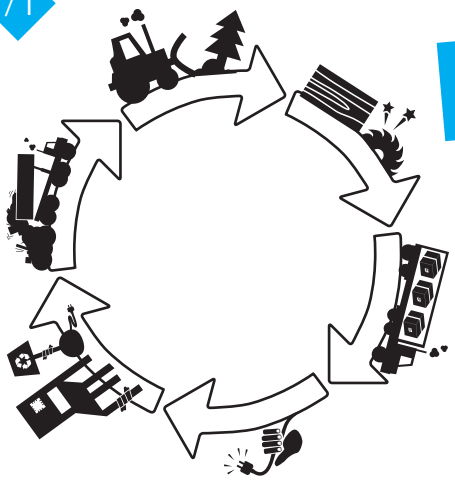


// LIFE CYCLE ASSESSMENT

Getting your head around life cycle thinking

Everything that is created goes through several key life cycle stages: the extraction of raw materials, manufacturing, transportation, packaging, use and of course end of life. Each of these life cycle stages has a variety of inputs (such as materials, energy, water, human power etc.) and outputs (such as waste, emission, pollutions, by-products etc.) these can be identified and assessed for their environmental impacts using life cycle assessment or LCA. Once these are understood, decisions can be made to reduce the impacts that occur across the life of a product.

LCA is a scientific approach used to understand the life cycle impacts of a product, system or service. It is a very technical process and is governed by ISO 14040. LCA is all about uncovering what happens across all the different life cycle stages that a product or material goes through. An LCA starts with defining the 'goal and scope' which is about explaining what exactly is going to be assessed. Then all the processes (such as mining, processing materials, energy production, and manufacturing processes) are defined and analysed to get a clearer picture of all the things that have to happen in order to make a material or product. At this stage databases with the impact information are used. Once the assessment is complete, the skilled LCA expert can analyse the data and define where the impacts are occurring to then provide recommendations on what can be done to reduce these.

Just as a person has a life story a product or material has one too!

Life cycle thinking is about understanding the entire life of a product

A full LCA can take quite a bit of time and almost always needs an expert to conduct a respectable assessment. A designer can choose to do a full LCA (with training), use quick online LCA tools, do very rough assessments or use life cycle thinking (LCT exploring strategies to reduce environmental impacts across the entire life of a product). The ISO 14040 standard requires that LCA's that are published or used for marketing must be peer reviewed by another LCA professional. LCT is a way of looking at the design processes and product development from a holistic systems level – it's about thinking through the entire life of the product or material from extraction of raw materials through the end of life.

Five main life cycle stages that a product goes through

1. Material Extraction
2. Manufacturing
3. Packaging & Transportation
4. Use
5. End of Life

A life cycle approach to product development can provide greater opportunity to reduce the environmental impacts associated with a product. It can also result in cost savings and more efficient production. Using a life cycle-based approach can also:

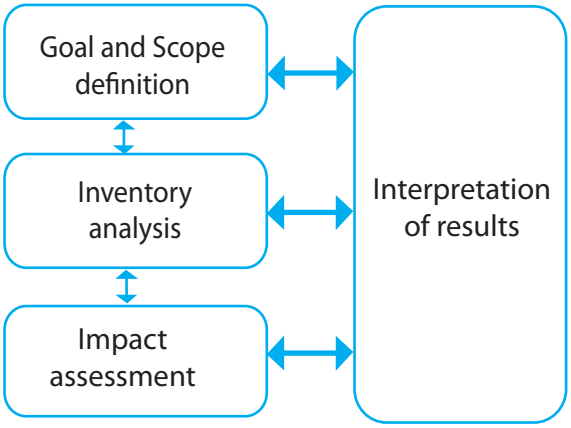
- Reduce the environmental burden of designing, producing and consuming a product across its entire life
- Allow for a better understanding of environmental impacts across a variety of impact categories
- Assist in shifting production processes and product lives from 'cradle-to-grave' to 'cradle-to-cradle'
- Provide a holistic view of a product across its entire life, not just on one aspect (such as materials, manufacturing or end of life)
- Stimulate market growth in new areas as innovative approaches to product development are explored
- Increase consumer value and perception of products through better environmental credentials
- Reduce costs associated with production, distribution and end of life management
- Provide a standardised assessment process for identifying environmental impacts

// LIFE CYCLE ASSESSMENT

There are four main stages to conducting an LCA. these include:

1. Defining the goal (objective) and scope (boundaries) of the assessment. This is when the functionality of a product is defined and it is decided what will be included and excluded from the study.
2. Inventory analysis involves making a list of all the materials, substances and chemicals taken from the environment (input) and released into the environment (output)
3. Impact assessment is the part when the data gathered in stage 2 is grouped into the different impact categories such as water, air and waste emissions.
4. Interpretation is when all of the data is analysed to identify where the impacts are occurring and what the major areas of environmental concerns are.

How an LCA is conducted according to the ISO 14040 Standard



CLASS ACTIVITIES

EPA student activities:
www.epa.vic.gov.au/students/activities_lifecycle

'Food Footprint' – The biggest contributor to Victorian's Ecological Footprint is food. Next time your family visits the supermarket, record information about the food items in your shopping trolley, www.epa.vic.gov.au/students/activities_lifecycle/lifecycle_activity1.asp

'How environmentally friendly is your lunch" – This activity investigates the life cycle of your school lunch, www.epa.vic.gov.au/students/activities_lifecycle/lifecycle_activity2.asp

Use the free classroom activities on LCA for years 7-12:
www.istc.illinois.edu/info/library_docs/tn/99-031.pdf

'Is bottled water the new eco-disaster?' – Read the newspaper article and answer the questions, www.epa.vic.gov.au/students/activities_lifecycle/lifecycle_activity4.asp

'The secret life of an everyday product' – Choose a product you use regularly and investigate each stage of the products life cycle by addressing the following questions, www.epa.vic.gov.au/students/activities_lifecycle/lifecycle_activity5.asp

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Australian Life Cycle Assessment Society 'Life Cycle Assessment', www.alcas.asn.au

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LCA links "Life Cycle Thinking", www.life-cycle.org/?tag=life-cycle-thinking

Powerhouse Museum "Ecologic", www.powerhousemuseum.com/education/ecologic

United Nations Environment Program (UNEP) "Life Cycle thinking", www.unep.fr/scp/lifecycle/assessment.htm

EPA Victoria "Life Cycle Management", www.epa.vic.gov.au/Lifecycle/whatis.asp

CSIRO: www.csiro.au/Organisation-Structure/Flagships/Sustainable--Agriculture-Flagship/Life-cycle-assessment.aspx

Watch the short youtube video on an introduction to LCA by Leyla Acaroglu: https://www.youtube.com/watch?v=D55PVhdMA8o

LCA course by the USA EPA: www.epa.gov/nrmrl/std/lca/lca.html

// ECO DESIGN STRATEGIES

Approaches to designing more eco products

Eco-design strategies are approaches to designing products that provide a framework for reducing the environmental impacts through design. There are lots of strategies and approaches, many of which are easy to incorporate into any design process. The objective of ecodesign is to understand environmental impacts, and to then make good design decisions that will reduce them across the life of the product.

This cannot be stressed enough: designers hold great power and capacity to make positive changes to the multitude of products that fill our lives. Designers are in a unique position to solve problems through creativity. As a core part of the design process, the social and environmental impacts that come about as a result of our creative problem-solving need to be understood and minimized.

"ecodesign addresses all environmental impacts of a product throughout the complete life cycle of the product, whilst aiming to enhance other criteria like function, quality and appearance."- Phillip Goggin

Thinking about the entire life cycle of a product is important, and once it is understood where the biggest impacts are occurring ecodesign strategies can be employed to help reduce these. Ecodesign strategies include (read on for more details on key strategies):

Design for dematerialization – Reducing the overall size, weight and number of materials involved in a design is a simple way of reducing the overall environmental impact. As a general rule, more material means more impact.

Design for Longevity – Creating products to last longer can help to avoid, reduce and/or defer environmental problems, especially those associated with waste at the end of life. Longevity is about creating products that are timeless, durable and will retain their value so people can re-sell them at the end of life.

Design for recyclability – What happens to a product at the end of life is assisted by the choices made at the start. What materials have you selected – can they be recycled in the country that the product will be used in? Have you combined materials with fastenings that will make it hard for them to be pulled apart and recycled? These are important considerations when designing for recyclability.

Design for upgradability: being able to upgrade a product as people's needs or technology changes is an important part of increasing the sustainability of a product – the longer it lasts the better as materials are valued for longer and it reduces the need for someone to buy something new.

Design for disassembly: this is all about knowing a product is put together so that it can be easily and cost effectively taken apart at the end of life to recapture materials for recycling. For example gluing two different materials together might make it hard for them to be taken apart and recycled at the end of life.

Design for multi-functionality: is when a product is designed to serve a number of different functions or tasks so that it can be transformed into something else for example packaging which is reusable as a different product .

// ECO DESIGN STRATEGIES

CLASS ACTIVITIES

Do a product autopsy by pulling apart an old product and identifying and weighing all the components that make it up. How many screws are there? What types of alternative connection methods could be used to increase the likelihood of disassembly and recycling at end of life?

Set an eco-redesign project by setting a brief that involves taking an existing product and re-design it using eco-design strategies. Each different strategy will result in a different product design outcome – use life cycle thinking to compare the options and see which one would have the best environmental outcome.

Set an eco-design challenge in class. Set a brief and in groups get the students to brainstorm design solutions using eco-design strategies in a set time frame (5 minutes, 1 hour ect). Its amazing what ideas you come up with when there are time pressures!

TEACHERS RESOURCES

What is Eco Design resource kit covering tips on fashion and textiles, product design and graphic design: www.business.vic.gov.au/BUSVIC/STANDARD/PC_64558.html

TU Delft University in the Netherlands is renowned for its Design for Sustainability program and, along with the UNEP, has developed extensive online resources for designers. These are available at www.d4s-de.org/

The United Nations Environment Program (UNEP) also has a dedicated section on sustainable production and consumption, available on its website at: http://www.uneptie.org/scp/

Check out the great article by Alan Chochinov, who runs Corr 77, on "10 steps to Sustainable Design": www.treehugger.com/sustainable-product-design/allan-chochinovs-10-steps-for-sustainable-design.html

The National Eco Design Curriculum was developed in 2007 – there are a variety of downloaded slide packs with valuable information on eco design: www.training.nsw.gov.au/clearhse/Preview.do?no=267&type=O

Industrial Designers Society of America Eco Design resource hub includes a useful link directory: www.idsa.org/ecodesign-section-weblink-resource-project-2011

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Watch the short introduction video to ecodesign strategies by Leyla Acaroglu www.youtube.com/watch?v=xw5IZ_v3mql

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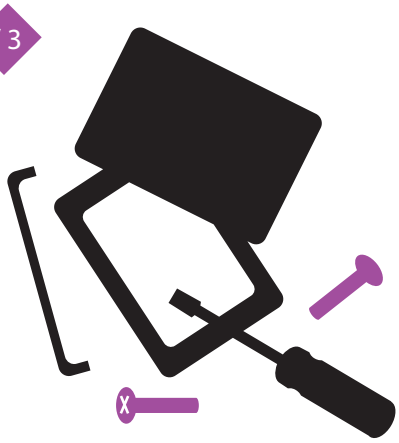


// DESIGN FOR DISASSEMBLY

Eco Design Strategies

Design for disassembly (DfD) is a design strategy that helps to reduce the end of life impacts associated with a product. As the name implies, it's about designing products that can be easily disassembled to enhance the likelihood and economic benefit of recycling them. DfD is also about considering the materials that are coupled together, and the ease of disassembling products so that valuable materials can be recovered at the end of life.

ADVANTAGES

The advantages of designing products to be disassembled at the end of life include:

> Increased likelihood of repair and reuse of the product, thus extending its usable life
> Better value products and increased brand perception in the consumer market
> Increased capacity to capture and recycle the product at the end of life
> Reduced waste going to landfill and reduced loss of valuable materials
> Facilitates producer responsibility and compliance with take-back regulations
> Reduced overall environmental impacts associated with the product

Designing products so that they can easily, cost-effectively and rapidly be taken apart at the end of the product's life so that components can be reused and/or recycled

CONSIDERATIONS

What core features of the product are valuable, and will thus provide an economic incentive to recover these materials from the product?

How can the process of disassembly be made simple and intuitive through the design?

What fasteners and connections are being used? These should be easy to disassemble, but not be a weak aspect of the product.

Can the product be designed to give it a second life? Can it be transformed into another product before it is discarded? Can components be remanufactured into other products?

What is likely to happen to the product when it has reached the end of its life? What can be done to the design to increase its recyclability?

Have you created labels and diagrams that communicate the disassembly process?

Are materials that are easy to recycle being used?

How has the product structure been designed to enhance the disassembly process?

Have you avoided adhesives that will reduce potential for disassembly?

How can the fact that the product is designed for disassembly be communicated to the consumer so that they do not throw it away?

Can the product be reclaimed, refurbished and resold?

Encourage upgrading, repair and re-use before recycling; try to position joins and disassembly points on one side, so the product does not have to be turned over or moved during disassembly.

Can the product be reclaimed, refurbished and resold?

How long will the product last? What is its intended and actual life span likely to be? How can the design enhance the longevity of the product?

What connections are used between the different materials and parts? Are these strong or do they create weak points? Can alternative connections methods be used? Consider using snap, interlocking or screw connections instead of glues or solder.

How can you reduce the number of parts and processes for disassembly?

Try to select materials that can be recycled together with ease – this is especially important with plastics.

Try to separate parts into modular sub-assemblies that can be easily removed.

// DESIGN FOR LONGEVITY

Eco Design Strategies

Design for longevity is the process of designing a product so that it lasts longer. It can add considerable environmental advantages, and can also help consumers to develop an association of quality with a product. Longevity is natural in some product categories such as solid wood furniture or fine jewellery, but it is a feature that needs to be built into more complex consumer goods – especially ones that have higher embodied environmental impacts.

Products should be designed to last longer because materials (often valuable and rare ones) get 'locked up' inside a product when it is created, and unless a product is recycled these materials get lost when it is discarded. Then a new product must be created to fill the gap made from the old product being thrown out, which requires more resources, and the cycle goes on and on... unless we design longevity into products so that they are valued and used for longer.

Longivity is about making things last longer so that less products need to be purchased

Design for longevity is also important because far too many products have built-in failures – known as 'planned obsolescence' or product 'death dating'. This has increased the disposability of complex products and enlarged the environmental impact associated with product development

CONSIDERATIONS

What is the main functionality of the product, and how can this be enhanced through the design so that the consumer values and uses the product for longer?

How can the product be designed to enhance its durability?

Consider how the product can be designed within a system or service, as opposed to a single product that is used and then discarded.

How long should the product last in comparison to how long the average comparable product currently lasts? How can its life be extended through good design decisions?

Can the product be taken apart and fixed? Is the user easily informed about how to fix, upgrade or repair the product if need be?

Can the product be retro-fitted to adapt to new trends in technology or fashion?

Can the product come with repair instructions?

What is the most likely way the consumer will use the product? Are there parts that are likely to break due to wear and tear? How can these be protected or replaced?

If the product is disposable, find ways of encouraging further uses before discarding.

What materials are being used? Are they appropriate for the function? For example, using plastic to encase a product that could be exposed to heat is likely to decrease its life expectancy.

Can the product be reclaimed, refurbished and resold?

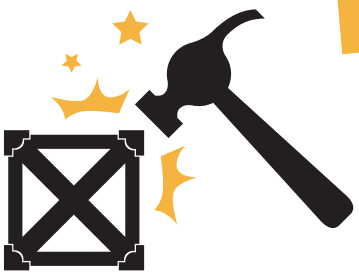
How can the aesthetics or styling of the product be designed to make it timeless? This involves resisting fads and employing classic design principles.

How can the design of the product facilitate it having a second life? For example a glass jar that becomes a drinking glass, or a box that can become part of the product it packaged.

Can the product serve more than one function to reduce the need for other products?

// DESIGN FOR UPGRADABILITY

Eco Design Strategies



Upgradability refers to how easily a product's parts can be replaced or upgraded. It could be as simple as being able to buy a new screen if it breaks or, in more complex circumstances, having new features added to make the product work better as technology evolves. We upgrade or 'retro-fit' homes to be more efficient, so products with high embodied impacts should be the same (such as laptops, whereby hard drives can be upgraded instead of getting a new one every three years).

CONSIDERATIONS

Design the product to be modular so that additions can be made at a later date, or parts can be easily removed and repaired.

Consider how changing fashion trends might impact on your product's perceived value, and design in upgrade options. For example, an office chair with fabric that can be replaced in line with fashion trends will last far longer than a chair that cannot be upgraded.

How can the product's competitiveness be enhanced through upgrades?

Consider how the product fits within the wider service system and what changes could be made in the future that might impact on the product – for example, changing networks or adopting different technological platforms.

Incorporate methods of communicating the optimal use, lifespan and upgrade options to the consumer.

Consider how the product can be a part of a product service system.

// DESIGN FOR DEMATERIALISATION

Eco Design Strategies

Reducing the amount of materials needed to produce a product as well as the number of different types of materials that are used in one product are important approaches to dematerialisation. The general rule is more material means a bigger impact. This also applies to reducing the amount of waste and off cuts from the manufacturing process.

CONSIDERATIONS

Look at ways of laying out patterns or cutting materials to reduce the amount of waste and offcuts.

Lightweighting is when you reduce the amount of material to have an overall lighter product – this is also good from a financial perspective as less material means less cost – however it's important to not lightweight so much as to make a product flimsy or un-durable.

Materials that have a honeycomb structure on the inside such as cardboard and some wood products have a reduced amount of material but are still strong and durable.

Make sure you pick the right thickness of materials for the job – avoid over engineering

Reducing the overall size, weight and number of materials involved in a design is a simple way of reducing the overall environmental impact. As a general rule, more material means more impact.

// PRODUCT STEWARDSHIP

Taking responsibility for a product across it's entire life

Product Stewardship is about taking responsibility for the entire life of product, specifically its disposal. It encourages all of the participants involved in a product's life cycle to take shared responsibility for the impacts to human health and the natural environment resulting from a product's production, use and end of life.

The product stewardship approach gives manufacturers incentives to take responsibility for the entire life-cycle impacts of their products, including packaging. Product stewardship requires companies to take back their products at the end of life. It inspires companies to address energy and material consumption, air and water emissions, the amount of toxins used, worker safety and waste disposal options.

FEATURES

There are three key features of product stewardship:

1. Moving the burden of addressing good end of life management of products from the communities responsibility back to the producers responsibility
2. Providing incentives to producers to design-in environmental considerations through eco-design
3. Recovering valuable materials that would otherwise be lost to landfill

Product stewardship can be voluntary or regulatory (laws that enforce responsibility)

EXAMPLES

WEEE stands for Waste Electrical and Electronic Equipment, and is a policy that requires electrical goods producers to take back their products and recycle them at the end of life. In recent years WEEE initiatives have been embraced by governments around the world. WEEE policies are driven by a growing concern over the large amount of consumer electrical goods being produced, consumed and discarded. WEEE policies are put in place to try to reduce this by shifting the responsibility of dealing with potentially hazardous waste back onto the producers.

Recently in Australia, the government has introduced the National Product Stewardship Act with waste televisions and computers being the first product categories to be governed by the act. There is also soon to be a national voluntary product stewardship scheme.

A voluntary product stewardship program is where companies or industry bodies take it upon themselves to responsibly manage their products end of life. Good examples of this in action are the ByteBack program for computers in Victoria, and the Australia-wide Mobile Muster phone recycling program.

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// PRODUCT STEWARDSHIP

Case Studies

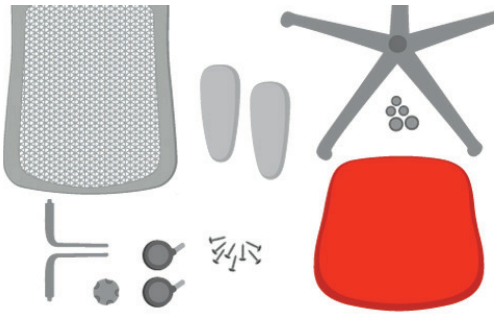
PATAGONIA

Patagonia is an international outdoor active garment company that has embraced voluntary product stewardship through a variety of initiatives including the Footprint Chronicles and recently they started the Common Threads Recycling Program – an initiative which encourages customers to return their unwanted Patagonia products to their nearest store for recycling. They also encourage their customers to find a new home for any unwanted products through donating them to charity or selling them on ebay. The initiative aims to keep all Patagonia products out of landfill or from being incinerated

Since 2000, they have been using Bluesign® technologies to evaluate and reduce resource consumption and to screen raw materials, including dyes and finishes used in their supply chain. This auditing systems aims to improve and establish management systems in 5 key areas of the production process – resource productivity, consumer safety, water emissions, air emissions and occupational health and safety. They also use e-fibres – environmentally friendlier fibers in a number of their products which include recycled and recyclable polyester, organic cotton, hemp, organic wool and chlorine-free wool.

HERMAN MILLER

Herman Miller design and manufacture chairs and office furniture and are at the forefront of sustainable design and product stewardship. Their Design for the Environment (DfE) team creates products that are designed for disassembly and a take back program so that all the materials can be taken apart at the end of life and reused or recycled.

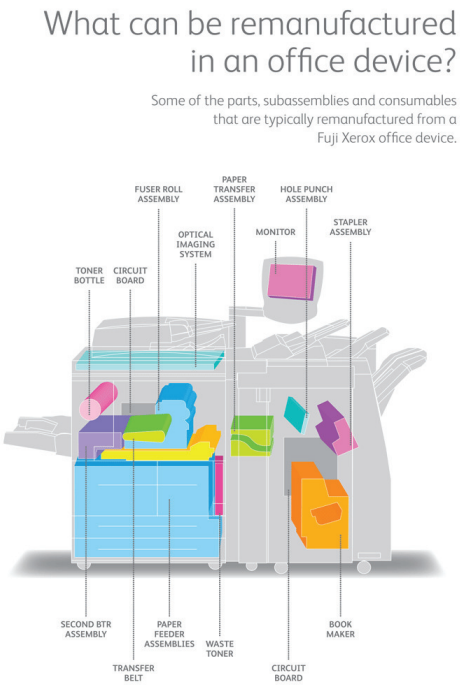


Herman Miller Celle chair disassembled

FUJI XEROX

The photocopier company Fuji Xerox has changed the way they offer their products from simply selling machines to selling the service of photocopying which means that they can repair and upgrade their machines even after years of service. They embrace life cycle including by; recycling part and consumables, remanufacturing of used parts, use of closed loop recycling technology and development of end of life recycling centers across the Asia Pacific region.

Their products are designed to support remanufacturing and recycling at end of life and because of their voluntary product stewardship initiatives they can reduce costs of manufacturing through the design of machines that are easy to disassemble and recycle. Every piece of equipment is built to allow the disassembly of standardized, long life parts so they can be easily remanufactured or recycled. As a result of manufacturing operations new resource input was reduced by 2,000 tons and 15,500 tons of carbon emissions were avoided.



Fuji Xerox remanufacturing diagram

FUJI xerox

MORE INFORMATION

Patagonia: www.patagonia.com/us/footprint/

Herman Miller: www.hermanmiller.com.au/About-Us/Environmental-Advocacy

Fuji Xerox: www.fujixerox.com.au/environment/product_stewardship.jsp

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