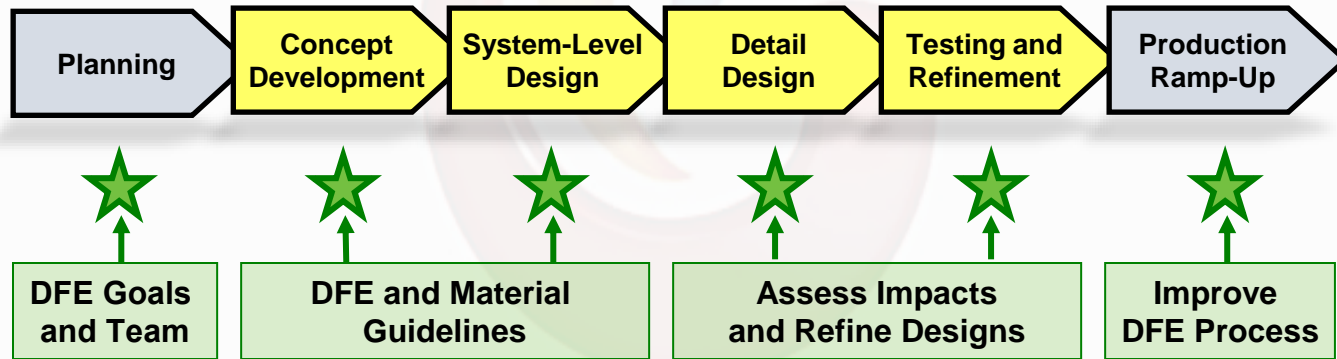
Transition to a Circular Economy



“Conditions” for Sustainability

- Consider the earth as a closed system with limited solar input and natural bio cycles.
- Solar energy and other renewable fuels are sustainable energy sources.
- Resource usage must balance to the rate the earth creates each resource (even the rate at which the earth creates fossil fuels).
- Toxic wastes, heavy metals, radiation, and other “molecular garbage” must be eliminated because they are not part of the bio cycle.

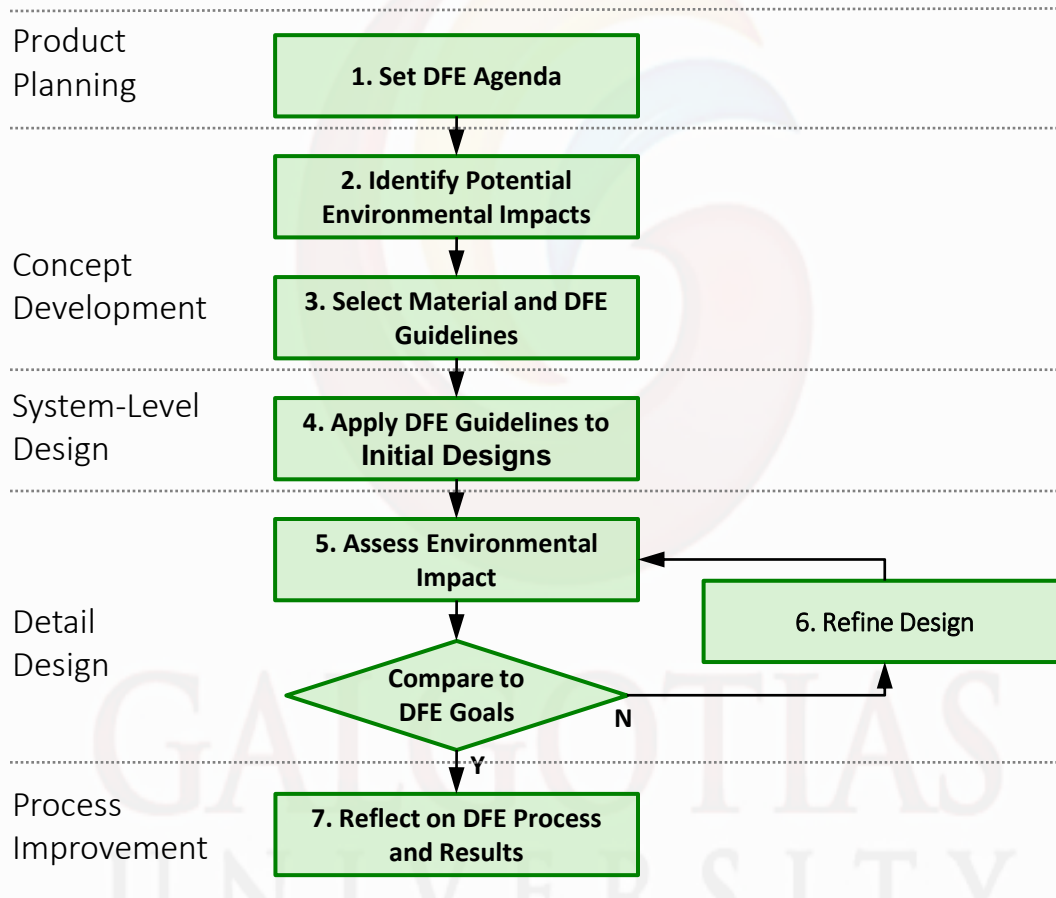
Product Development Process



DFE can be integrated into the standard product development process.

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DFE Process



DFE and Material Guidelines

Example DFE Guidelines

- Do not combine materials incompatible in recycling
- Label all component materials for recycling
- Enable easy disassembly into separate material recycling streams
- Use no surface treatments
- Eliminate packaging
- Reduce weight and size for shipping

Example Material Guidelines

- Use recycled and recyclable industrial materials
- Use natural materials which can be returned to biological decay cycles
- Use processes which do not release toxic materials
- Capture and reuse all hazardous materials

Herman Miller



Aeron, 1994



Mirra, 2004



Setu, 2009

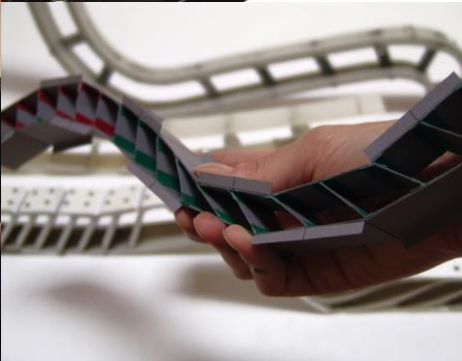
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Herman Miller's Environmental Goals *Perfect Vision 2020*

- *Zero* landfill
- *Zero* hazardous waste generation
- *Zero* air emissions (VOC)
- *Zero* process water use
- *100%* green electrical energy use
- *100%* of sales from DfE products
- Company buildings constructed to a *minimum* LEED Silver certification

Setu Spir





Studio 7.5, Berlin

Herman Miller

Setu Multipurpose Chair

- Environmentally friendly and non-toxic materials
 - 41% aluminum, 41% polypropylene, 18% steel, by weight
- Recycled materials
 - 44% by weight - 23% post-consumer, 21% post-industrial
- Less material content
 - 20 lbs lighter than most task chairs
- Easy to disassemble
 - 86% easily separable materials
- Recyclable
 - 92% by weight
- Production line uses 100% green power
- No air or water emissions released in production
- Returnable and recyclable packaging

Source: Herman Miller, Inc.

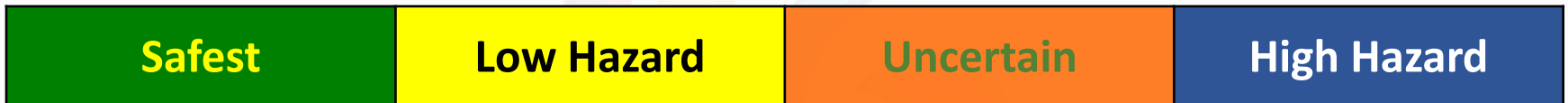


 HermanMiller

Herman Miller

DFE Assessment Method

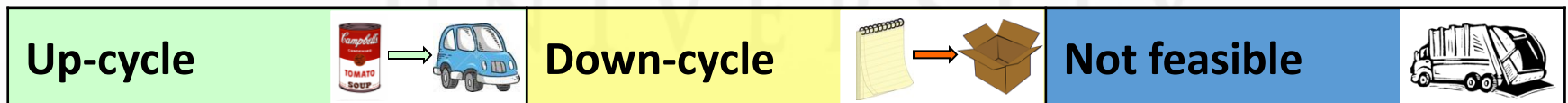
Material Chemistry (33.3%)



Recycled Content (8.4%)



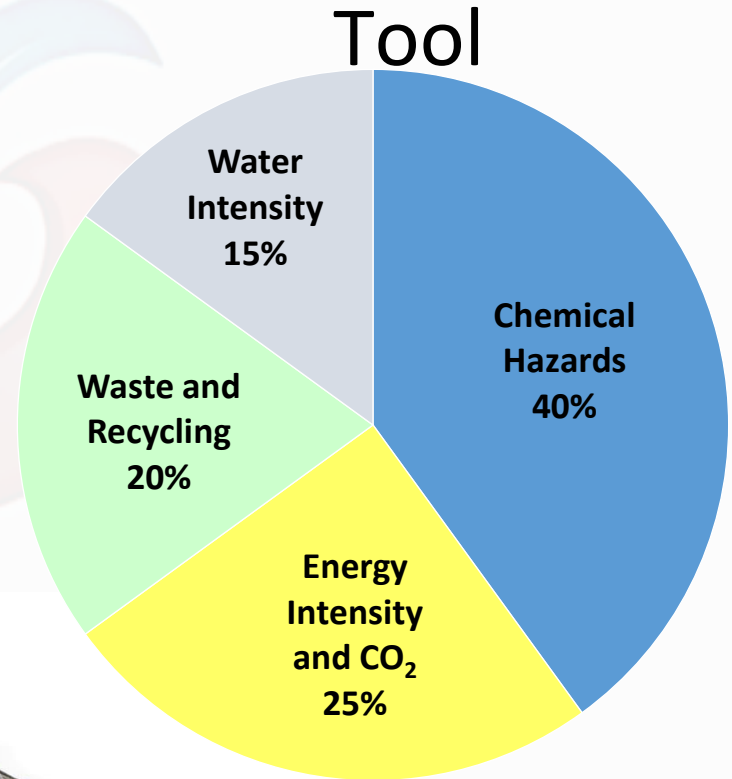
Disassembly (55.5%)



Nike *Considered Design*

- New products are designed for recyclability, using environmentally preferred materials.
- The materials analysis tool evolves to reflect best practices and Nike's changing environmental values.
- Nike's goal is for all new products to be developed using its *Considered Design* standards.
 - footwear by 2011
 - clothing by 2015
 - equipment by 2020

• Materials Analysis



Better Packaging for Puma: Clever Little Bag

- Designed by Yves Béhar and fuseproject
- 65% less cardboard than standard box
- No laminated printing, no tissue paper
- Less weight and space in shipping
- Less electricity and fuel used to produce
- Reusable bag replaces the polyethylene retail bag, is made of recycled PET, and is also recyclable

vision.puma.com

www.fuseproject.com



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Four Simple DFE Rules

1. Design products and processes with **industrial materials that can be recycled continually** with no loss in performance, thereby creating new industrial materials.
2. Design products and processes with **natural materials that can be fully returned to the earth's natural cycles**, thereby creating new natural materials.
3. Design products and processes that **do not produce unnatural, toxic materials** that cannot be safely processed by either natural or industrial cycles.
4. Design products and processes with **clean, renewable sources of energy**, rather than fossil fuels.

Final Message on Green Design

- This is hard.
- This is important.
- This is our responsibility.
- This is a great opportunity...
 - for businesses and entrepreneurs
 - for scientists, engineers, and designers
 - for researchers



References

1. Karl T. Ulrich and Steven D. Eppinger (2009), Product Design and Development, 4th Edition, Tata McGraw-Hill Publishing Company Limited, ISBN: 978-0-070-14679-2
2. Stephen C. Armstrong (2005), Engineering and Product development Management– The Holostic Approach, Cambridge University Press, ISBN: 978-0-521-01774-9.
3. IbrahimZeid (2006), Mastering CAD/CAM, 2nd Edition, Tata McGraw-Hill, ISBN: 978-0-070-63434-3.
4. [Anoop Desai](#), [Anil Mital](#) and [Anand Subramanian](#) (2007), Product Development: A Structured Approach to Consumer Product Development, Design, and Manufacture, 1st Edition, Butterworth-Heinemann, ISBN: 978-0-750-68309-8.

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The logo of Galgotias University is a circular emblem with a stylized 'G' shape. It features a gradient of colors: a light blue outer ring, a yellow inner ring, and a white center. The text 'Thank you' is superimposed over the logo.

Thank you

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