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Applying Thought

Sustainability by Design

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Good design must address these sustainability challenges (as relevant)

- Climate Change
- Biodiversity at Risk
- Runaway waste overshoot
- Healthy, Safe and Low-footprint Products
- Water Stress
- Sustainable and Livable Cities
- Access for the poor to - Energy, Clean water, Sanitation, Nutrition, Education, Primary health care, Livelihoods, Markets, Financing, Affordable products

The three pillars of sustainable design

Minimize Env. footprint

- Conservation of non-renewable resources : Metals, Minerals, Fossil fuels,
- Zero/Minimal pollution of : Land, Water,Air
- Conservation of forests and biodiversity

At every lifecycle stage: Extraction, Manufacture, Transport, Use and End-of-Life

Minimize adverse social impact

- **Reduce and eliminate during the product lifecycle: Child and Forced labor, Discriminatory practices**
- **Fair wages**
- **Emphasis on diversity**

No adverse health impact

- ‘In Use’ : Elimination of all toxics that may have possible adverse health impact
- ‘In Manufacture’: Minimize pollution of water, land and air
- ‘End-of-life’: Eliminate any possibility of health impact in the process of disposal

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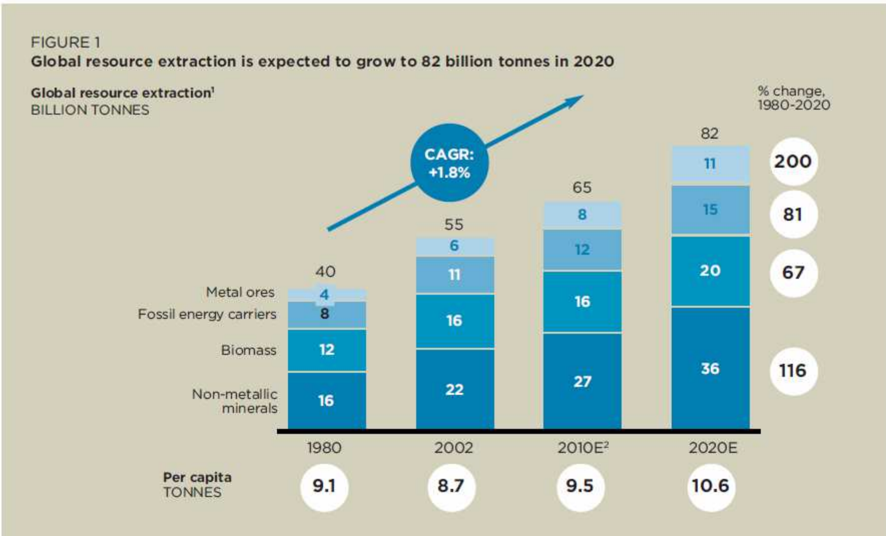
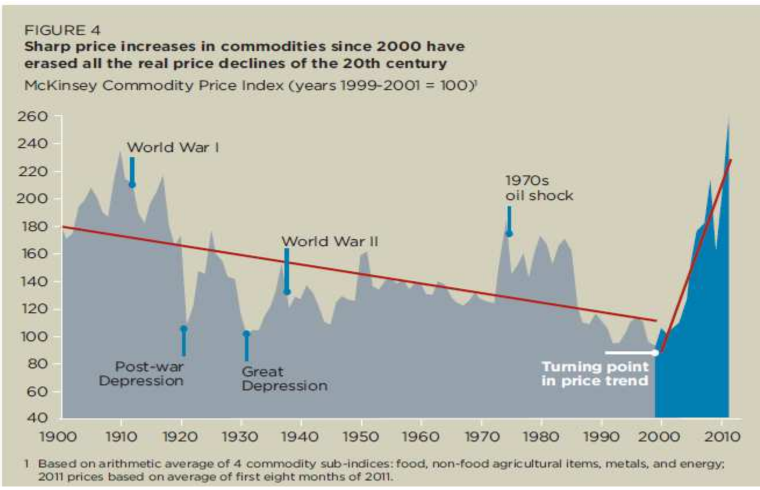
The emergent drivers of change

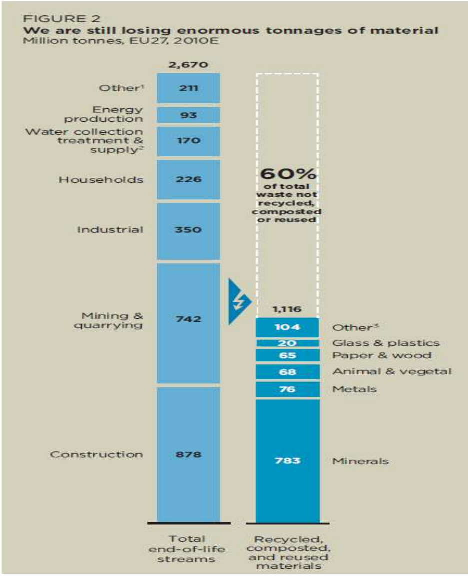
1. Increase in raw material and natural resource use : 65 bn tons in 2010 → 82 bn tons in 2020



First decade of 21st century saw highest ever price volatility in commodities



Enormous leakages : In EU, 60% of waste is let go



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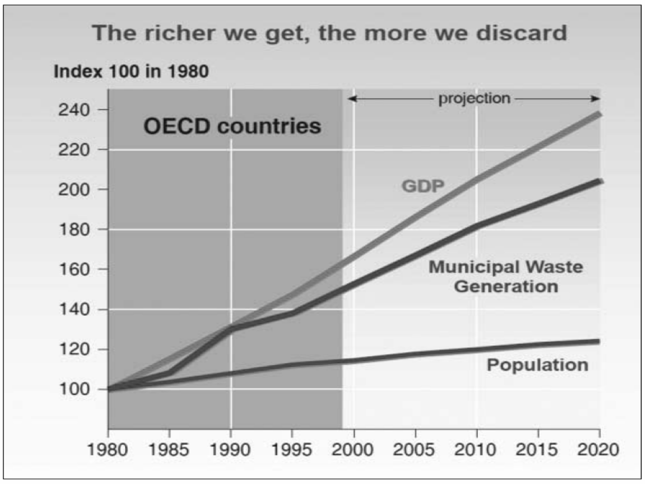
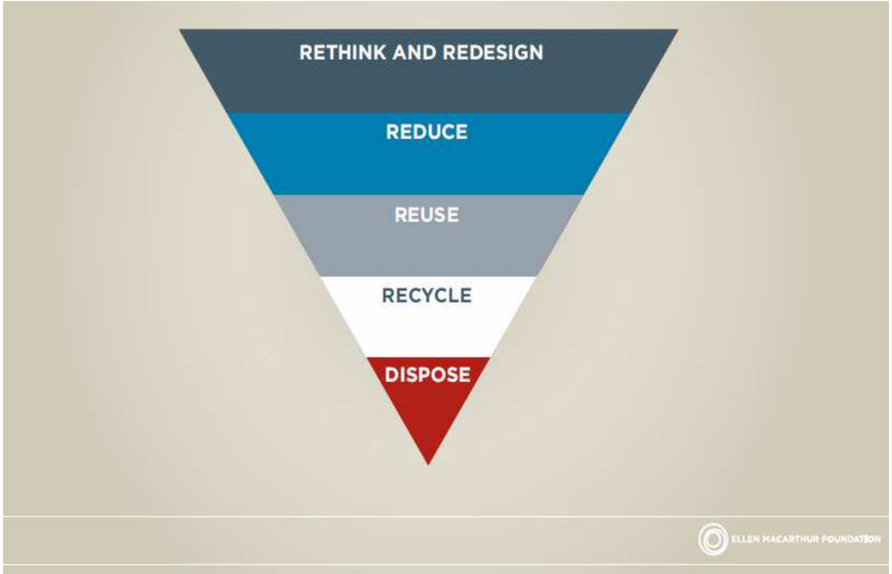
Waste as a design challenge

Wealth and Waste



Over the last three years, organizations like the Ellen Macarthur Foundation (EMF) has successfully seeded global advocacy and action around the concept of the 'Circular Economy'. A lot of my talking points draw from the work that is happening in this sphere

Looking differently at Waste : The 4th R



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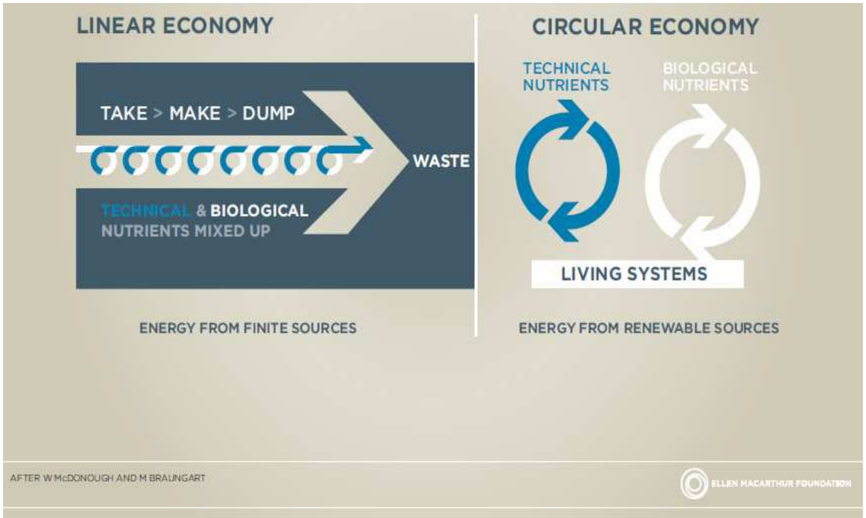
From the Linear to the Circular



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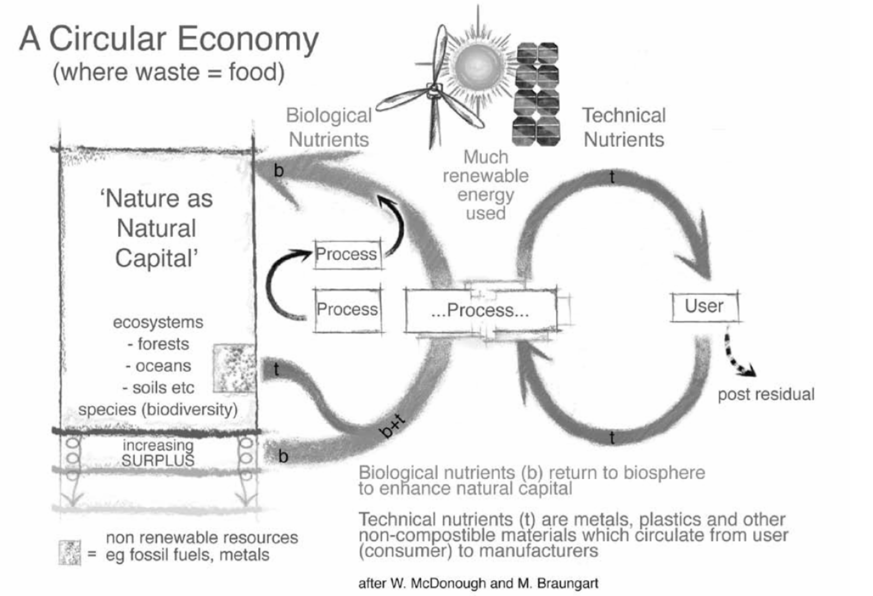
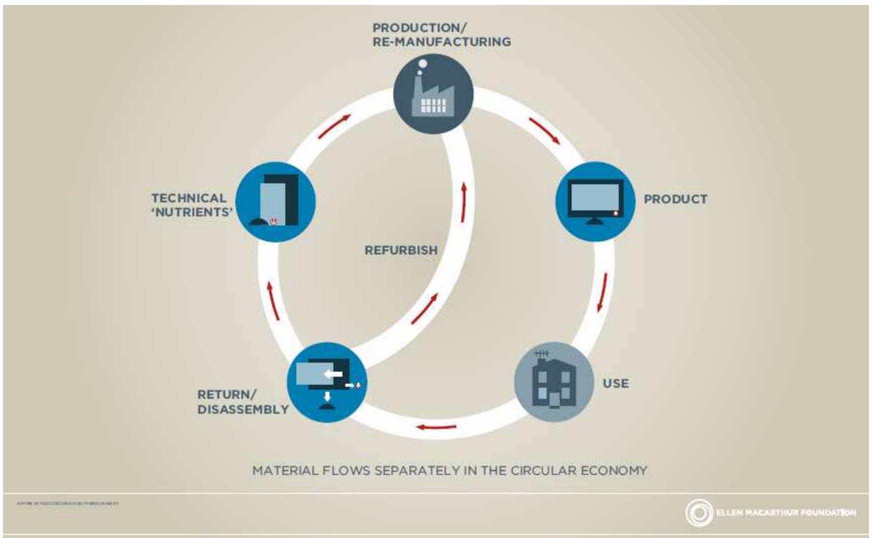
Closed loop systems – a schematic view



Technical cycle in a circular economy



The principles of a circular economy

1. **Restorative and Regenerative:** from **Open Loop to Closed Loop**

2. From **Disposal → Downcycling → Upcycling**

3. **Extend Product Life** :**Standardization ,Modularization, Toxics-Free and Design for Easy Disassembly**

4. **Innovative business models** e.g. from Ownership to Leasing

5. **Change Supply Chains for** reverse cycles and cascades

Some tools and frameworks for 'Circular Design'

Life Cycle Assessment → **The assessment of the environmental burden of a product at every stage through its life cycle**

Industrial Metabolism → **The mapping of flows of materials and energy through the entire lifecycle at an aggregate level**

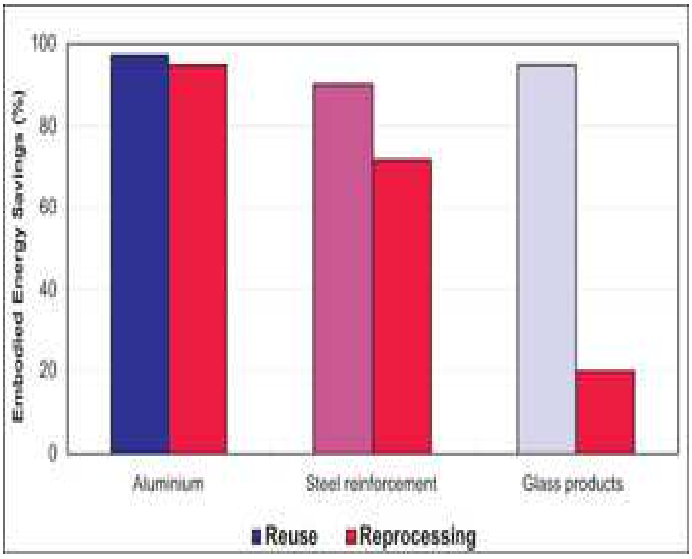
Design for Env / LifeCycle Design → **A design framework that incorporates lifecycle impacts from the perspectives of 'Manufacturability' and 'Recyclability'**

Cradle to Cradle → **A design framework based on the philosophy of infinite cycling of the same material nutrients**

The principles of Cradle to Cradle design

1. Less Bad is No Good
   – Recycling of aluminum cans : Expensive, Toxic and Wasteful…is it better than sending to the landfill ?
2. Eco-efficiency Vs Eco-effectiveness
   – Efficiency is static and limiting , Effectiveness is abundant and dynamic
   – Buildings that seal windows, reduce sunlight, need constant monitoring Vs Buildings that let in sunlight and fresh air and are spatially vibrant
3. Waste equals food
   – Carpets that upcycle waste continuously (Technical nutrient)
   – Swiss textile mill Rohner → eliminate 80000 toxic chemicals and replace with just 38 positive chemicals. At end-of-life, cloth can be 'thrown' back into soil to biodegrade naturally
4. Respect diversity
   – Eschew the 'One size fits all' principle in design

Reuse Vs Recycling

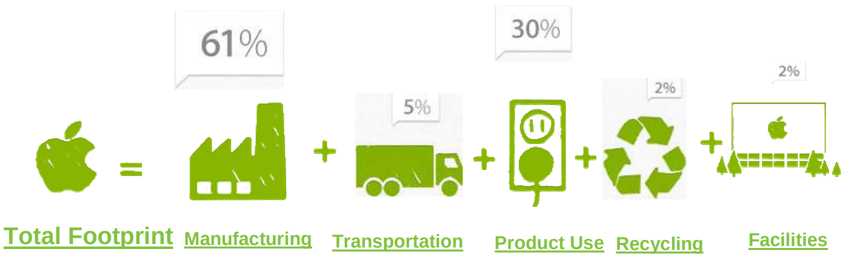


The potential for materials savings

	Mobile phone[1]		Smartphone[1]		Light commercial vehicle[1]		Washing machine[1]	
	USD	Percent	USD	Percent	USD	Percent	USD	Percent
Price[2]	36	100%	400	100%	41,400	100%	970	100%
Input costs[3]	27	75%	228	57%	39,730	96%	832	86%
Material	16	44%	128	32%	22,760	55%	437	45%
Labour	2	6%	29	7%	4,140	10%	223	23%
Energy	2	6%	2	1%	680	2%	18	2%
Other[4]	7	19%	69	17%	12,150	29%	155	16%

With material savings comes energy savings

Lifecycle GHG footprint of Apple computers



Extended footprint of Wipro computers

Operational

GHG footprint : 4400 tCO2 e

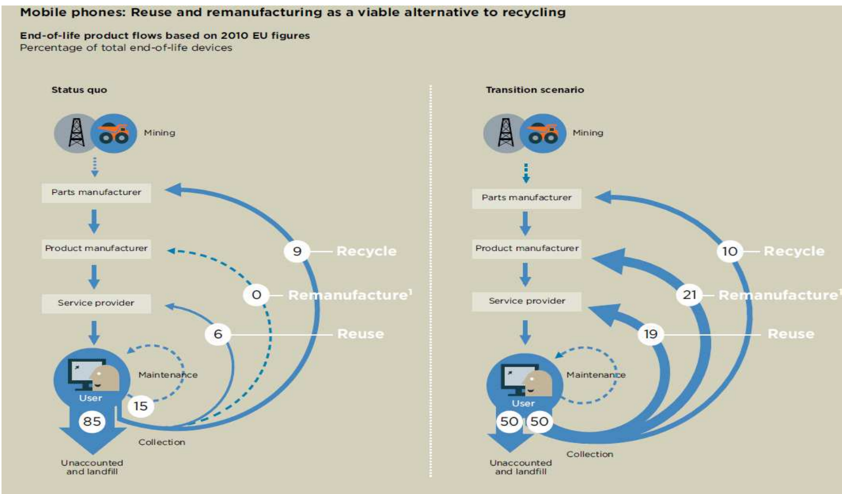
Water footprint : 18000 m3

Waste generation : 25 m tons

Supply Chain

Total GHG emissions (tCO_2e)	21,705
GHG Intensity (tCO_2e per $ mn)	217
Total water consumption (m^3)	1,726,703
Water intensity (m^3 per $ mn)	17,260
Total waste generation (tonnes)	1,018
Waste Intensity (tonnes per $ mn)	10

The cost of a remanufactured mobile phone can be nearly 50% less ; overall savings of nearly $ 2.2 bn per annum in material and energy costs



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Looking ahead : what will drive the shift ?

1. The foundations already exist

The shift to tighter environmental standards and relentless emphasis on resource efficiency have already started in many sectors and geographies

2. A new design mindset

Innovative companies will pioneer a shift to a design paradigm that is modular and helps extended lifecycles through easy disassembly, refurbishment and remanufacture

3. Capabilities in the Reverse Cycles

Important technological capabilities already exist : RFID, Reverse tracking etc ; What will be needed are (i) setting up ‘Sectoral’ and ‘Geographical’ reverse networks (ii) developing ‘refurbishment’ and ‘remanufacture’ capabilities

4. Changes in the Consumer Mindset

The gradual adoption of 'Share and Lease' models in preference to 'Buy and Own' will be driven by (i) Financial benefits (ii) Social network effects

Leasing 'Washing Machines' can help save 30% per wash cycle

5. Breakthroughs in Materials Science

Critical breakthroughs needed in the development of 'bio' alternatives that can help accelerate 'safe' upcycling or disposal

Some early examples

Michelin's 'Pay Per Kilometer' model for tyres : Less upfront cost, Less stock keeping and Less overall cost of fleet management

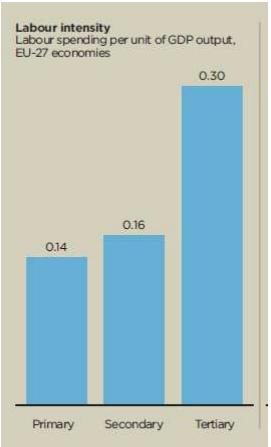
Caterpillar Remanufacturing remakes engines that are resold with 'performance and reliability' standards that are the same as for new. CAGR of 9% per annum.

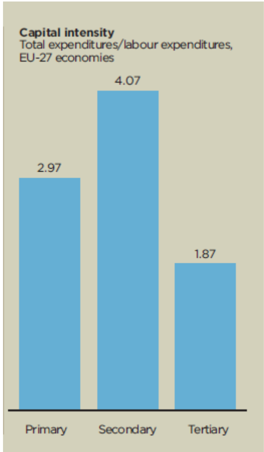
Tomra produces reverse vending machines that collect and sort empty beverage containers

The potential payoffs are huge

Financial	Estimated $ 380-650 BN savings in the EU alone in just a few product categories
Environmental	Significant reduction in material, energy and water footprint. Example : Over a 20 year period, a 'lease based model ' for washing machines can help save 180 Kgs of steel and 2.5 tons of CO2 per consumer
Social	Can help create thousands of new jobs, especially in relatively low-skill sectors ; Reverse logistics, and Refurbishment cycles can accelerate this trend. Can catalyze new waves of entrepreneurship across social strata

Creating new jobs





Good design is part of a larger unifying concept – it preserves nature and the best of human culture while promoting human dignity

The transition is likely to be messy, non-linear and iterative

Early movers will need tenacity and staying power but can reap significant benefits

Thank you