Aalto University
School of Arts, Design
and Architecture

Sustainable design S6

Tatu Marttila
Friday 10.5.2024

Agenda

9.15–9.30

Product and material impact assessment – discussion & recap

9.30–10.45

Sustainability assessment; Exercise in groups

10.45–11.00

Break

11.00–11.30

Strategies for life cycle extension and end-of-life management: *EcoDesign strategy checklist*

11.30–12.00

Assessment and redesign exercise for sessions 5–8

Product and material impact assessment – a recap

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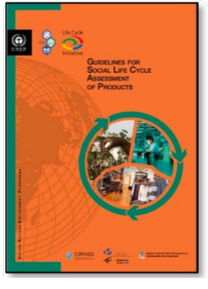
Sustainability impact assessment

To be able to compare products and materials and make design choices, there is a need for **comparable data to support impact assessment**.

- Carbon footprint as a general way of assessing environmental impacts
- Also several indicators for social well-being are available
  (e.g. Human Development Index)
- Granta EduPack database (on Aalto computers) package provides a resource that can be used to help to gather information on materials (and also nations), to support material selection and assessment.

The 'golden standards' for sustainability impact assessments:

Sustainability

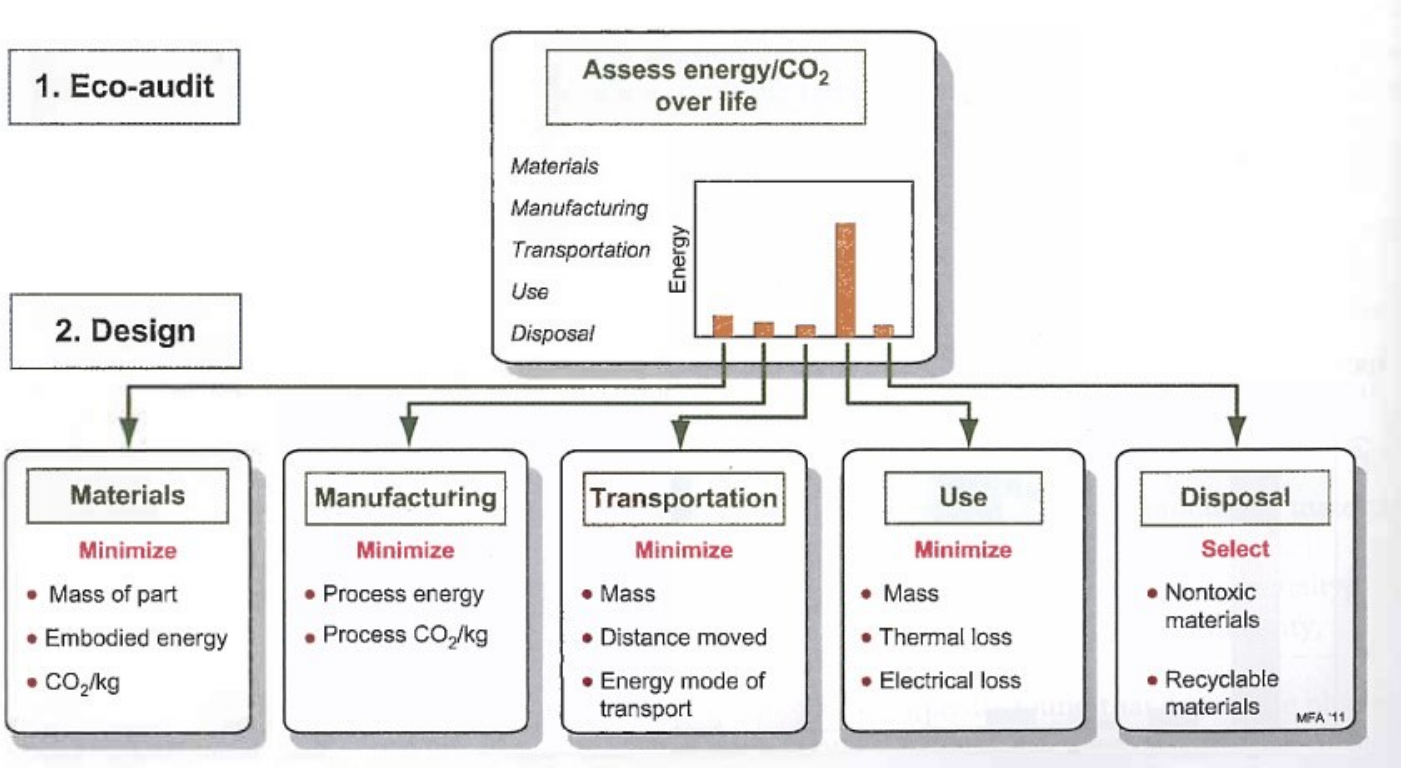
Capitals	Natural	Manufactured and financial	Human and social
			
Tools	(E-) LCA Environmental life cycle assessment	LCC Life cycle costing	S-LCA Social life cycle assessment
Origins	SETAC (1991 on)	Multiple – EU, US, Other	UNEP/SETAC (2009) (2)
Methods	ISO 14000 series (1997 onwards)	Technical cost modeling (1)	
EduPack Tools	Eco-audit tool	Eco-audit with cost Part-cost estimator	

(1) http://ec.europa.eu/environment/gpp/pdf/WP-LifeCycleCosting.qx.pdf

(2) http://www.unep.fr/shared/publications/pdf/dtix1164xpa-guidelines_slca.pdf

Source: Ashby, M. (2013) Materials and the Environment: Eco-Informed Material Choice

Product level life-cycle assessment:



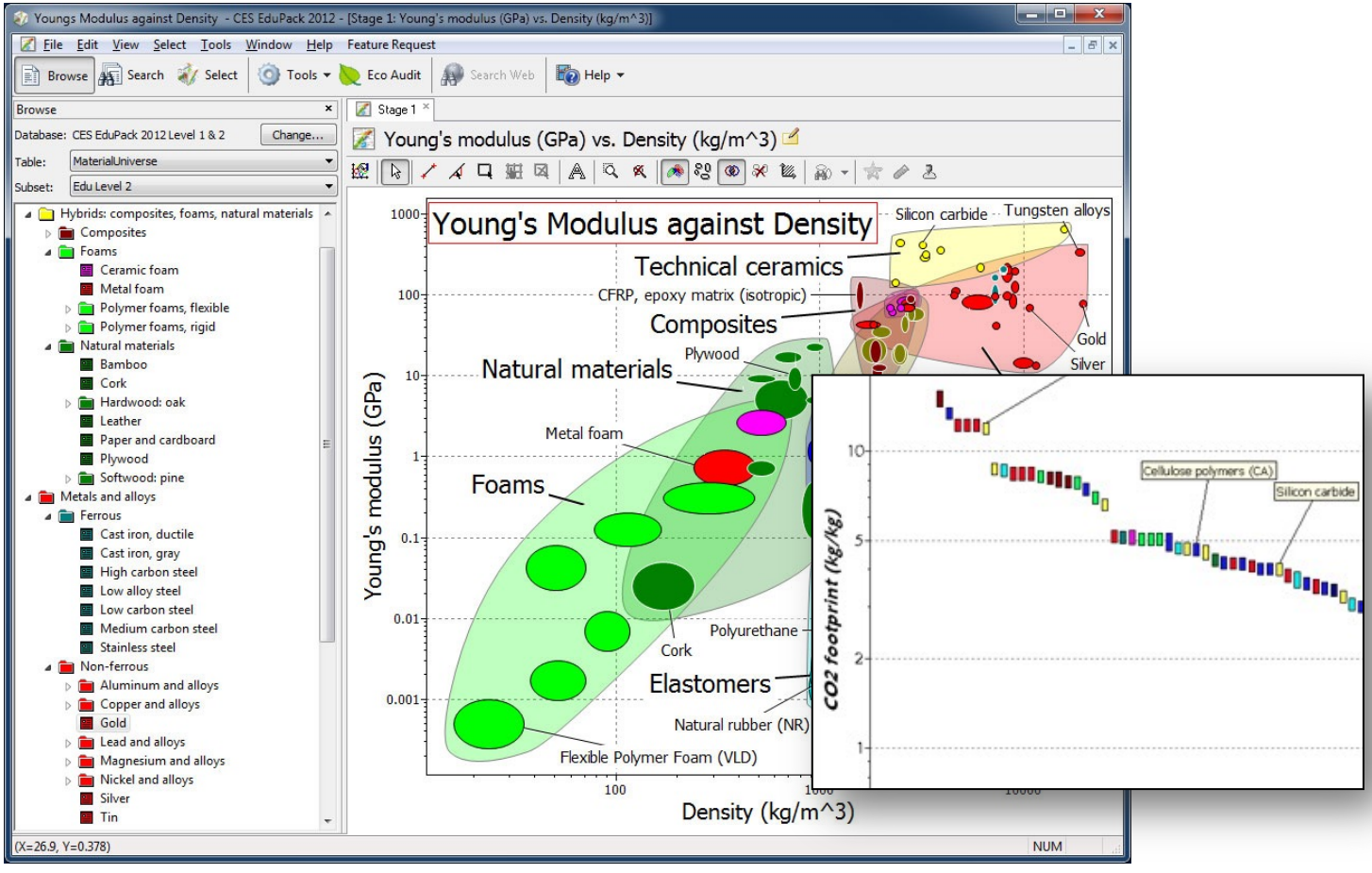
Source: Ashby, M. (2012) Materials and the Environment: Eco-Informed Material Choice

Qualitative SLCA approach – MET matrix:

MET (materials, energy, toxicity) matrix/table is an SLCA tool/method to manage research in eco-auditing and LCA processes:

Life phase	Materials	Energy	Toxicity
Raw materials	List of components and materials	Embodied energy	Issues in materials production; eg. CO2
Production processes	List of production processes	Energy consumption in production	Eg. CO2 in manufacturing
Transport/ logistics	Infrastructure in transport & logistics	Energy consumption in logistics	Means of transport? CO2 per kg?
Use phase	Materials needed during use (eg. Coffee filters)	Energy consumption during use	Waste of consumables
End-of-Life (EoL)	EoL choices for components/materials	Impacts of EoL choices	Impacts of EoL choices

Quantitative data-driven approach:



See session 5 slides for Granta Edupack intro…

Granta Edupack remote use

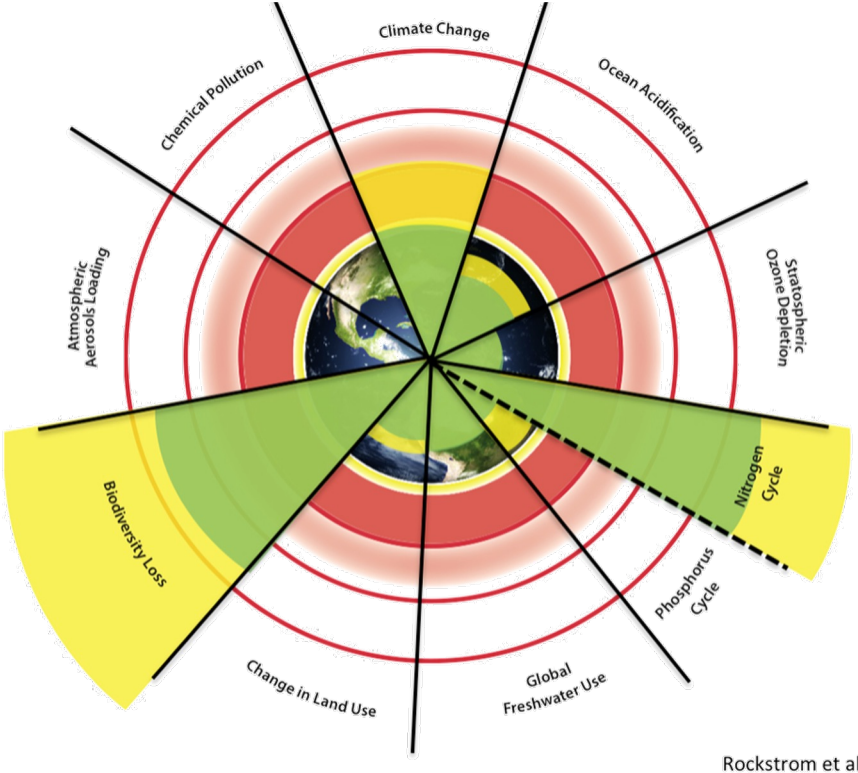
Granta Edupack is also available to use through Virtual Destop:

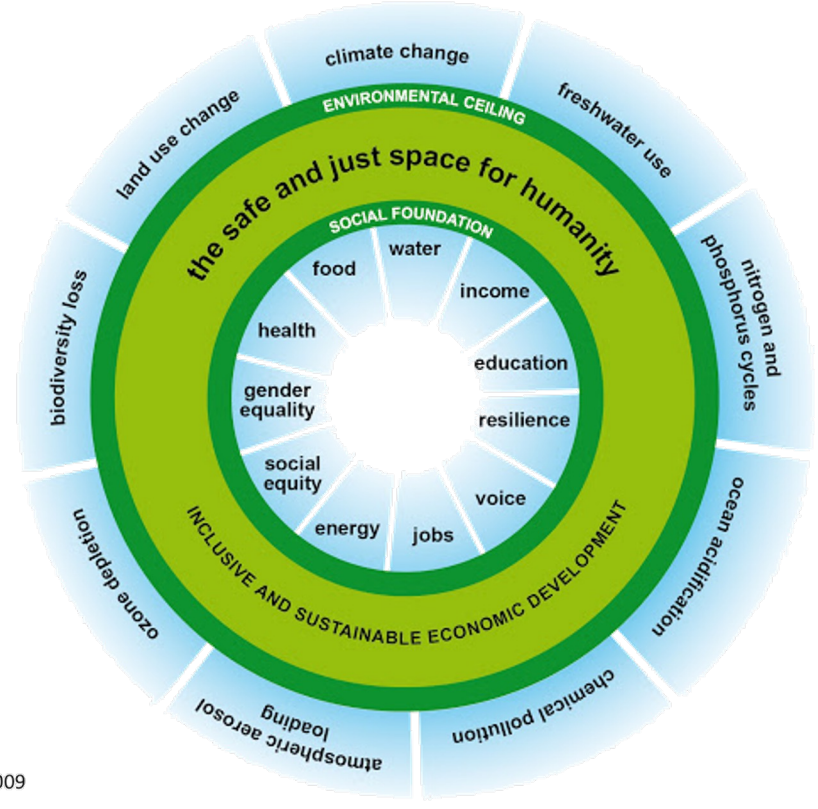
https://www.aalto.fi/en/services/vdiaaltofi-how-to-use-aalto-virtual-desktop-infrastructure

You can also download Granta Edupack from https://download.aalto.fi/
(this works unfortunately only for PC computers, though Mac users could use Bootcamp or emulator to run Windows on Mac)

Sustainability assessment

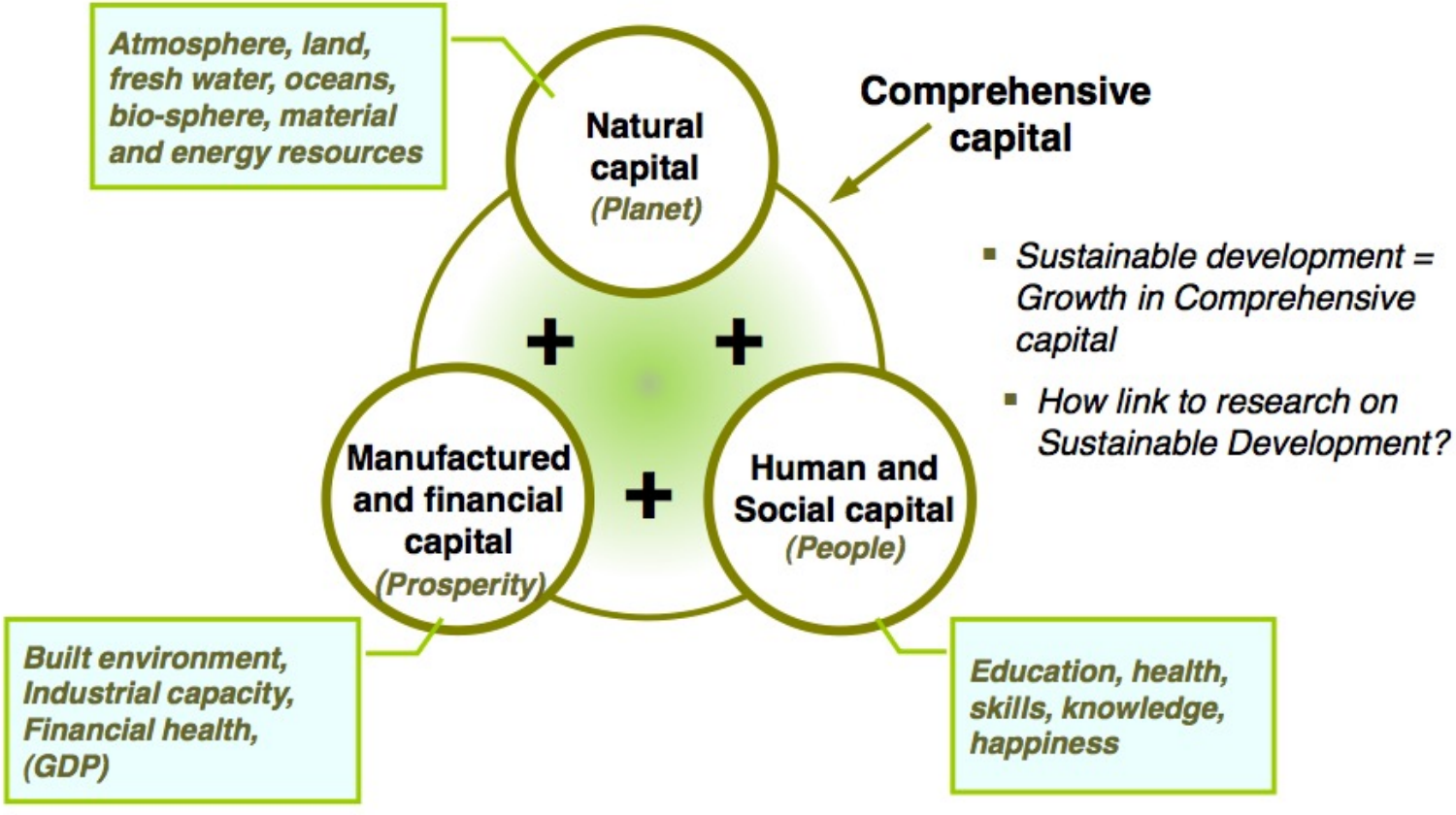
Sustainability, a complex concept…





Rockstrom et al., 2009

…governing shared and comprehensive capital…



- *Sustainable development = Growth in Comprehensive capital*
- *How link to research on Sustainable Development?*

Source: Ashby et al. (2013) Materials & SD

Sustainability in design

Considerations: “Sustainability” vs. “Sustainable development”?

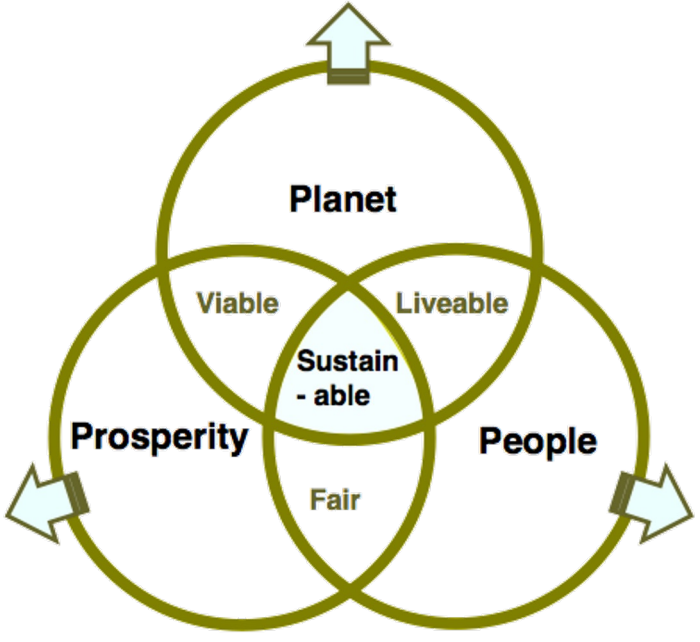
Triple bottom line (TBL) Reporting:

Financial bottom line

Social / ethical performance

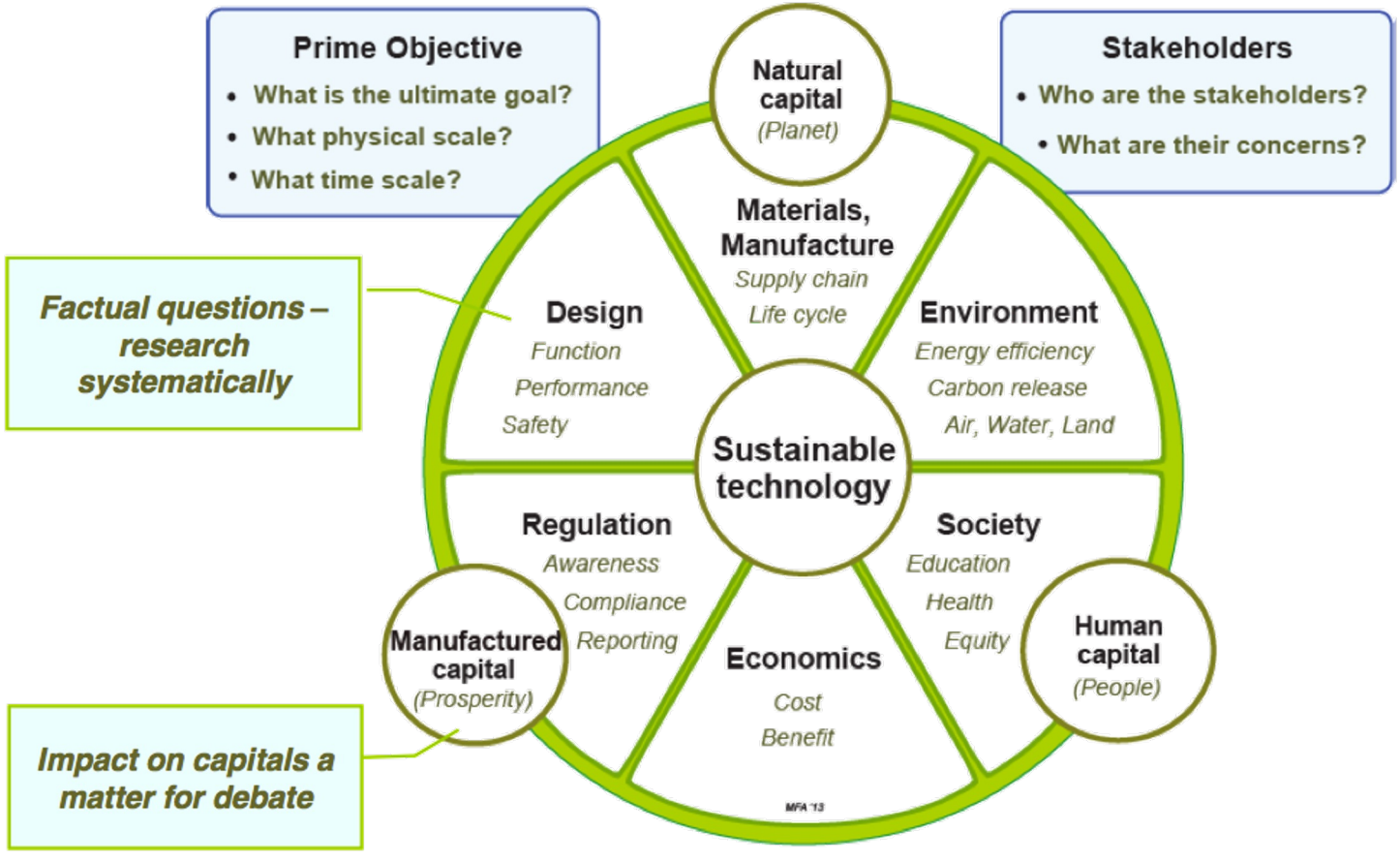
Environmental performance
(Elkington, 1994)

Decouple the circles – unpack their meaning…



Source: Ashby et al. (2013) Materials & SD

Analysing design solutions:



Source: Ashby et al. (2013) Materials & SD

Sustainability impacts assessment process in design

Steps to assess sustainability impacts and potential:

1. **Identify prime objective for assessment (product / service / process etc.)**
2. **Define system boundaries for the assessment**
3. **Review stakeholders and both production system and product components**
4. **Perform “fact-finding” on stakeholders and components (Materials & Manufacturing; Environment; Society; Economics; Regulation; Design)**
5. **Integration back into communicative message (Natural capital; Manufactured capital; Human capital)**

Key elements in sustainability assessments:

Materials (of a product):

- Mass, density, price; recycled, recyclable?
- Critical materials? (rare, no substitutes, supply chain risks, geopolitics)

Energy / carbon footprint:

- How much energy is needed?
- When and where is it needed?

Environment:

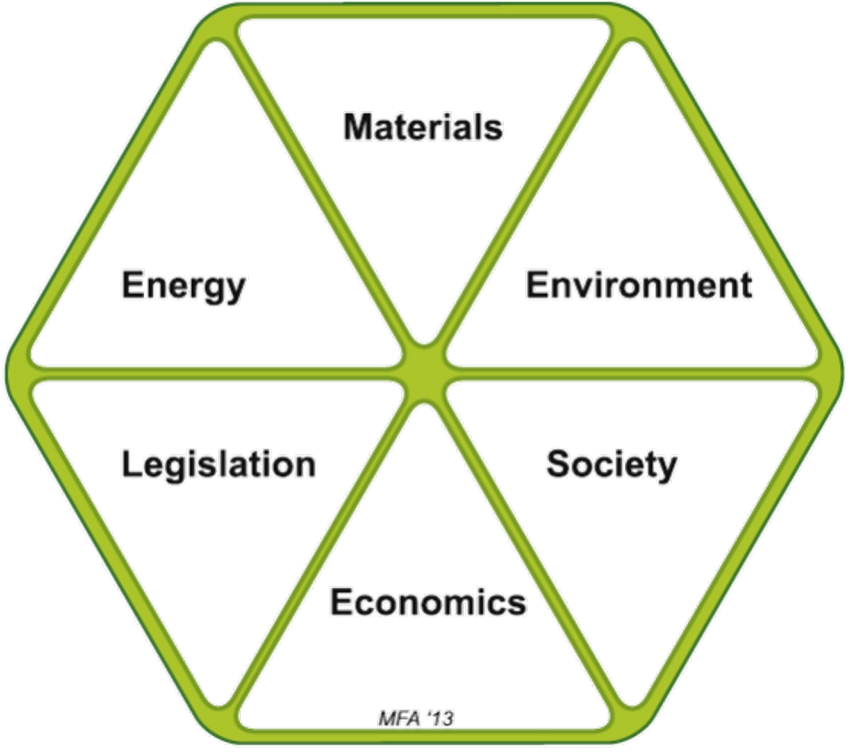
- Ecological footprint/handprint
- Toxicity/accumulation

Legistlation:

- Policies & legislative frameworks
- Guidance & Costs

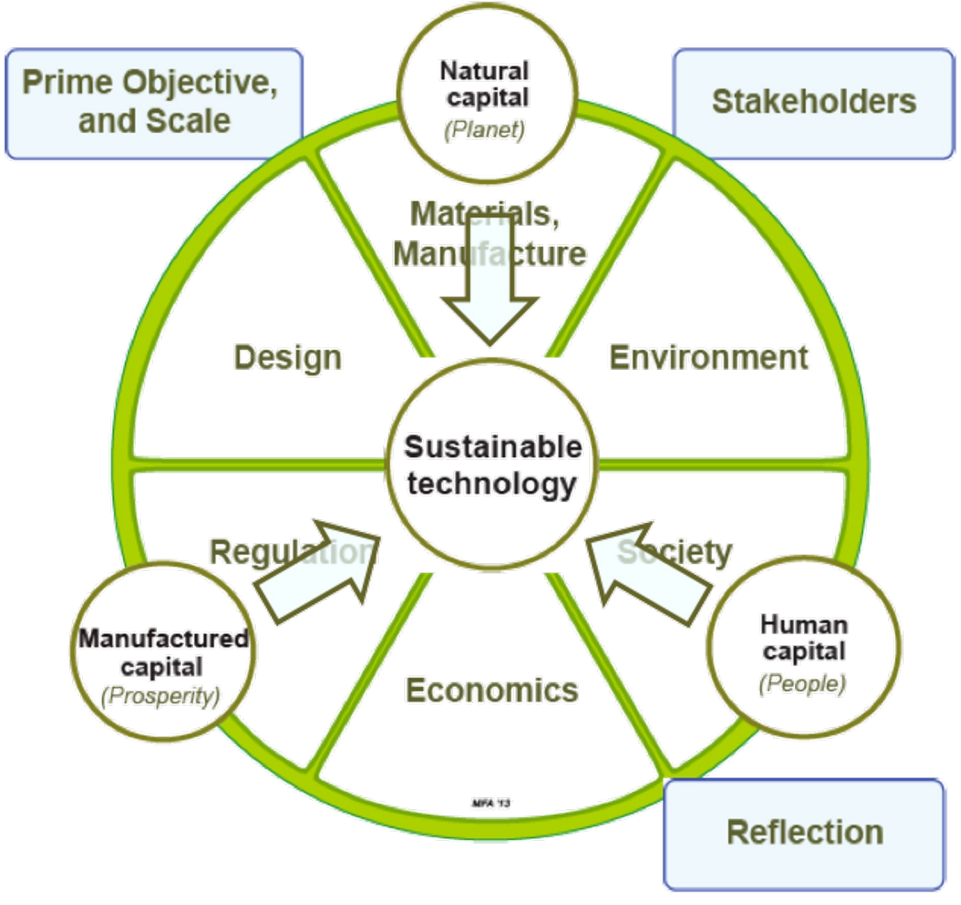
Society and Economics:

- Fairness and quality of life, good jobs
- Risk, investments, competitive advantage



Source: Ashby, M. (2013) Materials and the Environment: Eco-Informed Material Choice

Assessing sustainability impacts / potential:



Step 1: Clarify Objective

Step 2: Stakeholders

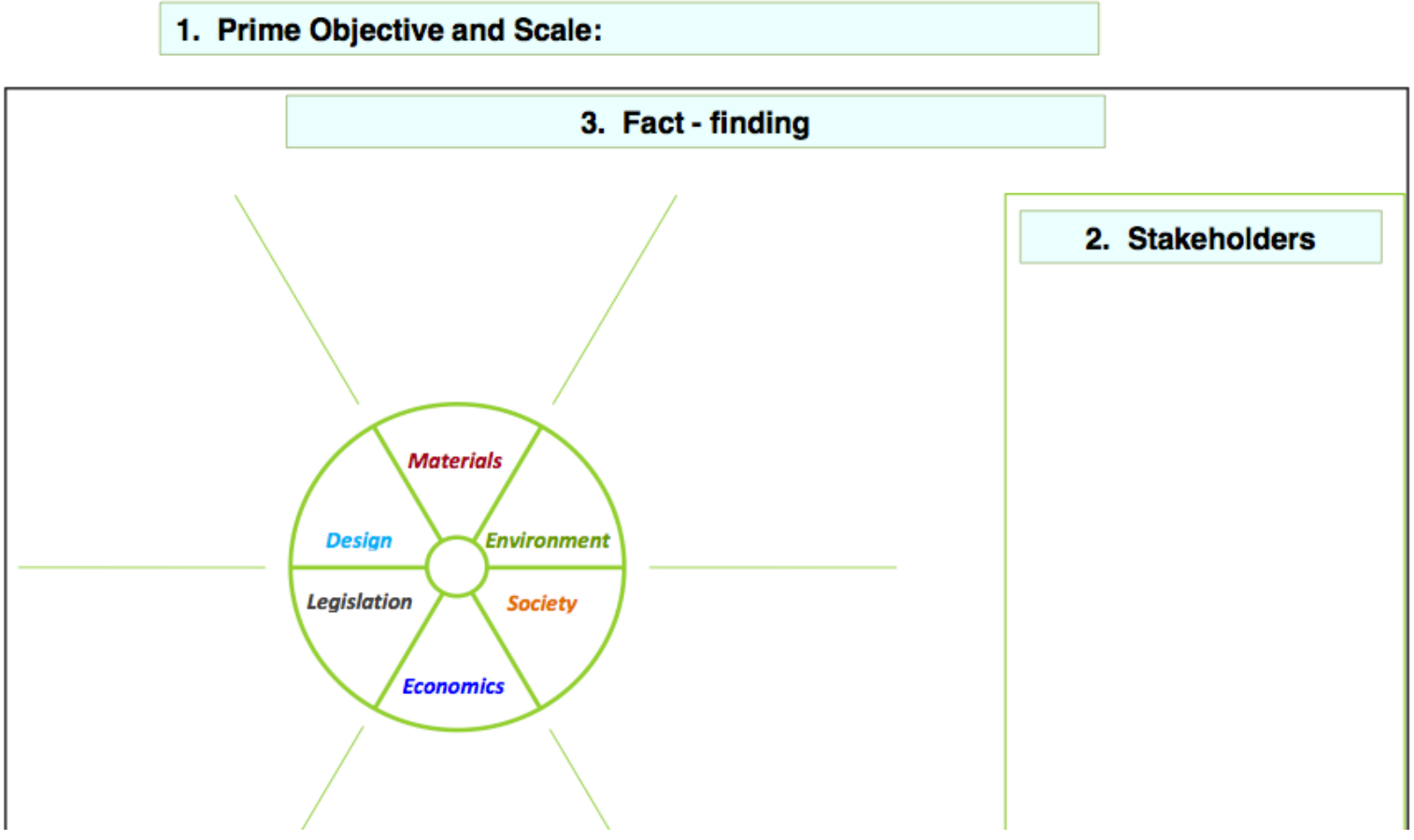
Step 3: Fact finding
- objective

Step 4: Integration
- subjective

Step 5: Reflection

Source: Ashby et al. (2013) Materials & SD

Granta Edupack fact-finding sheet:



Sustainability assessment examples

(from Ashby et al. 2013)

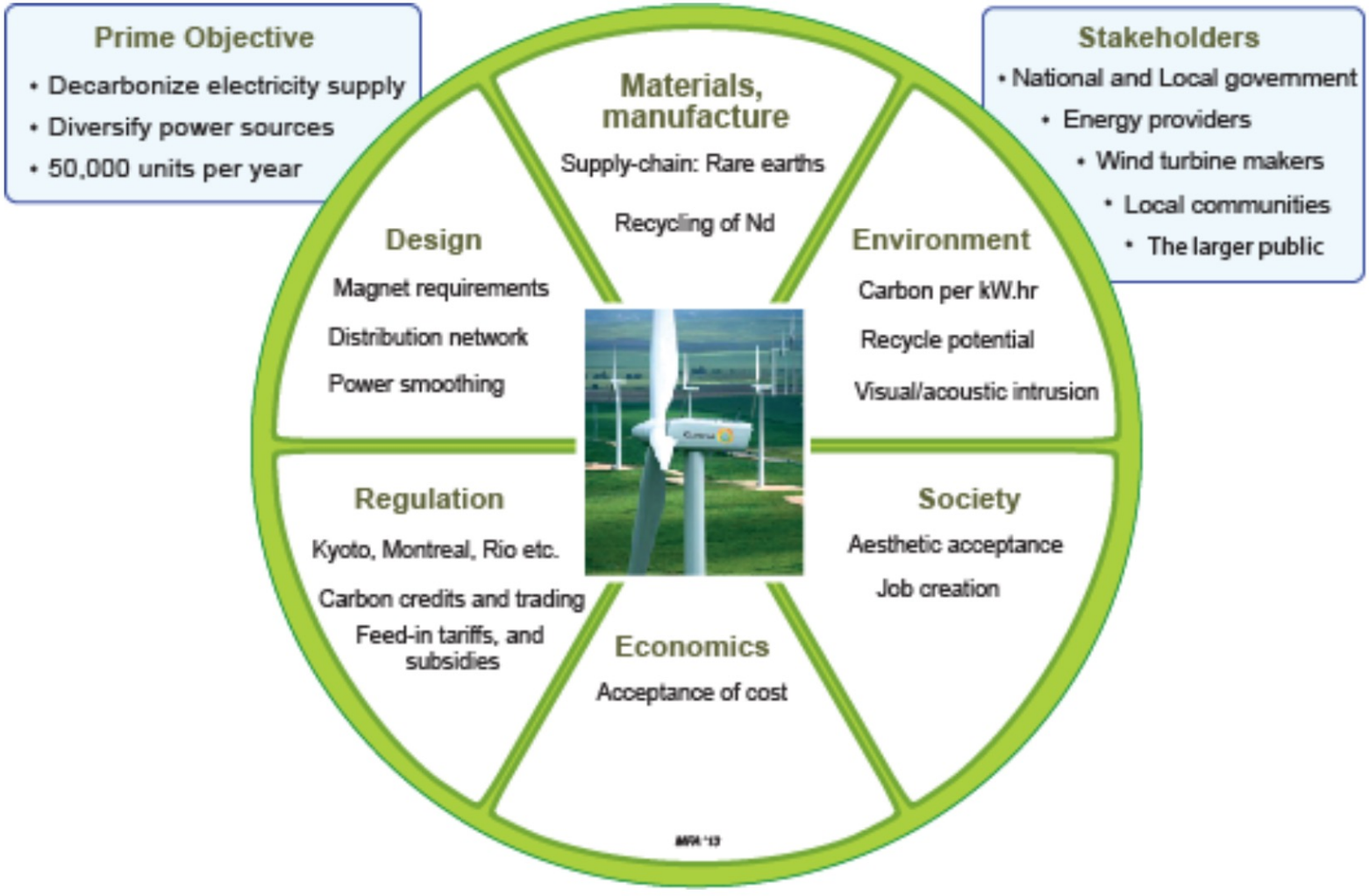


Figure 18 *Fact-finding for Wind farms*

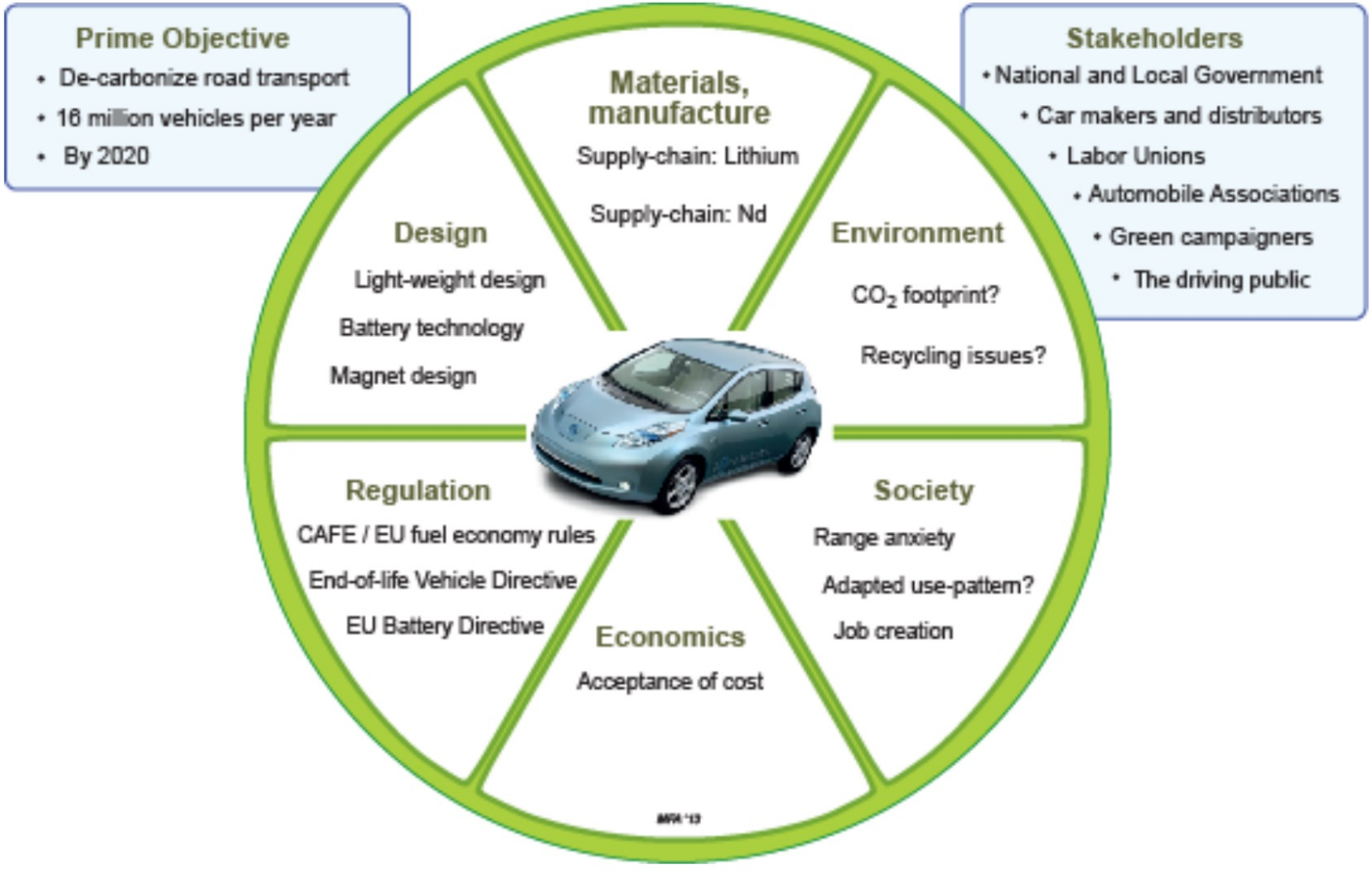


Figure 22. Issues of importance to the sustainability of electric

Exercise in groups

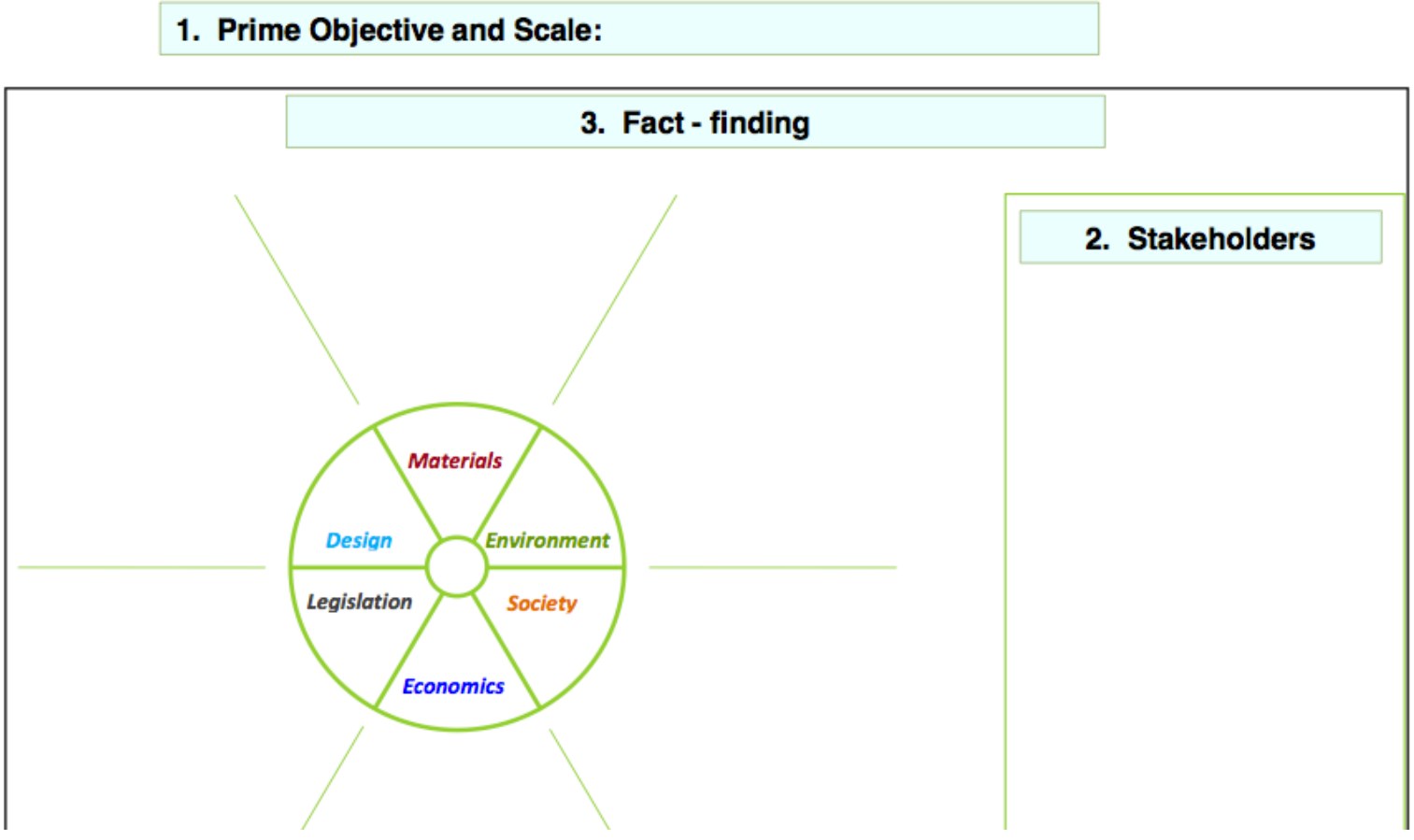
Exercise in groups

Split in 8 random groups, perform assessment on general impacts:

- *Group 1: Cement & concrete*
- *Group 2: Steel*
- *Group 3: Paper & cardboard*
- *Group 4: Cotton*
- *Group 5: Packaging plastics (e.g. PP)*
- *Group 6: Bioplastics (e.g. PLA)*
- *Group 7: PV energy (ie. solar panels)*
- *Group 8: Electric bicycles*

- Discuss in groups (15 min), fill some points to the Granta fact-finding canvas (15 min), then present findings briefly to others (back to class at 10.30)
- For the online canvases for groups, go to (QR code): https://miro.com/app/board/uXjVMKOradk=/?share_link_id=755211120876

Granta Edupack fact-finding sheet:



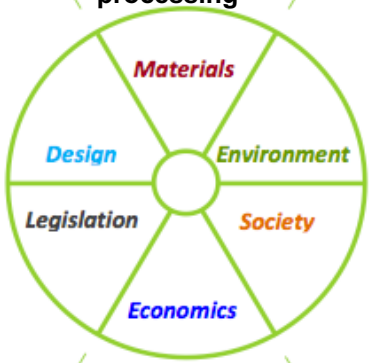
Electronic products & waste (example):

1. Prime Objective and Scale: *12 million tons WEEE annually in EU (amount of WEEE waste in 2020)*

3. Fact - finding

- Critical materials involved
- Toxics of production
- High energy consumption in production/ processing

- Highly compact design (eg. phones)
- Rather short product life
- Difficult recycling



- Production/ processing/ transport impacts
- Mining industry impacts / toxicity
- Old products are inefficient
- Severe EoL issues

- Carbon trade & Paris agreement
- EU eco-design directives
- Mandatory recycling (PRO's)

- Crucial in contemporary life (eg. phones)
- Labor issues in mining, production, processing, EoL?

- Value of markets is high, but low market for recycled materials (eg. plastics)
- Cost of recycling is high

2. Stakeholders

Important stakeholders:

- Raw material industry (incuding mining)
- Manufacturing industry
- Policymakers
- Consumers and associations
- EoL / PRO's & recyclers

Strategies to improve product sustainability

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Strategies to improve product sustainability

- Life-cycle assessment as a cornerstone
- Consider production; Remember also societal aspects!
- Less harm from materials: Consider alternatives, processes, and end-of-life options
- More value from materials: Extending product life and product use (consider service systems)
- Consider end-of-life options and processes
- Design for R: Reduce, Reuse, Recycle, Recover (and Regenerate etc.)
- Communicate with values against throwaway society (eg. ‘luxury’ vs. cheap products?)

Ecodesign checklist

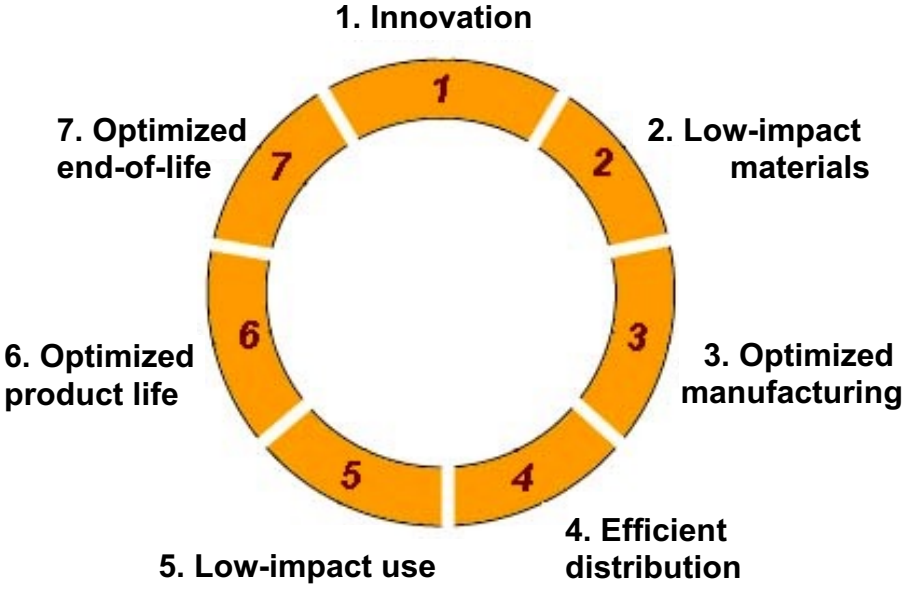
The **EcoDesign checklist by TU Delft** is a life-phase based checklist with questions that provides support for the analysis of a product's impact on the environment. It provides relevant questions that need to be asked when establishing environmental bottlenecks during the product life-cycle.

See:

- **EcoDesign checklist at MyCourses** (in ‘Readings and materials’)
- http://wikid.io.tudelft.nl/WikID/index.php/EcoDesign_checklist

EcoDesign checklist: Strategy wheel

1. **Define the product idea, product concept or existing product that will be analyzed. Evaluate existing system or your concept.**
2. **Systematically score the product on each dimension of the strategy wheel, linked to life phases of the product.**
3. **Consider the optimization options for each of the dimensions, paying special attention to those where the current design scores badly.**



EcoDesign strategy wheel by TU Delft

Ecodesign strategies:
1. Innovation

- Rethink how to provide the benefit
- Serve needs provided by associated products
- Anticipate technological change and build in flexibility
- Provide product as service
- Share among more users
- Design to mimic nature

Ecodesign strategies:
2. Low-impact materials

- Avoid materials that damage human health, ecological health, or deplete resources
- Use minimal materials
- Use renewable resources
- Use waste by-products
- Use thoroughly tested materials
- Use recycled or reused materials

Ecodesign strategies:
3. Optimized manufacturing

- Design for ease of production quality control
- Minimize manufacturing waste
- Minimize energy in production
- Minimize number of production methods and operations
- Minimize number of components/materials

Ecodesign strategies:
4. Efficient distribution (logistics)

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

Ecodesign strategies:
5. Low-impact use

- Minimize emissions/integrate cleaner or renewable energy sources
- Reduce energy inefficiencies
- Reduce water use inefficiencies
- Reduce material use inefficiencies

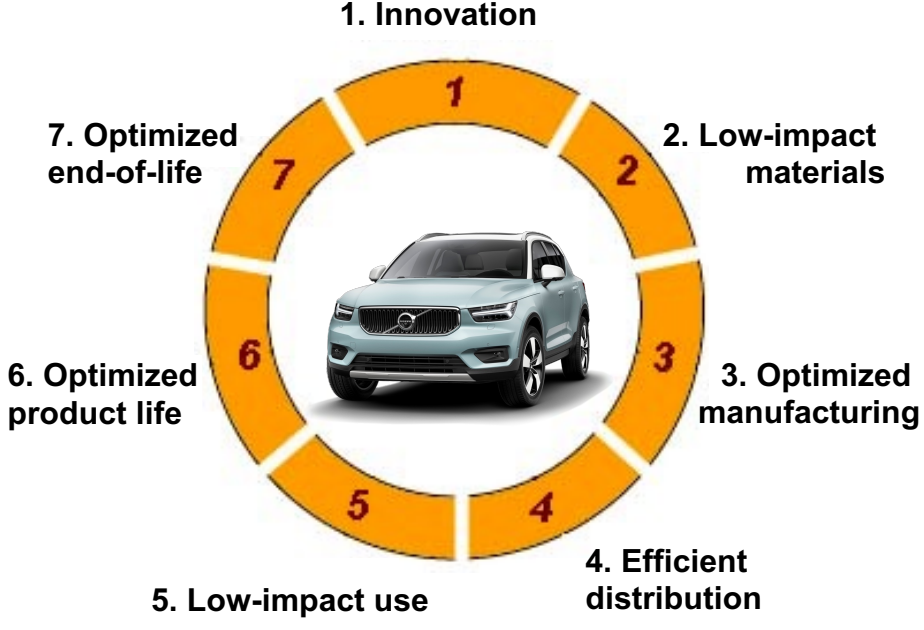
Ecodesign strategies:
6. Optimized product lifetime

- Build in user’s desire to care for product long term
- Design for take-back programmes
- Build in durability
- Design for maintenance and easy repair
- Design for upgrades
- Design for second life with different function
- Create timeless design

Ecodesign strategies:
7. Optimized end-of-life

- Integrate methods for product collection
- Provide for ease of disassembly
- Provide for recycling or downcycling
- Design reuse, or ‘next life of product’
- Provide for reuse of components
- Provide ability to biodegrade
- Provide for safe disposal

Strategies to improve product sustainability



Sessions 5–8: Assessment and redesign exercise

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Assessment & redesign exercise (sessions 5–8)

Assessment and redesign exercise consists of two parts:

1. **Assessment of sustainability impacts (of product/material)**
2. **Redesign improvements**

- **Exercise is done independently, assessment followed by redesign;**
- **Final results are communicated on next Friday (DL for uploads on Thursday) with a digital poster and pitch talk**
- **Reflection on assessment in learning diary after session 8!**

Assessment & redesign exercise: (part 1)

In the assessment part (part 1) of the exercise, you first select a product/material for assessment, and then perform a simple assessment on your selected topic.

After this session:

- **Lock your topic for assessment!** (could be product, material, even service)
- Identify material(s), related processes (production, transport), stakeholders
- Identify major sustainability issues and impacts along the life phases
  - *Raw materials production; Manufacturing processes; Transport/logistics; End-of-Life (EoL) options; and/or use phase itself*
- **Consider dominant phases and sustainability issues, and start to think of improvements!**

Assessment and redesign exercise: Redesign phase (part 2)

Based on your assessment, proceed to suggest improvements. You can consider for example:

- **Material alternatives**
- **New ways of production or logistics**
- **Improving societal aspects**
- **Improving efficiency in use**
- **Services and sharing**
- **Communication with design**

Discussing topics…

Example topics:

- **Product (domestic, leisure)**
- **Electrical device**
- **Clothing/textile**
- **Vehicle/transport system**
- **Material (its usage, production)**
- **Food (product, ingredient)**
- **Etc..**

- *What is your topic?*
- *Have you thought of important impacts?*
- ***Let's discuss topics briefly!***

Assessment and redesign examples

Assessment example: Lidl sneakers

LIVERGY® Lidl sneakers

Materials:

- *Upper: Nylon*
- *Lining and insole: textile*
- *Outsole: Polyurethane*

-> Fossil-based plastic in various forms

Sustainability issues:

- *Labor issues in manufacturing location (China)*
- *Material issues (fossil-based)*
- *End-of-Life issues*
- *Focus life phases: Materials & manufacturing, EoL*

Redesign example 1: Lidl X Ioncell® sneakers

Lidl X Ioncell® sneakers

Materials:

- *Upper: Ioncell cellulose fibre*
- *Lining and insole: Ioncell*
- *Outsole: 50% recycled rubber*

Sustainability improvements:

- *Improved material selection*
- *Production partner with fair labor conditions*
- *Future focus in end-of-life improvement, in-store collection*

Ioncell® cellulose fibres, see: https://ioncell.fi/
Sneaker design based on Decathlon NH150 eco-sneaker

Redesign example 2: Lidl 2ndLeg sneakers & recycle service

Lidl X 2ndLeg sneakers & recycle service

- *Lidl proceeding to sustainability in clothing*
- *In-store collection system for old sneakers*
- *Back-end recycling and upcycling facilities*
- *2ndLeg sneaker collection in stores*

Sustainability improvements:

- *From producing new cheaply, to recycling and reusing old*
- *Support for local actors in upcycling*
- *Access to waste streams for recycling*
- *Feasibility?*

Assessment and redesign exercise: Poster & pitch (for next week Friday!)

Communicate your assessment and redesign:

- **Produce a one- or two-page PDF poster; Upload to MyCourses by Thursday midnight!**
  - Layout option 1: Use one-page landscape layout with text and images of existing product on left side, and redesign on right side
  - Layout option 2: Use two pages with landscape format, with existing product on first page, and redesign on the second
- **Describe your topic, assessment and redesign**
- **Communicate sustainability issues and suggested improvements**
- **Present with a 3 min pitch in next Friday's session!**

Poster example

Product assessment

LIVERGY® Lidl sneakers
Materials: Nylon, Polyurethane
Sustainability issues:

- *Labor issues in manufacturing location (China)*
- *Material issues (fossil-based plastics)*
- *End-of-Life issues*
- *Focus life phases: Materials & manufacturing*

Redesign idea

Lidl X Ioncell® sneakers
Materials: Ioncell® cellulose fibre, recycled rubber
Sustainability improvements:

- *Improved material selection*
- *Production partner with fair labor conditions*
- *Future focus in end-of-life improvement, in-store recycling?*

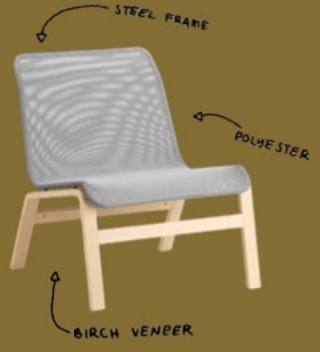
Some assessment and redesign examples from previous years:

IKEA

ORIGINAL
NOLMYRA CHAIR

FSC

Circular HUB



TRANSPARENCY
- Production chain is unknown.
- Unknown manufacturing locations and material origins. Most likely somewhere in Asia.
- Reported labor and sustainability issues at some factories, while some are reported to be doing ok.
- No third party auditors, instead internal auditors (biased) and a code of conduct for factories (which not all factories reportedly follow)

MATERIALS
- **Fabric:** Not-recycled polyester is a non-biodegradable fossil-based material, production uses a lot of water and is very energy-intensive. It is also a source of micro-plastic.
- **Metal frame:** Steel production is very energy-intensive and has a lot of CO2 emissions. Recycling metal has similar issues.
- **Wood:** Birch veneer used is FSC certified and thus more responsibly made than the other two materials. Veneer is rather sustainable - less wood is needed to build furniture, it's somewhat biodegradable and relatively easy to recycle.

END OF LIFE
- Ikea has a second-hand program called the circular HUB, where consumers can bring some Ikea furniture to be resold at Ikea. In return you get an Ikea gift card.
- Issues are that most people don't know about the program, you can only bring in certain furniture and the gift card encourages buying new products. There are no recycling options in-store.

TRANSPARENCY
- Transparent production chain.
- Detailed information on factories and manufacturing origins as well as material origins.
- Only certified, reliable factories with good labor conditions.
- External auditors to identify labor and sustainability issues in production reliably.

MATERIALS
- **Fabric:** Polyester is exchanged with a recycled or repurposed textile material. Each chair could be unique, and materials could be selected based on what is available to avoid making new textiles.
- **Metal frame:** Metal frame is replaced with veneer to reduce emissions in production and to better the recyclability of materials.
- **Wood:** Veneer is made from recycled wood to reduce foresting. Veneer glue could be made non-toxic and recycled by using a glue made from textile waste. Glue could be made from old Ikea textiles.

END OF LIFE
- Ikea in-store recycling - consumers can bring their products to either re-sell them or to recycle the materials depending on product condition. Applies to all products, direct payment (could be built into the price of the product. "pantti") instead of gift card.
- Ikea invests into recycling their most used materials (wood, textile) by themselves to create new materials for new products in-house. Textiles are recycled and textile waste is used for making veneer glue. Solid wood used for veneer, veneer used for chipboard.
- Through recycling their own products, Ikea could eventually become circular and less unsustainable.

REDESIGN

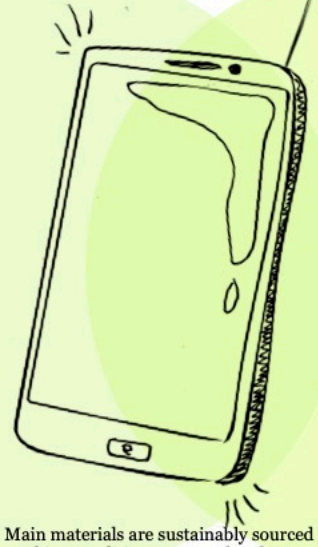
Some assessment and redesign examples from previous years:

iPhone 8 by Apple Inc.

Main materials:
Aluminium, iron, lithium, gold and copper
Sustainability issues:

- Labor issues in manufactoring and mining locarions
- Environmental problems caused by material mining (for exmp. deforestation, water usage and -pollution, producing toxic waste
- End-Of-Life issues
- Transportation and logistics between mining-manufacturing-assembling-customers
- Recycling of rare minimals only around 1%
- Easily brakeable, hard or expensive to repair

EcoPhone



Sustainable option for iPhone or others.

- Ethically sourced materials
- Minimizing transport and logistic CO_2 emissions
- Recycling rare minerals and materials such as gold, copper, iron and others
- Focusing on EOL improvement
- Encouraging giving the product as long life cycle as possible with making repairs easier and providing operating system updates as long as possible.

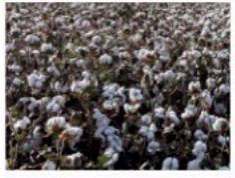
Main materials are sustainably sourced (or when possible recycled), and working conditions are regulated. Manufacturing parts and assembling the final product are executed as near as possible each other.

EcoPhone's shell is made with recycled plastic, to minimize breaking when falling. The phone is assembled to be easily DIY fixed at home, so when needed, you can for example repair its battery or camera parts at home.

The focus is in EOL improvement, providing newest updates for atleast 5 years, and when needing a new phone, EcoPhone will take back the old one and recycle all parts as needed.

Some assessment and redesign examples from previous years:

assessment: cotton *the most often used natural fibre worldwide*



materials:

- Raw material ie. cotton fibre consists of
  - cellulose 91% and water 8%

main processes:

- Cultivation, picking manually or mechanically, ginning (separating the cottonseed), distribution in bales for yarn manufacturing, spinning (ring, rotor etc.), weaving and dyes & other post-treatments

sustainability issues: current cotton production is unsustainable

- Cotton cultivation severelly degrades soil quality and causes pollution due to use of harmful pesticides and fertilisers
- High water usage - global cotton production requires over 250 billion tons of water annually
  - 10 000 litres of water to produce 1 kg of cotton
  - c. 2700 liters to make one cotton t-shirt
- Emissions - 8.3 kg CO_2
- EoL: Non-recyclable but c
  extent (untreated cotton is r
  - three main EoL options
    landfilling
- India and China are the b
  - Social issues rise questi
    e.g. corruption perceptio
- Production provides incor
  worldwide but cotton indus

redesign: spinnova *the climate-positive textile fibre*

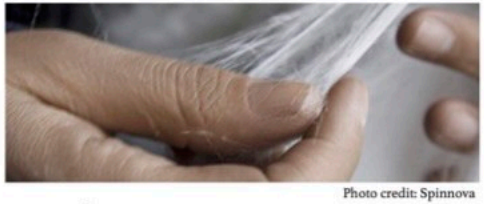


Photo credit: Spinnova

materials

- Same pulp that's used for making paper
- Wood comes from FCS and/or PEFC certified tree farms

main processes

- Treating pulp mechanically to create micro fibrillated cellulose (MCF): Finely ground pulp mass flows through a unique nozzle, where the fibres and fibrils rotate and align with the flow, creating a strong and elastic fiber network. The fiber is then spun and dried.

sustainability improvements:

- Fast EoL: 100% Recyclable & 100% biodegradable
  - Recycled without harmful chemicals & losing quality, no need to add virgin fibres
  - fibre can return to nature quickly (few months of biograding) in natural environments, leaving nothing harmful behind
- Minimal water usage - 99.5% less than conventional cotton's over the entire lifecycle from farming to fibre process
- 0% microplastics as made of wood - no pollution to ocean
- Emissions - production saves more CO_2 emissions that emits
- Finnish innovation - the new, industrial scale production unit will be located in Jyväskylä, Finland
- Social issues
  - Supplier Code of Conduct formulating started in 2021
  - Requirements related to human rights, environment and ethical business practices
  - Aligned with the principles of the UN Global Compact & the labour standards set out by the International Labour Organisation (ILO)
  - Corruption perception index in Finland is 85

Some assessment and redesign examples from previous years:

Alepa city bikes and electrical scooters

City bikes:
+ More enviormentally friendly than other means of transportation
+ Inexpensive to use
- Standardised bikes might not be suitable for everyone
- Limited usability (have to be returned within 30 min)

Electrical scooters:
+ Flexible usage.
They can be left almost anywhere. Users pay for intial unlocking and then buy the minute
+ Easy to use
- Expired batteries become problematic waste
- Injuries

Upcycled citybicycle

The redesigned city bike would upcycle and repair abandoned/second hand bikes. Shifting the focus from manufacturing standardized bicycles into repair and maintenance. Each bike would be unique, giving users more of a choice in picking a suitable bike.

The payment model would work in a similair way to electrical scooters with an inital fee and after that the user would be charged by usage time. This would make their use more flexible since users can pick up and leave the bikes whereever. Since they would be issued by the city the price could be lower than the electrical scooters making the bikes a more attractive option.

Tasks for next Monday session…

Continue work with your Assessment & redesign exercise:

- **Finalize your assessment, make use of assessment tools (MET matrix, fact-finding sheet, Granta database)**
- **Begin to ideate redesign improvements (ecodesign strategies)**
- **Begin to think about the poster and your presentation talk**

Diary this week & readings for next week

Reading:

***Allwood, J., & Cullen, J. (2010). Sustainable Materials – with Both Eyes Open* (see MyCourses)**

- Chapter 16: Longer life products
- Chapter 17: Reducing final demand

Learning diary entry for this week:

"How comprehensive understanding and knowledge offered by Granta Edupack to guide sustainable design action? Reflect on controversies and contradictions (i.e., challenges in the process) from a design perspective."

<u>See you on Monday (13.5.) at Jeti in A-Grid!</u>

Thank you!