Circles to Spirals

a personal compendium
of sustainable design

Ollee Means

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Table of Contents

Introduction 1

Sustainable Concepts 3

Circular Economy 4

Utilitarian Objects 5

Longevity 7

Repair 8

Upcycling 9

Resources — (in)finite? 10

Adaptable Design 13

Adaptable Design — Daily Life 15

Adaptable Spaces 16

Adaptable Design — Modularity 17

More — Better? 19

Repair — KitchenAid 22

Adaptable Design — Drivers 24

Adaptable Design — Enduring Relevance 26

Circular Economy — Butterfly Diagram 28

Circular Economy — Two Strands 29

Decoupling 42

Product Chain 44

Alternative Consumption 46

Circular Economy — Capitalism — Politics 48

Money, Money, Money 51

Efficiency — Effectiveness 53

The R Strategies 56

R Strategies — Design Impact 59

Circular Economy — Resilience 62

Upcycling — Trash into Treasure? 64

Upcycling — Usage 65

Innovation — Gambiarra, Jugaad, and Technological Disobedience 67

Upcycling — Design 69

Designer — Upcycler 73

Upcycling — Enablers 76

Upcycling — DIY/DIFO 77
Upcycling — Insights 79
Trashion 81
Legalities 84
Oversights — Constraints 86
Thermodynamics — Entropy 87
Entropy — Perpetuity 89
System Boundary Limits 90
Lock In's 92
Jevons Paradox 93
Behaviour — Policy Making 95
Idealism 96
Consulting 98
Corporate methodologies 101
Reflections 103
Spiral Economy 105
The Corkscrew Economy — Rethinking Plastic Recycling 106
From Corkscrew to Spiral — Reimagining Material Value 109
The Spiral — Fundamentals 111
Anti-Entropic Actions 112
Quality 114
Material — Agency 116
Craft 118
Tractors — Mechanical Design 120
Timelessness 122
Timelessness — Re-domestication 124
Collecting — Top to Bottom 126
Parallels — Financial Markets 128
Conclusion 131

Introduction

Circles to Spirals takes the form of a loose compendium, a list of words that charts my own journey as a young designer. Circles to Spirals is a journey from blind optimism to realistic action. The compendium serves to introduce us to the key concepts at the heart of sustainable design.

Our compendium starts with the simple things: fixing, breaking, remaking, remodeling, and using objects for purposes other than those intended (I guess this is how a lot of designers start).

This compendium acknowledges that sustainable design is not an accident, but a consequence of intentional and sequential decisions. From designers, manufactures, consumers and those who process waste.

The compendium then widens its span to consider the circular economy, which presents the possibility that waste can be designed out of the system by keeping products and materials in indefinite circulation. As we progress through our compendium – and discuss the pros and cons of a circular economy – we will discover that the circular economy, which has become a very influential idea in recent decades, represents an optimistic delusion. We will learn how the term has been propagandised to the Global North, and how it serves corporate and political vested interests.

With all its faults, the circular economy nevertheless allows us to look forward to a sustainable design practice. Our compendium entries next turn to the

‘thought experiment’ of the spiral economy. A circle is too flat, too two-dimensional, too simple. When seen in three-dimensions the circular economy is revealed to be a spiral. The representation of a spiral can more usefully model ways to delay, halt or reverse waste within a given material’s use-time.

At the end of our compendium, we will consider different ways in which design sustainability can be read through the model of the spiral economy, which is a development of the laudable, if at times misdirected, aims of circular economy.

Sustainable Concepts

Sustainable terminology is a slew of words, a cohort of terms which are often used without a full understanding of what they mean. Simple words, like 'recycle' and 'repair', are bundled together with terms like 'circular economy' and 'regenerative design'.

In Circles to Spirals I want to go beyond the dictionary definition and provide an exploration of the real-world consequences of such words. For instance, what does 'repair' mean beyond fixing a broken item? You must consider the people involved, the decisions required when designing an object, an objects value — monetarily and emotionally, and the availability of materials and spare parts. The words I have chosen to focus on in Circles to Spirals are Circular Economy, Adaptable Design, Longevity, Repair and Upcycling. These peak my interest, and provide a direction of exploration.

Circular Economy

Korhonen, Jouni, Antero Honkasalo, and Jyri Seppälä. 'Circular Economy: The Concept and Its Limitations'. Ecological Economics143 (2018): 37–46.

https://doi.org/10.1016/j.ecolecon.2017.06.041

Emgin, Bahar. 'Trashion: The Return of the Disposed'. Design Issues 28, no. 1 (2012): 63–71.

https://doi.org/10.1162/DESI_a_00124

Circular economy is an umbrella term for a range of practices which proposes an economy respectful of Earth's planetary boundaries — a system of production and consumption with no waste. Discarded material (manufacturing offcuts, municipal trash, discarded products) are fed into new systems of production, which lowers the need to extract new material. This is paired with extending the life of objects through reuse, repair, refurbishing and recycling. The goal of the circular economy is lofty yet simple — 100% circularity.

The circular economy differs from the current economy which is linear. This follows a take, make, and dispose production line which moves toward its ultimate product, waste. As Bahar Emgin maintains, *"[waste is the] matter of putting things in a state of absence, invisibility, or remoteness — either metaphorically or literally."* This process depletes natural resources, and there is only so much to take — a finite supply. The linear economy prioritises the private sector, then society, then nature. The circular economy aims to benefit society, nature, and business equally.

Utilitarian Objects

Adaptable design is forward thinking (as opposed to futuristic). At its core, it's about utility throughout an object's life, transforming to meet new needs. I love many utilitarian and adaptable objects.

Take the Swiss Army knife: an unassuming object packed with attachments and combinations, each designed for a specific task. Its charm lies in its simplicity — a low-tech tool with infinite uses. A practical tool for the handy individual, with large and small blades, wood saw, can opener, screwdriver, wire stripper, punch, toothpick, file, hooks, scissors, and pliers, to name a few of its many adaptations.

Or consider the Land Rover Defender. Iconic in its design and function, it's a useful vehicle in any terrain. You can find Defenders in both concrete jungles and real jungles, in dunes of snow or sand. With bolted-on parts that can be easily repaired using a standard tool kit, its modularity is deeply utilitarian (as an Englishman, I also love it because its British).

Then there's construction equipment: scaffolding, cranes, diggers are masterpieces of adaptability. This equipment and these machines may seem unremarkable at first glance, however the engineering that goes into them — their 'future proofing', their usage in a variety of environments and needs is extraordinary. The required ruggedness and modularity make construction sites great archives of current adaptable design.

I'm not drawn to these objects simply by their practicality — their design also requires a thoughtful balance of form and function, adaptability, and endurance. Such qualities are worth exploring further.

Longevity

Longevity speaks to how long something lasts — or doesn't. Just this week, my toaster broke after five years, and my iPhone gave out after three. Frustrating, to say the least.

Longevity marks objects that serve us reliably over time; objects that retain their function and appeal. Longevity is a quality tied closely to durability. We often consider the longest-lasting objects as inherently sustainable, but this view lacks nuance.

What defines longevity for sustainability is subjective and differs with each user and object. For example, a pair of shoes might endure twenty years — at fifty, they become uncomfortable, at one hundred, they're a museum piece. In contrast, a watch at fifty is a classic; at one hundred, an heirloom.

Longevity can be negative. 'Forever chemicals,' designed to persist indefinitely, remain far from sustainable without processes to break them down.

Longevity is somewhat artificially constructed by narratives that suggest an appropriate object life. Product warranties which may cover two, five, or even ten years. For designs focused on true longevity, could warranties span fifty, one hundred, or even a thousand years?

Repair

Repair is a personal favourite. I've written a ten-thousand-word Master thesis on how the expected length of time a repair will take influences the likelihood the object will be repaired.

I repair objects all the time, mainly mechanical objects. I'm not great with electronics (no toasters or iPhones), but plenty of bicycles, furniture, and old machines. A basic set of tools, a simple understanding of mechanics and a healthy dose of curiosity gets you far. You learn a lot about how things are made by taking them apart. How is fabric and foam fitted to seating; how a geared motor works; how to change ball bearings. What is the use of a torque wrench, why is it important? (To not overtighten bolts, by the way). Basic wiring. Repair is a practical education.

Upcycling

Upcycling is the reuse of discarded materials, often in a novel way. The term has gained popularity in Europe and America, principally through the channels of design and fashion. It is becoming increasingly significant in digital culture as social media amplifies the novelty of upcycling.

Upcycling provides a method for emerging designers to enter their field without high material start-up costs. Equally, high-end brands use upcycling to bolster their sustainability narrative.

Resources ~ (in)finite?

Deutsch, David, and Marian Tupy. 'We Will Never Run Out of Resources'. Human Progress, 28 July 2023.
https://humanprogress.org/we-will-never-run-out-of-resources/

Naval Ravikant. 'To a Caveman Very Few Things Are Resources'. Naval, 13 December 2021.
https://nav.al/caveman

Korhonen, Jouni, Antero Honkasalo, and Jyri Seppälä. 'Circular Economy: The Concept and Its Limitations'. Ecological Economics 143 (2018): 37–46.
https://doi.org/10.1016/j.ecolecon.2017.06.041

Tupy, Marian, and Gale Pooley. 'The Simon Abundance Index: A New Way to Measure Availability of Resources'. CATO Institute, 4 December 2018.
https://www.cato.org/policy-analysis/simon-abundance-index-new-way-measure-availability-resources

Will we run out of resources? It's a daunting question with no simple answer. I ask near the beginning of Circles to Spirals because it's a premise in the push for a more sustainable world. We cannot continue as we are. We cannot sustain take-make-dispose models for an extended period of time.

On one side, technological pessimists predict scarcity. On the other, technological optimists argue that innovation will keep resources abundant. The issue is more clearly defined as resource accessibility, can humanity maintain sufficient supplies at fair prices and limit negative externalities.

Finite resources like coal, steel, and oil will eventually run out. Unless someone invents a way to create new oil reserves (which is not desirable), we'll reach the last drop at some point. But does that mean all resources will be exhausted?

As Naval Ravikant puts it, "To a caveman, very few things are resources." Our perspective on what a resource is, changes as technology advances. Aluminium, lithium, and cobalt are valuable today because we know how to utilise them. Similarly, future generations will likely discover new, (hopefully greener) materials. This optimism aligns with thinkers like physicist David Deutsch, known as the 'Father of Quantum Computing,' and Marian L. Tupy, co-author of the paper 'The Simon Abundance Index: A New Way to Measure Availability of Resources', who believe human ingenuity will continue to secure resources. They point out that since 1800, even as the global population grew eightfold, resources have remained accessible and affordable, thanks to technological and market-driven efficiency. The Simon Abundance Index, named so after economist Julian Simon, continues to prove this. Simon disagreed with the many scholars that believed population growth would lead to the catastrophic exhaustion of resources. Simon believed human innovation could overcome shortages through efficiency, increased supply, and substitutes.

David Deutsch and Marian Tupy use the example of the aluminium can. In the 1950s, a cola can weighed almost 85 grams; today, it's less than 15 grams — an example of dematerialisation. Similarly, the smartphone has replaced numerous physical items: calendars, maps, cameras, and radios, reducing material demands overall. Deutsch and Tupy challenge fears of resource depletion. While they support the circular economy, they argue that the real limitation is not physical scarcity but our ability to unlock and process new resources through knowledge and innovation.

There is an opposing argument. Jouni Korhonen, et al argue that increased efficiency often leads to higher consumption (Jevons Paradox) and that switching resources isn't always straightforward due to sunk investments, known as 'lock-in costs.' For example, even if sodium could replace lithium batteries, the heavy investment in lithium infrastructure complicates the transition, as investors want to benefit from their cost before a transition occurs.

Adaptable Design

Graces Guide - British Charity 115342. 'Frank Leslie Watson'. 1930, Accessed 27 May 2024. https://www.gracesguide.co.uk/Frank_Leslie_Watson

Adaptable objects are designed to change their function or form: car seats fold to save space, DSLR cameras switch lenses for stills and motion, and washing machines adjust cycles for different fabrics — with some even weighing clothes to optimise water usage and run time. Other common examples include the Bic multi-coloured pen, the all-in-one scanner, and the sofa-bed.

Some people mistakenly confuse adaptable objects with versatile ones. Hiking shoes, for example, work well across various situations, however, while hiking shoes may suit many environments, they remain the same shoe in every setting. They do not adapt; their form or structure doesn't change based on the conditions they are used in. Whereas hiking trousers that zip off into shorts, do change form and structure depending on their environment. Adaptability is a condition of function.

In 'Obsolescence and Organisation' F L Watson states:

> **"It will not be overlooked that a whole factory may become obsolete, independent of the condition of its machinery, if it is not practicable to modify its lay-out and arrangements for internal transport to meet up-to-date systems of management and productive methods, or if**

such modification is not undertaken in time. This can be guarded against by elastic and adaptable design in laying out a new factory. But external changes, such as transport developments, may render the position of the factory obsolete, and political and economic changes may have the same result."

Adaptable Design ~ Daily Life

My grandparents had a drop-leaf table in their conservatory. Wings up when the family came for lunch, wings down when it was the three of us. The sides of the table, or “wings”, made the table smaller or larger.

The smartphone is perhaps the most extreme example of consumer adaptable design. It calls, texts, browses the internet, plays music, serves as a bank pass, plays videos, and more. Reconfigurable apps and displays adapt to our tailored needs. Software updates strive to keep pace with technology which brings more adaptations. Smartphones even adapt themselves. Switching to ‘sleep’ mode at night, ‘focus’ mode at the office, and blocking apps when overused.

In the beginning I, like many others, found this autonomous adaptability a bit unsettling. Although I think most people have become used to it and even expect it.

Adaptable Spaces

The adaptability found in furniture is also found in architecture.

Consider a Madrid apartment by PKMN Architectures. Each room is 15 square metres, but the total space does not equal the sum. The key? Moving walls. Central dividers and rolling walls let the owner transform their space in moments. Becoming a dressing room, sitting area, boudoir, or kitchen as needed. Functional and aesthetic.

With the rise of hybrid work and smaller living spaces, such designs may become popular, if not for entire homes, then for parts. The ability to transform a bedroom to an office, a study to a yoga studio, or for the stairway to transition into a bouldering wall, suggests endless options.

Note: A similar term, 'adaptive design' or 'adaptive reuse' refers to an architecture practice focused on reuse strategies for existing buildings (for example SuperUse Studios). Whilst a core part of sustainable architecture, there are nuanced differences to adaptable design.

Adaptable Design ~ Modularity

Modularity is the breakdown of products into smaller pieces or modules, which are interconnectable and changeable. Often modules are used to provide an alternative function to a product. Thus, enabling adaptability.

Modules can enable repair, stave off obsolescence and provide opportunity for material reclaim. By designing products with modular components, individual parts can be easily replaced or upgraded without discarding the entire product, which reduces waste and extends the product's lifespan.

Fairphone is a smartphone designed with repairability in mind. Its modular construction allows users to replace specific parts. Fairphone can send replacement modules in the mail for the user to plug and play. Modules that contain the microphone, camera, battery, or screen for example, which means repairs and upgrades are easy. The Framework brand is a similar concept in the laptop computing space.

IKEA offers some modular furniture. Their modular sofas, allows customers to swap out or add sections as their needs change. If a section becomes damaged, it can be replaced instead of discarding the entire sofa. This flexibility encourages long-term use and reduces the environmental impact associated with frequent furniture replacement.

Granular modularity aids material reclaim and recycling. For example, imagine a sofa that is modular at the material level. The fabric can be easily removed

from the foam, the foam is not glued to the frame. The frame can be separated into constituent parts — springs and wood.

More ~ Better?

{ Chapman, Jonathon. Emotionally Durable Design. Second Edition. Routledge, 2015

Adaptable design can negate single-function objects. I don't need multiple-coloured pens if I have a one multi-colour pen. But how far can this go?

Some say the modern phone is so good at taking photographs that it has killed the physical camera. At the time of writing I have the iPhone 15, only 1 iteration behind the most current model. The iPhone 15's camera is remarkable; its quality is sublime. However, it does not replicate the experience of my actual camera. Twisting the dials, pulling focus, framing through a viewfinder, the sound of the shutter clacking, photography is an art and a craft in which the experience of the tool is essential. The rise in analogue photography is not a hype, it is an experience of a specific apparatus for a dedicated task.

Let's contrast the singular function of the camera the dual function of the sofa bed. Beyond the primary role of 'sofa', the sofa bed provides comfort for overnight guests.

A sofa bed challenges the traditional boundaries between day and night, public and private. If one piece of furniture can serve as both seating and sleeping space, it might not only eliminate the need for a dedicated bed but also render the bedroom itself obsolete. For homeowners, this shift offers a chance to reimagine the home: fewer rooms, fewer possessions, and potentially, smaller living spaces.

This issue dovetails the growing minimalist and tiny house movements, where multi-functionality and efficiency reign. The utility of a sofa bed supports the ideals of urban minimalism, offering a symbolic and practical response to resource scarcity. It also reflects deeper shifts in how we perceive home: not as a static set of rooms, but as a flexible, adaptive environment.

In urban areas, where high-density and housing crises loom large, small homes are common and thus the sofa bed's potential expands. With less space required per household, developers might shift from building out to building up, or repurposing existing space in the city — maximising the number of dwellings per square kilometre.

However, this trend intersects with other cultural and economic phenomena. The rise of Airbnb, for instance, has already blurred the line between personal and commercial spaces. A sofa bed in a studio apartment could transform the space into a rental asset, driving the kind of hyper-urbanisation and speculative ownership that exacerbates housing shortages and increases urban density.

The sofa bed represents more than its practical function; it is a cultural object for shared experiences like sleepovers, spontaneous visits, and hosting family. These interactions imbue it with emotional significance.

We are more likely to care for objects with emotional significance. To look after them, to cherish them. Chapman argues this is one step to solving the climate crises. Imbuing objects with emotional significance to improve their durability; something

he calls ‘Emotionally Durable Design’. Chapman argues that the climate crisis is primarily a behavioural challenge, not merely a material one. If people value objects for the stories and relationships they represent, they are less likely to replace them unnecessarily.

The sofa bed illustrates Chapman's argument — its cultural role and capacity to hold memories show how objects can transcend their functional purpose. Designing with this in mind encourages emotional durability staving off obsolescence.

While the sofa bed may not single-handedly solve the housing or climate crises, it is important to consider it as cultural object, which fosters social connections. Think what other objects you may own which hold this power? The family dining table, inherited cookware, a handmade quilt.

Repair ~ KitchenAid

Wohlforth, Julia. 'The KitchenAid: Shared Cultural Nostalgia for Past Ideas of Progress'. The Coalition of Master's Scholars on Material Culture, 12 February 2021.

https://cmsmc.org/publications/the-kitchenaid

Yesterday, I repaired a 60s-era KitchenAid for a neighbour. Cast iron body, proper mechanical gears. Easy to disassemble. Unscrew, lift the lid, and there it is — the machine's heart. A quick re-grease, minor cleaning, assembly, and a test. Payment in cake gratefully accepted. Julia Wohlforth cheerfully proclaims of the KitchenAid:

> **"An unchanging aesthetic which balances beauty, functionality, and durability, has made the KitchenAid iconic, and has endowed it with a sentimentality that traverses generations, a sentimentality for the future its past users imagined."**

The KitchenAid is durable and enduring. A single motor drives many attachments — 80+ offered by the brand. Created in 1908 for professionals, the KitchenAid was marketed for domestic use a decade later. Then redesigned in 1937 to its iconic form.

Blending, chopping, beating, whisking, measuring, mashing, cutting, grinding, grating, spiralling, pasta-making. Saving kitchen space. Avoiding repetition of motors and cables. Encouraging future expansion (good marketing trick). KitchenAid built an ecosyst-

em, fostering consumer trust. You can buy a second-hand base, and still buy new attachments to meet your needs. Forward thinking design.

Other brands, such as the Vitsoe Universal 606 and Makita Tools, echo this model. Makita offers 325+ products that use the same interchangeable battery; a boon for tradespeople and the planet; reducing the need for multiple batteries.

Vitsoe's 606 shelving system was designed by Dieter Rams. It can grow and adapting over time. You start with a simple frame and then add pieces — shelves, cupboards, desks — as you go. It is one the most sustainable shelving options on the market. It holds its value on the long term, is easy to repair, and dare I say — super stylish.

Adaptable Design ~ Drivers

Yap, Jules. 'IKEA Hackers - Clever Ideas and Hacks for Your IKEA Furniture', 4 October 2022.
https://ikeahackers.net

IKEA. 'The Story behind the IKEA Hacking Movement and Exhibition – IKEA'. Accessed 28 November 2024.
https://www.ikea.com/sa/en/ideas/make-it-yours-the-story-behind-hacking-ikea-pub44bc2061/

Cole, Sean, and Roman Mars. Hacking IKEA. 99% Invisible. Accessed 28 November 2024.
https://99percentinvisible.org/episode/hacking-ikea/

I separate adaptable design into the formal and informal. Formal adaptations are designer-driven and intentional at the design phase. Informal adaptations are user-driven adaptations, DIY and guerrilla or third party 'hacks'.

Cameras with interchangeable lenses are formally and informally adaptable. Take a Fuji camera body, and replace one Fuji lens with another, this is a formal adaptation. An adaptation within the Fuji-ecosystem using Fuji specific mounts. But what if I have a Sony lens that I want to attach to my Fuji body? I can informally adapt by using a third-party connection between the two brands.

IKEA hacking is another example of informal adaptation. Thanks to IKEA's standardised systems, creative modifications are easy. People combine parts from different IKEA items or integrate non-IKEA components. On a larger scale, it is common practice to fit high quality cupboards to a cheaper IKEA kitchen carcass, this is an informal adaptation of IKEA's original design — by DIYers, carpenters and brands who sell the after-market cupboards. A refined look for a lesser cost.

The term ‘IKEA hacking’ originated from an informal blog created by Jules Yap, where people worldwide could share their creative modifications of IKEA products. The blog gained significant attention, prompting IKEA to issue a cease-and-desist letter in 2014, accusing Yap of profiting from the use of their brand name and colour scheme. This legal action sparked a strong backlash from the hacking community. Recognising the value of the movement to their business, IKEA and Yap eventually reached an agreement. Today, the website continues, a book has been published, and IKEA has embraced the concept by hosting its own hacking exhibition.

Adaptable Design ~ Enduring Relevance

Graces Guide - British Charity 115342. 'Frank Leslie Watson'. 1930, Accessed 27 May 2024. https://www.gracesguide.co.uk/Frank_Leslie_Watson

What started as F L Watson's idea from a 1930s Yorkshire factory is still relevant today. Create objects that evolve with technological, social, and market changes. A hopeful vision for design and sustainability.

I think most people prefer objects that stand the test of time. I do. I cherish the stories and patina objects carry — particularly if they adapt to my future needs.

In my home, I see adaptable design's potential. Our folding chairs save space; the modular Paul Cadovius shelving rearranges and expands; we have multi-functional kitchen gadgets; my beloved Fuji camera has interchangeable lenses.

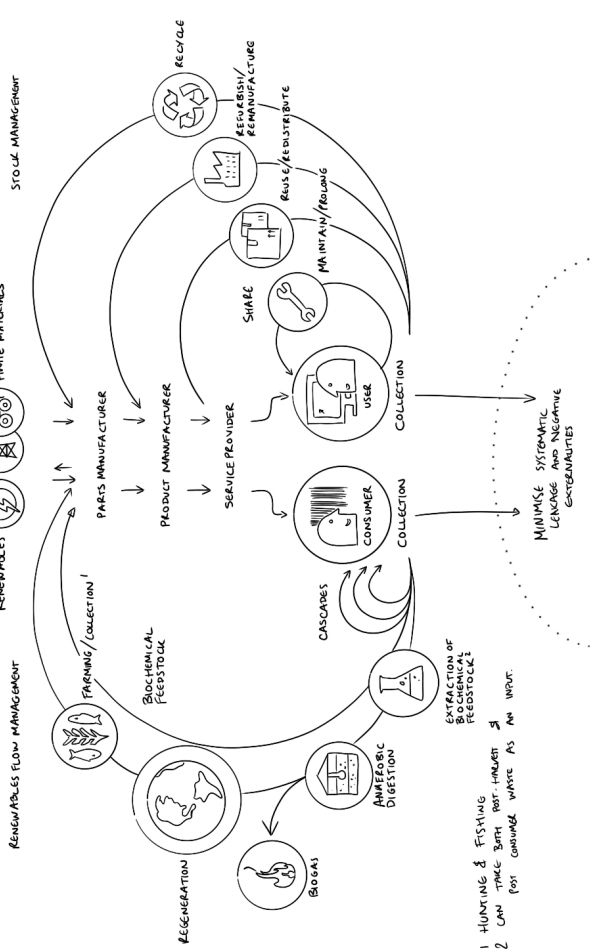
Those are formal examples. We have informally adapted our belongings too. Old table legs with new tops; lighting with different shades to the original; chair frames have new seats. Standardisation and modularity made these changes much easier.

I enjoy the synergy between formal and informal adaptability. As a designer, my home influences my creations. I consider adaptability's full capacity to encourage objects to have meaningful lives. Worthy

objects endure, they are passed on, handed to friends, gifted forward, which, for me, is a desirable yardstick of good design.

The phrase "a jack of all trades is a master of none, but oftentimes better than a master of one" fits well. Specialised objects have a place in the world, yet in most cases, an adaptable object is a master of none, but oftentimes better than a specialised one.

Circular Economy ~ Butterfly Diagram



Adapted and redrawn for this publication based on an original diagram by the Ellen MacArthur Foundation.

Circular Economy ~ Two Strands

The text *The Circular: What, Why, How and Where,* provides an in-depth overview of how the concept of the circular economy developed. The circular economy evolved from a confluence of diverse schools of thought, each contributing unique perspectives on sustainability, resource management, and economic theory. This lineage can be separated into two general strands: an *economic strand* and *material strand*. Each strand developed independently before converging to form the foundation of the circular economy as we understand it today. Notable contributions to the vocabulary include Industrial Ecology, the Performance Economy, Cradle to Cradle and Spaceship Earth.

1940s

The terms 'industrial ecology' and 'industrial symbiosis' are introduced, describing the strategic placement of industries to optimise resource use and minimise waste.

1940s–1970s

Over the following three decades, 'industrial ecology' and 'industrial symbiosis' gain traction and become more widely recognised.

1966

Athelstan F. Spilhaus envisions a fully closed-loop system where all water is reused and all solid waste recycled.

- Spilhaus, a geophysicist, meteorologist, and inventor, later served as an executive on the board of UNESCO, championing innovative environmental concepts.

1970

Athelstan F. Spilhaus delivers an address as President of the American Association for the Advancement of Science, presenting the first public vision of what would later be recognised as the circular economy within the material strand (although the term had not yet emerged).

- Spilhaus outlines the concept of eliminating waste, stating:

> **"The object of the next industrial revolution is to ensure that there will be no such thing as waste, on the basis that waste is simply some substance that we do not yet have the wit to use... In the next industrial revolution, there must be a loop back from the user to the factory, which the industry must close. ... If American industry should take upon itself the task of closing this loop, then its original design of the article would include features facilitating their return and remaking."**
>
> **(Spilhaus, 1970: 1673)**

He introduces the idea of 'loops'—joining the output of waste to the input of production. This foundational concept, known today as 'closing the loop', remains central to circular economy practices.

1989

Robert A. Frosch and Nicholas E. Gallopoulos publish a seminal paper in Scientific American, calling for a transition from traditional industrial models to an 'industrial ecosystem', a framework inspired by biological systems.

- They propose optimising energy and minimising waste by ensuring that industrial inputs come from outputs and that outputs, in turn, become inputs again — a concept akin to Spilhaus' vision two decades earlier.
- Frosch and Gallopoulos assert:

> **"The industrial ecosystem would function as an analogue of biological ecosystems."**
>
> **(Frosch and Gallopoulos, 1989: 144)**

These ideas originated from within the US automotive industry rather than anti-industry groups, highlighting how resource assurance underpinned their rationale.

- Frosch, a theoretical physicist, served as Vice-President of General Motors Research Laboratories and had previously led NASA and UNEP initiatives.
- Gallopoulos, with a background in chemical engineering, led environmental science and engine research at GM.

They emphasised the importance of widespread adoption and understanding of these concepts beyond academia, urging industry leaders, policymakers, and media to recognise the value of industrial ecology and system optimisation.

1997

The 'Journal of Industrial Ecology' is founded, providing a dedicated platform for research and discussion on industrial ecology.

- Over the years, the journal becomes a key source of publications related to the circular economy.

2001

The ‘International Society for Industrial Ecology’ is established, solidifying the field’s significance and fostering collaboration among researchers, industry leaders, and policymakers.

Ekins, P, T Domenech, P Drummond, R Bleischwitz, N Hughes, and L Lotti. ‘The Circular: What, Why, How and Where’”. Managing Environmental and Energy Transitions for Regions and Cities, 2019.

https://www.oecd.org/cfe/regionaldevelopment/Ekins-2019-Circular-Economy-What-Why-How-Where.pdf

Frosch, Nicholas E. Gallopoulos, Robert A. ‘Strategies for Manufacturing’. Scientific American, 1 September 1989.

https://www.scientificamerican.com/article/strategies-for-manufacturing/

Spilhaus, Athelstan. ‘Resourceful Waste Management’. Science News 89, no. 25 (1966): 486–98.

https://doi.org/10.2307/3950241

Spilhaus, Athelstan. ‘The Next Industrial Revolution’. Science 167, no. 3926 (27 March 1970): 1673–1673.

https://doi.org/10.1126/science.167.3926.1673

Journal of Industrial Ecology (1997–Present): Journal of Industrial Ecology. Yale University Press.

https://onlinelibrary.wiley.com/journal/15309290

International Society for Industrial Ecology (2001): International Society for Industrial Ecology.

https://is4ie.org

1966

Kenneth Boulding publishes 'The Economics of the Coming Spaceship Earth', a seminal paper that laid the groundwork for the modern circular economy framework.

Boulding's insights quickly influenced other works but took decades to fully integrate into mainstream economic thinking.

He contrasts two economic models:

» Cowboy Economy:

"The illimitable plains and also associated with reckless, exploitative, romantic, and violent behaviour, which is characteristic of open societies."

» Spaceship Economy:

"The earth has become a single spaceship, without unlimited reservoirs of anything, either for extraction or for pollution, and in which, therefore, man must find his place in a cyclical ecological system which is capable of continuous reproduction of material form even though it cannot escape having inputs of energy."

Boulding advocates a shift from an economy of stock production (extraction-focused) to one of stock maintenance (regenerative and sustainable).

1968

NASA released the Earthrise photo. Highlighting the fragility of Earth from space for the first time.

1969

The first Moon landing takes place.

Buckminster Fuller publishes 'Operating Manual for Spaceship Earth', which, like Kenneth Boulding's 'Economics of the Coming Spaceship Earth '(1966), emphasises Earth's finite resources and the need for sustainable economic models.

- Fuller coined the term *Spaceship Earth* during earlier lectures, one of which Boulding attended. Boulding's essay preceded Fuller's book, but both shared similar themes of stewardship and resource limitation.

1972

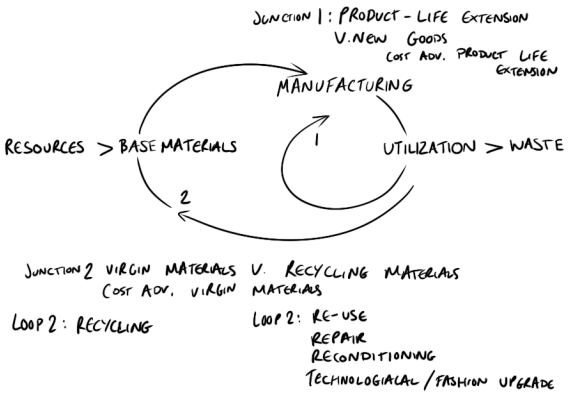
The Club of Rome releases 'Limits to Growth', a groundbreaking report led by Donella Meadows, an American environmental scientist, educator, and literary author.

- Using computer simulations, the report predicts that unrestrained economic growth will lead to resource depletion and environmental collapse, closely aligning with Boulding's 'Cowboy Economy' model.
- The report suggests that without systemic changes, societal collapse could occur within a century, projecting 2073 as a possible date.

1973

Global oil crises highlight the finite nature of resources.

1981



Adapted and redrawn for this publication based on an original diagram by Stahel & Reday, 1976.

Walter Stahel and Geneviève Reday publish a report that lays the groundwork for the circular economy, introducing concepts such as ‘loops’ and ‘circulating materials’.

While the term ‘circular economy’ is not yet used, their work represents a pivotal step in its development.

The publication responds to contemporary challenges, including oil price shocks and high unemployment in Europe.

Stahel and Reday advocate shifting from fossil energy and material use to human labour, arguing that this approach could:

- Create more jobs.
- Reduce dependency on virgin materials.
- Provide economic and environmental benefits by extending the life of products through reconditioning and incorporating recycled materials.

These ideas, particularly the focus on durability, reconditioning, and material circulation, remain central to circular economy principles today.

1982

Walter Stahel publishes an essay where he describes a 'spiral-loop system', aiming to minimise material and energy flows while reducing environmental degradation, without compromising economic growth or social and technological progress.

Stahel outlines the potential for business opportunities and innovation within this system, while also addressing barriers to their implementation.

- Opportunities: Redesigning products and services to extend their lifespan, creating jobs in repair and reconditioning, and reducing resource dependency.
- Barriers: Resistance from traditional industries, regulatory hurdles, and a lack of awareness or incentives for businesses to adopt circular practices.

1990

The term 'circular economy' is first published in the textbook 'Economics of Natural Resources and the Environment' by David Pearce and Kerry Turner.

- Pearce and Turner reference Kenneth Boulding's 1966 work, connecting contemporary circular economy literature to its foundational ideas.
- Their publication provides the most comprehensive depiction of the circular economy at the time, introducing critical insights:
- Acknowledgement of the impossibility of achieving endless recyclability loops, a concept later confirmed by research.
- Distinctions between renewable and non-renewable resources, highlighting the unique challenges of each.
- Recognition of the natural environment's ability to act as a 'waste sink' for biodegradable materials that cause no harm.

2002

Cradle-to-Cradle, Remaking the Way We Make Things by William McDonough and Michael Braungart is published, advocating for regenerative design principles.

- The publication draws from existing ideas, which Paul Ekins critiques as embellishments of pre-existing information — a sentiment echoed by some scholars.

2005

Ellen MacArthur gains public prominence after breaking the record for solo non-stop sailing around the world in 71 days.

- During her journey, she reflects on the finite nature of Earth's resources, inspiring her interest in circularity and sustainability.

2010

Ellen MacArthur leverages her platform and connections and launches the Ellen MacArthur Foundation (EMF).

- The foundation aims to accelerate the global transition to a circular economy, becoming a key player in promoting circularity through research, education, and collaboration.

2013

The Ellen MacArthur Foundation (EMF) collaborates with several large corporations and McKinsey & Company to release three publications on the circular economy.

- One of these publications introduces the 'Butterfly Diagram', now a widely recognised depiction of the circular economy.

The EMF publicly acknowledges the schools of thought that influenced their interpretation of the circular economy, including:

- *Cradle-to-Cradle, Remaking the Way We Make Things* by William McDonough and Michael Braungart (book).
- Janine Benyus' *Biomimicry: Innovation Inspired by Nature* (book).
- Gunter Pauli's *Blue Economy (*book).
- Walter Stahel's 'Performance Economy' (concept).
- John T. Lyle's work on Regenerative Design (concept).
- The general field of Industrial Ecology (academic practice).

This statement showcases the EMF's effort to unify the material and economic strands of the circular economy. While earlier works like *Cradle-to-Cradle* touched on this integration, the publication of the 'Butterfly Diagram' provided an accessible visual that clearly distinguished and connected the biological and technical cycles.

Ekins, P, T Domenech, P Drummond, R Bleischwitz, N Hughes, and L Lotti. 'The Circular: What, Why, How and Where'. Managing Environmental and Energy Transitions for Regions and Cities, 2019.

https://www.oecd.org/cfe/regionaldevelopment/Ekins-2019-Circular-Economy-What-Why-How-Where.pdf

Meadows, Donella, Dennis Meadows, Jorgen Randers, and William Behrens. Limits to Growth, 1972

Boulding, Kenneth. 'The Economics of the Coming Spaceship Earth'. Presented at the Sixth Resources for the Future Forum, Washington D.C, 8 March 1966.

http://arachnid.biosci.utexas.edu/courses/thoc/readings/boulding_spaceshipearth.pdf

Fuller, Richard Buckminster, and Jaime Snyder. Operating Manual for Spaceship Earth. New ed-2013. Baden: Müller, 1969

Stahel, Walter R., and Geneviève Reday-Mulvey. Jobs for Tomorrow: The Potential for Substituting Manpower for Energy. 1. ed. New York, NY: Vantage, 1981

Stahel, Walter. 'The Product Life Factor'. An Inquiry into the Nature of Sustainable Societies, 1982.

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Pauli, Gunter A., ed. The Blue Economy: 10 Years, 100 Innovations, 100 Million Jobs. Taos, NM: Paradigm Publications, 2010

Ellen MacArthur Foundation. 'Towards the Circular Economy Vol 1-3', 1 January 2013.

https://www.ellenmacarthurfoundation.org/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an

Pearce, David, and Kerry Turner. 'Economics of Natural Resources and the Environment'. American Journal of Agricultural Economics 73, no. 1 (1991): 227–28.

https://doi.org/10.2307/1242904

Benyus, Janine. Biomimicry - Innovation Inspired by Nature. Adobe Digital Edition June 2009. Harper Collins, 1997.

https://elmoukrie.com/wp-content/uploads/2021/11/janine-m-benyus-biomimicry_-innovation-inspired-by-nature-harper-perennial-2002-2.pdf

Ellen MacArthur Foundation. 'Schools of Thought That Inspired the Circular Economy', 23 March 2023.

https://www.ellenmacarthurfoundation.org/schools-of-thought-that-inspired-the-circular-economy

Decoupling

{ Ellen MacArthur Foundation. 'Circular Economy Introduction'. Accessed 22 November 2023. https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview

The main condition of a circular economy is decoupling economic activity from finite resource consumption. The Ellen MacArthur Foundation plays a crucial role in shaping the discourse on the circular economy, as highlighted in the timeline previous.

> **"The circular economy is a system where materials never become waste and nature is regenerated. In a circular economy, products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling, and composting. The circular economy tackles climate change and other global challenges, like biodiversity loss, waste, and pollution, by decoupling economic activity from the consumption of finite resources."**

Decoupling economic activity from resource consumption means enabling economic growth that isn't tied to increasing resource use. In this model, businesses and the broader economy can expand without consuming more resources — a critical goal

for achieving sustainability. Economic activity continues, but within environmentally sustainable limits.

There are two main types of decoupling:

Relative

Here, economic growth outpaces resource use, meaning resources are used more efficiently. While resource consumption still rises, it does so at a slower rate than economic growth.

Absolute

This represents *true sustainability* in a capitalist society, where the economy grows while resource use declines, demonstrating that growth can be achieved with fewer resources.

Product Chain

Potting, José, Marko Hekkert, Ernst Worrell, and Aldert Hanemaaijer. 'Circular Economy: Measuring Innovation in the Product Chain'. PBL Netherlands Environmental Assessment Agency, January 2017.
https://www.pbl.nl/sites/default/files/downloads/pbl-2016-circular-economy-measuring-innovation-in-product-chains-2544.pdf

Stepping forward into the circular economy will require innovation at a product level. Potting et al, point out that innovation in the product chain leads to three types of circular transition.

Technology-Driven Transition focus on driving circularity through innovative product technology. This requires new approaches to software and hardware — for example, bioplastics. When the bioplastics industry changes the main technology of packaging, businesses and consumers need to adopt the technology for it to be effective.

Socio-Institutional Transitions with Minor Tech Changes are enabled by small improvements to existing technology, rather than a planned disruptive change in the fabric of society. Packaging-free shops, for instance, which change the way we buy things in a small way. This minor change in technology has a knock-on effect on the transport of packaging free groceries, the balance of chemical preservatives, and reusable containers.

Socio-Institutional Transitions Supported by Technology are significant changes in society aided by existing technology. For example, the shift to the sharing economy — such as using apps for car-sharing. The societal and cultural change is in the move from owning a product, versus accessing its function.

The sharing economy is enabled by technology like the internet and smartphones — generic technology can enable such a shift.

To advance the circular economy, innovation must occur across multiple dimensions — technological and socio-institutional. While no single approach is universally 'best', the choice of focus depends on context and resources. Rather than rigidly prioritising one type of transition over another, designers and businesses should adopt a balanced strategy, tailoring efforts to the needs of their sector while contributing to broader societal shifts. Creating synergy between innovation and societal adaptation.

Alternative Consumption

Alternative revenue models and socio-institutional change require large resources, unconventional policies, and collective engagement. They may also have the largest impact.

{ Potting, José, Marko Hekkert, Ernst Worrell, and Aldert Hanemaaijer. 'Circular Economy: Measuring Innovation in the Product Chain'. PBL Netherlands Environmental Assessment Agency, January 2017. https://www.pbl.nl/sites/default/files/downloads/pbl-2016-circular-economy-measuring-innovation-in-product-chains-2544.pdf

For example, let's consider a hypothetical scenario about communal washing machines and dryers in Dutch apartment complexes. Let's assume all Dutch apartments eliminate individual ownership of washers, favouring a communal laundry. Rather than tenants each having their own washing machine, each apartment has a laundrette with washing machines only tenants have access to. This idea will require a significant shift in resident attitudes, as private ownership is currently the norm in the Netherlands. This idea may be accepted from the beginning of the apartment's life, but the change from private to communal will require coordinated management among homeowners and their associations, as a cleaning and maintenance system is adopted. In some buildings, new and old, even provisions for a laundrette room will need to be made.

It would be a boon to the circular economy if all apartment buildings adopted this approach. At the retail level, manufacturers and retailers would need to adapt strategically, as housing associations invest

in more durable, industrial-grade machines. This would alter manufacturers' and retailers' business in the domestic sector.

How will they adapt to protect their profits?

Will they shift to a Product-as-a-Service (PaaS) model?

In this hypothetical, the core technology remains the same. A washing machine — private or communal — is a washing machine. Yet consumer behaviour, building infrastructure, and manufacturer revenue models will all need to change. This is an enormous challenge, and it's evident that achieving greater circularity requires substantial and collaborative shifts in social and institutional practices — not only in the product chain.

Circular Economy ~ Capitalism ~ Politics

Sauvé, Sébastien, Sophie Bernard, and Pamela Sloan. 'Environmental Sciences, Sustainable Development and Circular Economy: Alternative Concepts for Trans-Disciplinary Research'. Environmental Development 17 (2016): 48–56. https://doi.org/10.1016/j.envdev.2015.09.002

"At some point, the extra cost of improving and refining further a circular material flow will exceed the corresponding benefits to society, and this is true for any kind of environmental protection. Specifically, a circular economy must promote loops when socially desirable and efficient … i.e. as long as the benefit is greater than or equal to the cost. … e.g. should we invest in a new infrastructure to recycle a specific material in order to reduce waste and preserve the resource, or should we keep exploiting the raw material at cheaper cost, use the short term benefits to build a school and educate our children? When is the benefit greater than the cost?"

Sauvé, Bernard, and Sloan, 'Environmental Sciences, Sustainable Development and Circular Economy'.

Most circular economy literature is reticent on questions like: “When is the benefit greater than the cost?” Capitalism is built on monetary profit, with most investors seeking a clear, immediate correlation between their investment and their return. However, a circular economy investment may yield returns beyond financial metrics.

At some point, the effort and investment required to achieve perfect circularity provides diminishing returns. As with any environmental or resource management strategy, the key lies in balance: promoting circular loops where they provide genuine societal value and economic viability. The challenge is knowing when refining a material flow adds less societal benefit than the resources poured into it. For example, creating a recycling system for certain rare materials may indeed reduce waste, yet infrastructure costs can be immense. Sometimes, redirecting such funds to education, healthcare, or alternative innovations may have a greater social impact.

Each circular investment must consider its wider context: how immediate environmental gains weigh against longer-term social goals. Not every resource demand circularity at all costs; the aim is to find the balance where circular economy practices are both sustainable and beneficial to society. The guiding question becomes, "Is the benefit to society worth the cost of implementation?"

The European Commission envisions a transition driven by the private sector, facilitated by regulatory frameworks, economic incentives, and technological advancements. This approach rests on the assumption that market forces will eventually embrace a

sustainable, resource-efficient economy, effectively reorienting capitalist dynamics to redefine value and success. Regulation is hoped to inspire the private sector to account for social, intellectual, natural, and cultural capital alongside economic gain.

So, how does the European Commission truly intend to reorientate capitalism — the most powerful force humanity has created?

Money, Money, Money

Klevnäs, Per, Alexandra Kulldorf, and Per-Anders Enkvist. 'The Circular Economy and Covid-19 Recovery'. Material Economics, 2020.

https://materialeconomics.com/sites/default/files/2024-06/material-economics-the-circular-economy-and-covid-19-recovery.pdf

Mckinsey & Company. 'Growth within: A Circular Economy Vision for a Competitive Europe | McKinsey', 1 June 2015.

https://www.mckinsey.com/capabilities/sustainability/our-insights/growth-within-a-circular-economy-vision-for-a-competitive-europe

The circular economy is frequently linked with significant economic opportunities. The paper 'The Circular Economy and Covid-19 Recovery' (2020) gives this indication considering the pandemic's impact on EU economics. It projects that the circular economy could unlock up to € 535 billion per year in economic gains. Long-term benefits could reach € 160 billion annually. These numbers dramatically outweigh the risks, estimated at €50-€70 billion until 2030. Risks include sudden market changes, failing investments, declining prices of virgin materials, cash flow difficulties, higher business failure rates, and sticking with outdated systems. Of course, the upside must outweigh the risk otherwise no one would invest.

But when does it become too much? Management consultants McKinsey & Company's analysis is *very* optimistic (or bias):

> **"Our new study, 'Growth within: A circular economy vision for a competitive Europe', provides new evidence that a circular economy, enabled by the technology revolution, would allow**

Europe to grow resource productivity by up to 3 percent annually. This would generate a primary-resource benefit of as much as €0.6 trillion per year by 2030 to Europe's economies. In addition, it would generate €1.2 trillion in nonresource and externality benefits, bringing the annual total benefits to around €1.8 trillion compared with today."

I am unsure of the exact meaning of 'nonresource' benefits, as McKinsey does not provide a definition. However, I assume the term refers to broader advantages beyond resource extraction, such as job creation, the development of new business models, enhanced consumer value, and cost savings achieved through optimising sustainable supply chains.

Comparing these figures can feel like comparing apples to oranges. Public-facing financial forecasts often seem too good to be true. While the potential benefits are appealing, they rest on assumptions that may oversimplify the challenges or underestimate the risks. The circular economy's economic impact is undeniably complex and multidimensional. Achieving such benefits will require coordinated efforts across industries, robust policy frameworks, and technological advancements that may not unfold as quickly or seamlessly as predicted. From an economic standpoint, the exact outcomes of transitioning to a circular economy remain unclear — and perhaps overly optimistic. Balancing ambition with realistic expectations will be critical to understanding its true value.

Efficiency ~ Effectiveness

Stegeman, Hans. 'True Pricing Is Not Enough to Make an Economy Circular', 15 January 2019. https://www.triodos-im.com/articles/2019/true-pricing-is-not-enough-to-achieve-sustainability

Within the discourse of the circular economy, a key debate emerges between efficiency and effectiveness. Hans Stegeman, Chief Economist at Triodos Bank (a 'sustainable bank'), offers a compelling critique of the circular economy's reliance on efficiency as a guiding principle.

Stegeman highlights a fundamental distinction:

"Nature exists by the grace of waste as an input for other cycles, which is very effective, but not efficient. A system that is fully focused on efficiency lacks exactly that input for other cycles and is therefore not resilient."

In nature, resilience stems from adaptability and regenerative cycles. Waste becomes input, sustaining life in an interconnected system. This process is effective — focused on renewal and survival — but not necessarily efficient, as it allows for redundancy, variation, and resource circulation rather than maximised output. Stegeman's observation challenges conventional economic systems, which often prize efficiency above all else.

Prioritising efficiency in an economy — designing for smooth, controlled outputs with minimal waste — creates fragility. Such systems struggle to manage disruptions or adapt to new conditions. The circular

economy, by contrast, requires a shift towards effectiveness, where resilience and regeneration replace the relentless pursuit of cost-cutting and output maximisation.

However, current markets and economic frameworks are deeply entrenched in efficiency-driven models. For example, the concept of 'efficient markets' (Adam Smith's invisible hand) assumes that prices reflect all available information and optimally distributing resources. But this principle falls short in supporting a circular economy. Why? Because circular economy goods and services currently operate within linear market mechanisms, which undervalue circular innovation and fail to reflect the true costs of production.

Advocates for the circular economy often call for true pricing — assigning monetary value to social and environmental costs. For example, taxing emissions during production (€80 per tonne of CO2) could encourage businesses and consumers to make more sustainable choices, much like taxes on sugar or tobacco aim to reduce consumption.

However, as Stegeman critiques, the implementation of true pricing is fraught with challenges:

- **Measurement Uncertainty**: Calculating environmental damage is complex and imprecise. For instance, PBL estimates the annual environmental damage in the Netherlands at €31 billion, but the range varies widely — from €16 billion to €49 billion. On a per capita basis, this translates to anywhere between €900 and €2,800 per year — a 200% difference, creating uncertainty for policymakers and businesses.

- **Business Evasion:** Companies often find ways to minimise their tax burdens. While some may do so by adopting sustainable practices — an outcome aligned with circular economy goals — others may prioritise profit preservation over environmental impact and evade green taxes, undermining the system's effectiveness.

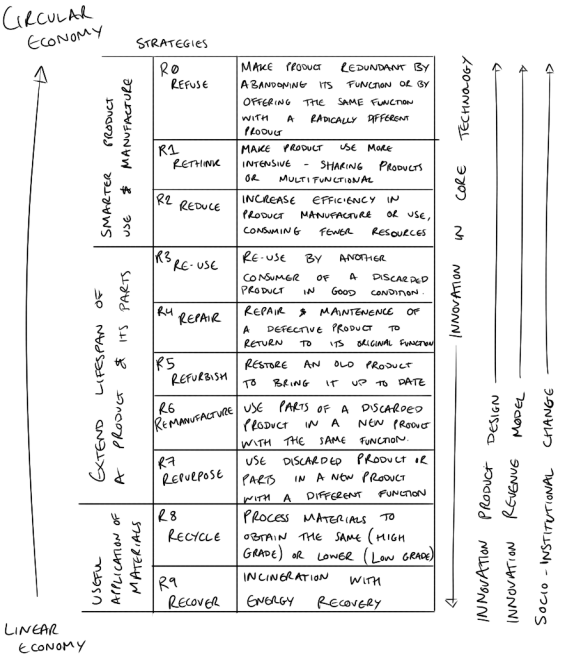
Ultimately, market mechanisms alone cannot drive the transition to a circular economy. Linear systems, focused on short-term efficiency, are ill-suited to price circular goods fairly or incentivise regenerative practices. The shift towards a circular economy requires deeper structural changes, including policies that reward effectiveness, encourage adaptability, and embed resilience in economic systems. Economic systems must embrace the complexities of regeneration and interconnectedness that define the natural world, abandoning outdated notions of efficiency that fail to address the climate crisis.

The R Strategies

Potting, José, Marko Hekkert, Ernst Worrell, and Aldert Hanemaaijer. 'Circular Economy: Measuring Innovation in the Product Chain'. PBL Netherlands Environmental Assessment Agency, January 2017.

https://www.pbl.nl/sites/default/files/downloads/pbl-2016-circular-economy-measuring-innovation-in-product-chains-2544.pdf

How does this affect Designers?



Adapted and redrawn for this publication based on an original diagram by PBL Netherlands Environmental Assessment Agency.

The Netherlands Environmental Assessment Agency (PBL - Planbureau voor de Leefomgeving) report outlines a hierarchy of circularity strategies, listed from most to least circular. The highest level, Refuse, represents the ultimate circular action, while Recover holds the lowest level. A higher circularity level signifies using fewer natural resources and exerting less environmental pressure.

As a product and furniture designer, I find R0 — Refuse — an immense challenge. It requires making a product unnecessary by either abandoning its function or offering it through a radically different means. Let's break that down: "making a product redundant by abandoning its function" sounds paradoxical.

Take chairs, for example. I could argue we have enough, sparing myself the challenge of designing new furniture. This is the most circular choice but threatens my livelihood. Shifting focus to Reuse, Repair, Refurbish, and Remanufacture offers alternative paths, but they may not fulfil my creative drive. Designing from scratch, transforming a sketch into a prototype and finally into reality, is exhilarating — and often requires scaling production to recover costs. The break-even point of production depends on factors such as product margins, sales costs, and operational expenses. For smaller productions with higher margins, this scale might involve producing just tens of items, whereas larger productions with lower margins could require thousands.

The diagram in Potting's work includes arrows representing the impact of innovation along the right side. Arrows pointing upward highlight where socio-institutional change and innovative product

design impact most, such as at R0 and R1. These levels encourage re-evaluating norms, beliefs, and practices. Potting notes, “Generally, recycling does not lead to substantial changes in products that would require socio-institutional change.” In contrast, technological innovation becomes more impactful at R9, where Recover — material recovery beyond incineration — presents rich opportunities for transformative technological advancements.

But how do we measure these changes? Potting suggests that disruptive changes from start-ups are easier to track than incremental ones within large organisations. Start-ups, by nature, can pivot radically to ‘disrupt’ markets, often becoming the face of circular economy innovation. This explains why they may receive outsized funding and investment compared to larger organisations.

R Strategies ~ Design Impact

The R0-R9 is not a formal circular economy transition framework, nor is it endorsed officially by governments, though it aligns with general principles. The European Environment Agency (EEA), for instance, provides high-level circularity questions for designers, such as:

- Does primary material consumption decrease in absolute terms?

- Does the design support reuse and recycling?

- Is the proportion of hazardous substances in products decreasing?

- Are products used more often or for longer?

- Do materials retain their value through high-grade recycling?

However, I can extrapolate the R0-R9 framework to explain how it may impact the role of designers.

R0 — Refuse: Make a product redundant by abandoning its function or offering it through alternative means. For designers, this means questioning the necessity of each new product. Instead of only adding to the market, they may seek ways to integrate or replace existing solutions, ultimately reducing the need for production.

R1 — Rethink: Maximise a product's utility. Designers are encouraged to develop multi-functional products or designs that fulfil multiple needs, making them adaptable over time. This requires deep consideration of versatility in form and function, challenging the traditional one-purpose approach.

R2 — Reduce: Minimise material and energy use. Designers must look for ways to create more with less — using fewer materials and reducing energy demands during production. Lightweight, minimalistic design and efficient manufacturing processes are increasingly prioritised.

R3 — Reuse: Reutilise products for the same purpose. Design now includes anticipating a product's lifecycle, enabling reuse rather than obsolescence. Durable materials and modular design make it easier for users to repurpose items over time.

R4 — Repair: Enable easy repair and replacement of parts. Designers must consider disassembly and modularity, creating products that can be repaired with minimal tools and accessible parts. This impacts the choice of materials, fastenings, and overall structure, making repairability a key design requirement.

R5 — Refurbish: Restore the product to a good condition. Products should be designed with durable finishes and replaceable components, allowing them to be restored to near-new condition. Designers may even plan for 'second-life' aesthetics, where products look better with age and wear.

R6 — Remanufacture: Use parts from used products to create new items. R6 encourages designers to standardise components and integrate recycled parts, reducing dependency on virgin materials. Designs may need to adapt to accommodate existing components, emphasising compatibility and interchangeability.

R7 — Repurpose: Use a product for a different purpose. Designers can give products multiple potential uses or create designs that adapt to new functions as needs change. This means thinking beyond a product's original intent, allowing it to find value in new applications. Upcycling and adaptable design.

R8 — Recycle: Convert product materials into new raw materials. Designers should prioritise materials that can be easily separated and recycled at the end of a product's life. This impacts material selection, avoiding composites or non-recyclable substances and leaning toward single-material construction or clearly separated components.

R9 — Recover: Extract energy or material from waste when recycling isn't possible. While this level is least circular, it reminds designers to consider the full lifecycle, including what happens to materials when recycling fails. Designers may work with materials that have potential for energy recovery, closing the loop even if total recyclability isn't feasible.

Circular Economy ~ Resilience

{ Kennedy, Steve, and Martina K. Linnenluecke. 'Circular Economy and Resilience: A Research Agenda'. Business Strategy and the Environment 31, no. 6 (2022): 2754–65. https://doi.org/10.1002/bse.3004

{ Taleb, Nassim Nicholas. Antifragile: Things That Gain from Disorder, 1st ed., New York: Random House, 2012

Is the circular economy resilient? Can it withstand or recover from difficulties? Of course, this is a projection — we won't know until it happens. Steve Kennedy and Martina Linnenluecke contend that the circular economy would, in fact, be more resilient than the linear economy. A synonym of resilience is antifragile, coined by Nassim Taleb. In Antifragile: Things That Gain from Disorder, Taleb explores fragility, robustness, and anti-fragility, observing that:

Fragile systems break under stress.

Robust systems withstand stress without changing.

Anti-fragile systems grow stronger through volatility and shocks.

A linear economy is robust until a shock proves its fragility, as seen in the dot-com bubble, the 2007-2008 financial crisis, and the COVID-19 pandemic. An ideal circular economy will be more localised with diversified inputs, which make the economy less susceptible to large shocks, operating as many connected nodes that cycle materials between one

another. From this perspective, a circular economy is anti-fragile compared to a linear economy, for several reasons.

Diverse Resource Inputs:

Many varied sources of materials instead of a single supply chain. Diversification reduces dependency and increases resilience to disruptions. There are options in times of failure.

Localisation and Decentralisation:

A circular economy promotes localised production and resource management. Decentralisation means fewer systemic failures when a single node is disrupted. Local systems can adapt and respond to specific conditions. Unlike linear economies which favour blanket solutions.

Adaptation to Shock:

Waste becomes a resource in a continuous loop, mimicking iterative evolution. Each material cycle enhances efficiency, learning, and improvement. Software may help automate part of these iterations, building on tried and tested methodologies.

Minimisation of Finite Resource Use:

Reducing dependency on finite resources lowers the risk of depletion. Resulting in fewer points of potential failure or being outpriced.

Upcycling ~ Trash into Treasure?

Closing the loop - An EU action plan for the Circular Economy, Pub. L. No. COM(2015) 614 final, CELEX:52015DC0614 (2015).
https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52015DC0614

HM Government. 'Our Waste and Resources Strategy for England'. HM Government, December 2018.
https://assets.publishing.service.gov.uk/media/5c18f11740f0b60bbee0d827/resources-waste-strategy-dec-2018.pdf

Scraps, remnants, fragments — combined, collaged, renewed — trash into treasure. Old sweaters become bags; jackets become caps; bottles become furniture; safety pins become earrings. Is it design? Is it art?

The concept of Upcycling has run the rounds in art, design, and social movements to stimulate creation amidst a lack of resources. However, the term is absent from political literature, the EU Circular Economy Action Plan, and the UK's Waste and Resources Strategy fail to mention it.

Upcycling ~ Usage

Sung, Kyungeun, Jagdeep Singh, and Ben Bridgens, eds. 'State-of-the-Art Upcycling Research and Practice: Proceedings of the International Upcycling Symposium 2020; Lecture Notes in Production Engineering'. Cham: Springer International Publishing, 2021.

https://doi.org/10.1007/978-3-030-72640-9

McDonough, William, and Michael Braungart. *Cradle to Cradle: Remaking the Way We Make Things*. 1st ed. New York: North Point Press, 2002

Braungart, Michael, and William McDonough. *The Upcycle*. North Point Press, 2013

Salvo. 'Reiner Pilz. Thinking about a Greener Future.' Salvo, 10 1994, sec. Pg 11.

https://www.salvoweb.com/files/sn99sm24y94tk181119.pdf

> **"The use of various material processes to create or modify a product from used or waste materials, components, and products, which is of equal or higher quality or value than its compositional elements."**

[Reiner Pilz]

The word 'upcycling' comes from the German engineer, Reiner Pilz. In 1994, this early adopter and upcycling evangelist stated in Salvo Magazine:

> **"I call recycling down-cycling. What we need is up-cycling, thanks to which old products are given a higher, not a lower, value."**

Pilz ran an interior construction business in Germany. He incentivised his joiners to use second-hand materials by paying them 10% extra (where

can I sign up). He designed with materials in stock, odds and ends, and second-hand materials. He engineered cutting systems to improve the processing times of materials. Fundamentally, other designers found materials to fit designs, but Pilz found designs to fit materials.

The term ‘upcycling’ didn’t gain much attention until eight years after the Salvo piece, when Michael McDonough and William Braungart’s influential book *Cradle to Cradle, Remaking the Way We Make Things* was published in 2002.

Cradle to Cradle focused on material cycles. At the end of an object’s life, materials become either biological or technical nutrients. Biological nutrients return to the Earth as biodegradable matter, while technical nutrients re-enter human systems like recycling or remanufacturing. In a cradle-to-cradle system, everything becomes a nutrient for something else. Sounds wonderful. Sounds circular.

Braungart and McDonough consolidated the term in *The Upcycle* (2013), defining 'upcycling' as converting technical nutrients into new materials for manufacturing. A methodical and deliberate process.

Innovation ~ Gambiarra, Jugaad, and Technological Disobedience

Oroza, Ernesto. 'Technological Disobedience Archive = Desobediencia Tecnológica Archivo'. Accessed 6 November 2023.
http://www.technologicaldisobedience.com/

Paulino, Fred. 'On Gambiarra'. The Repair Atelier, 15 February 2023.
http://repairatelier.com/lexicon-of-repair/2023/2/15/on-gambiarra

Koch, Christian. 'India's Ingenious Approach to Life'. BBC, 3 September 2018.
https://www.bbc.com/travel/article/20180902-indias-ingenious-approach-to-life

So far, I've tried to stick to with examples in the context I live and work in, those which I know best. However, it will be remiss to overlook Brazilian Gambiarra, Indian Jugaad, and Cuban innovations.

Gambiarra, Jugaad, and Cuban innovations arise in resource-limited environments (compared to many European contexts). In Cuba, product hacking and adaptation culture grew from necessity due to the American trade embargo (1960-61) and the collapse of the Soviet Union (1991). These events created a relationship of 'technological disobedience' with objects.

Categorising these as upcycling or adaptive design is tricky. Upcycling reuses discarded materials, while adaptive design combines disparate products or materials for new functions. Both are true in the Cuban case. The key distinction is whether the original materials were waste.

Viewing practices such as Gambiarra, Jugaad, and technological disobedience prompts a reconsideration of what *waste* truly is. In cities like London or New York with upper-middle class populations, similar initiatives might be labelled as upcycling — a creative reimagining of discarded materials. However, in the contexts of Brazil, India, and Cuba, these practices emerge as adaptive strategies born from necessity, rooted in local ingenuity and resilience.

The distinction between upcycling and adaptation lies in how each culture perceives and engages with waste. Such a distinction is meaningful only when understood within its specific cultural and socioeconomic framework — a context I acknowledge I lack.

That said, I would argue that Gambiarra, Jugaad, and Cuban innovations resonate more closely with informal remanufacturing than with upcycling. They represent transformative processes that go beyond aesthetics, addressing immediate needs through resourcefulness and creative problem-solving.

Upcycling ~ Design

{ Hoffman, Abbie, Izak Haber, and Bert Cohen. Steal This Book. New York: Four Walls Eight Windows, 1995

{ Arad, Ron. Rover Chair. 1981. Furniture. MoMA. https://www.moma.org/audio/playlist/188/2500

The practice of upcycling in art and design predates the term. Elsa von Freytag-Loringhoven, Marcel Duchamp, Abbie Hoffman, Martin Margiela, Alexander McQueen, Lamine Kouyaté are among its artistic proto-practitioners.

Freytag-Loringhoven and Duchamp transformed *waste* into valuable objects with the introduction of 'ready-mades' in the early 20th century. Here, found objects are reimagined as sculptures, ordinary items (urinals and bicycle wheels) were recontextualised as art in galleries. Moving from the known to the unknown.

In 1971, Abbie Hoffman, the social activist, hinted at the concept of upcycling in *Steal This Book*:

> **"Construction sites are a good source for building materials to construct furniture. (Not to mention explosives.) The large wooden cable spools make great tables. Cinderblocks, bricks, and boards can quickly be turned into a sharp-looking bookcase. Doors make tables. Nail kegs convert into stools or chairs. You can also always find a number of other supplies**

hanging around like wiring, pipes, lighting fixtures, and hard hats. And don't forget those blinking signs and the red lanterns for your own light show. Those black oil-fed burners are O.K. for cooking, although smoky, and highway flares are swell for making fake dynamite bombs."

Hoffman's observations resonate with me. Construction waste is abundant, and I've used it myself, I once repurposed a door into a desk before upgrading to found plywood elevated by sawhorses. Construction lights are a staple in the studios of my friends, highway flares, less so.

Hoffman's writing reflects the resourcefulness of 1960s-70s America, an era marked by economic prosperity and consumerist opulence. It was also a time when countercultural movements arose to challenge wastefulness and promote reuse. That eco-conscious ethos persists today, though its manifestations have evolved.

Hoffman's approach was primarily utility-driven, rooted in practicality rather than style. However, by the 1980s, upcycling, as Hoffman described, became stylish — even before the term itself existed — as the economics of art school met the aesthetics of reuse. Emerging designers, often constrained by limited resources, turned to salvaged materials to create innovative and highly sought-after collections.

In furniture design, pioneers like Tom Dixon and Ron Arad embraced salvaged materials. Dixon famously transformed scrap metal into striking,

sculptural furniture and lights. Similarly, Arad repurposed industrial materials like steel and corrugated iron to craft avant-garde furniture, exemplified by his Rover Chair, which upcycled a Rover car seat into luxury design.

In fashion, the trend also took hold, with designers like Martin Margiela. His debut collection in 1988 reimagined discarded garments into high fashion, such as his signature reconstructed dresses made from vintage silk scarves. Lamine Kouyaté of Xüly.Bët followed in the 1990s, repurposing second-hand clothing into deconstructed, bold new forms.

The early 2000s saw designers like Rick Owens, Alexander McQueen, and Christopher Raeburn push the boundaries further. Raeburn became known for his meticulous use of military surplus materials — such as parachutes — to create sustainable outerwear with a utilitarian aesthetic. His 2009 collection cemented upcycling's role in modern sustainable fashion.

Hoffman's utilitarian vision has been transformed by generations of designers who infused it with aesthetic and conceptual depth. From resourceful countercultures to luxury ateliers, upcycling has evolved from practicality to prestige, continuing to shape how we think about waste and value in design. Designers, from students to professionals, continue to use found material as an economical way to create.

If you want to upcycle your own objects, consider the following ethical and material questions:

Does it have cultural significance?

What does the original brand and designer stand for, and how does this affect the positioning of the upcycled object?

Is the material harmful or toxic when reworked with a specific process?

Where did the material come from geographically?

Where is the labour in relation to the waste generation?

Is it ethical (or environmental) to ship European waste to another continent?

How granular does this become? Is it ethical to upcycle waste generated in a different European country? Can Germany process Dutch waste? They are neighbours after all. What about Georgia processing Dutch waste? They're not too far apart on the map, but disparate economically.

Designer ~ Upcycler

A small inventory of upcycler designers.

Nicole McLaughlin

McLaughlin has gained Instagram fame as a self-proclaimed "upcycling and sustainable fashion" designer. From volleyballs transformed into slippers to camera bags reimagined as bralettes, and Haribo packets crafted into board shorts, their work is filled with tangible and creative examples of sustainability in action. These transformations showcase a unique and accessible approach to repurposing materials.

In addition to these projects, McLaughlin collaborates with brands like Arc'teryx, JanSport, and Vans, helping them shape and enhance their sustainability narratives. Through workshops and design initiatives, McLaughlin introduces innovative methodologies for integrating upcycling into mainstream fashion. This partnership is mutually beneficial — McLaughlin gains exposure and credibility by working with powerhouse brands, while the brands themselves benefit from the fresh, creative perspectives McLaughlin brings to their sustainability strategies.

Greater Goods

Founded in 2018 by Jaimus Tailor in London, the Greater Goods brand is built on the ethos of crafting functional, practical accessories. By upcycling reclaimed, damaged, or unwanted materials, or

incorporating environmentally sustainable resources, it creates pieces that are practical, durable, and uniquely upcycled.

The limited nature of the collections, thoughtful collaborations, and strong focus on sustainability combine to spark desirability, making each piece not just a product, but a statement.

Freitag

Founded in 1993, Freitag is based in Zurich-Oerlikon. The brand has championed circularity and upcycling from the very beginning. Freitag's aesthetic seamlessly communicates its ethos: "Old truck tarps, discarded bicycle inner tubes, and car safety belts" are transformed into durable and distinctive bags. One of its most iconic creations, the F13 bag (1993), has been part of the MoMA New York design collection since 2003.

Freitag employs a dedicated team to source used truck tarps. The process involves finding, selecting, washing (using collected rainwater), cutting, sewing, and ultimately selling. Each bag is unique, cut from a specific section of the tarp. This meticulous process, while labour-intensive and costly, creates products with a story and purpose. The Freitag brothers acknowledge that their bags may cost more than competitors' but argue they give far more in return. Customers are invited to value sustainability, individuality, and the deeper narrative behind the brand.

Rotor DC

Rotor DC is a worker-owned cooperative based in Brussels. Rotor DC is an enabler of upcycling, mainly dealing with materials salvaged from deconstruction.

The business also has an inhouse design firm, using its own store of materials to create interiors and furnishings.

Rotor DC grew from gaps in the used material market. Where the used market was mid-century modern, vintage classics or barn finds. It lacked options for consumers interested in more contemporary second-hand items or plain raw materials for re-use.

Upcycling ~ Enablers

Creating an infrastructure or network is an essential part of design practice. Enablers establish systems and support sustainable material flow.

A good enabler needs a rich network for sourcing materials, the skills to select suitable materials, and the infrastructure to process them. They also need the marketing know-how to sell them. Enablers — individuals or companies — are crucial to the future of upcycling, where design will be as much about creating frameworks and systems as it is about crafting objects.

Some designers create projects to become enablers. Enzo Mari's 1974 publication *Autoprogettazione* offered consumers instructions to build their own furniture using common materials, actively promoting upcycling and adaptation. More recent projects, such as Heron Preston and L.E.D Studios, who upcycled Mari's chair, continue to show how his work remains relevant. This demonstrates how enablers, through shared knowledge and systems, play a pivotal role in the broader upcycling movement.

Upcycling ~ DIY/DIFO

This weekend, I browsed the bookstore for pieces on DIY. This led me to think about the overlap between DIY and upcycling. Though distinct, they are undeniably interconnected. Upcycling and DIY exist as countercultures to traditional industries. Clothing manufacture, furniture making, upholstery, and car mechanics all have prevalent DIY and upcycling cultures.

DIY — Do It Yourself — is self-driven. It's typically undertaken for cost-saving or personal satisfaction and centres on doing the work oneself rather than hiring a professional. In the everyday it often refers to home repairs, maintenance, or small building projects. DIY is a social signal — one of capability, self-sufficiency, creativity, and the luxury of time to invest in personal projects.

DIFO — Do It For Others — is an approach where individuals apply DIY or upcycling skills to create for others, either as a service or part of a collective effort. DIFO reflects a socially oriented mindset, sharing the benefits of upcycling or DIY with a broader community and making these efforts accessible to those who may lack the time, tools, or expertise.

Is DIY more sustainable than traditional production? It's complicated. For instance, if 100 people build their own dining tables, each would need tools and materials, creating a repetitive and inefficient use of resources. From a strictly material and energy efficiency perspective, a factory producing 100 tables

could be more eco-friendly, as resources are consolidated and optimised. The same logic applies to upcycling: a factory producing 100 tables from reclaimed wood may have a lower environmental impact than 100 individual DIY tables. Of course, this simplifies the issue — factors like material transport, energy use, and the intangible value of personal engagement all play roles.

Upcycling ~ Insights

Is upcycling a DIY/DIFO term or is it more industrialised?

Kyungeun Sung offers data on publications about upcycling. As of the publications up to 2014, the category split was:

- 53%: Craft & Hobby

- 10%: Art & Design

- 9%: Science & Technology

- 8%: Business & Economics

- 10%: Miscellaneous

So, 73% of upcycling literature targets consumer processes: Craft & Hobby, Art & Design or Miscellaneous.

This piqued my curiosity. I turned to Instagram, our modern viewing glass for society. Whilst I understand this is not a scientific tool, and despite its bias and algorithmic tuning, it's a useful gauge of consumer trends. Searching #upcycle, #upcycled, and #upcycling returns over 15 million posts. Most fall under Craft and Hobby — individuals upcycling old clothes into tote bags, rescuing furniture, or making one-off items.

Sung, Kyungeun. 'A Review on Upcycling: Current Body of Literature, Knowledge Gaps and a Way Forward Kyungeun Sung', 2014 2013.

https://www.academia.edu/14163325/A_Review_on_Upcycling_Current_Body_of_Literature_Knowledge_Gaps_and_a_Way_Forward_Kyungeun_Sung

When combining Sung's literature review with my Instagram pseudo-review, it is apparent that upcycling is more associated with Craft and Hobby than with industrial application. Sung suggests clarification is the answer. To use terms like "*industrial upcycling based on recycling*", "*industrial upcycling based on remanufacturing*", "*individual upcycling based on product re-creation*", provides granularity, but I doubt
#IndividualUpcyclingBasedOnProductRecreation
will trend anytime soon.

Trashion

Shaw, Wendy S. 'Trashion Treasure: A Longitudinal View of the Allure and Re-Functioning of Discarded Objects'. Environment and Planning D: Society and Space 37, no. 1 (2019): 122–41. https://doi.org/10.1177/0263775818756643

Emgin, Bahar. 'Trashion: The Return of the Disposed'. Design Issues 28, no. 1 (2012): 63–71. https://doi.org/10.1162/DESI_a_00124

Szaky, Tom. *Outsmart Waste: The Modern Idea of Garbage and How to Think Our Way Out of It*. A BK Currents Series. San Francisco: Berrett-Koehler Publishers, Inc, 2014

Wendy Shaw's *Trashion Treasure* highlights a tension within the upcycling and reuse movement, especially as it becomes increasingly commercialised and trendy. She argues that, while reuse can be less harmful than traditional consumerism, it is unfolding in an era marked by a narcissism epidemic where a sense of entitlement drives resource consumption. This results in a paradox: the total consumption footprint remains high, with individuals viewing each little purchase as sustainable simply because it's 'eco-friendly.'

There's an obvious contradiction here. Movements rooted in reuse, recycling, upcycling, and DIY often position themselves as an escape from the capitalist cycle of consumption and object obsession. However, Shaw points out, these movements can end up mirroring consumerism through the curation and display of collected items, transforming environmental action into a kind of lifestyle aesthetic.

There's certainly a type of eco-conscious consumerism that, while less harmful, still plays into the culture of entitlement and object fetishism. Electric cars are a prime example. Their mass adoption and high price tags have turned them into

status symbols, and, as questions emerge about their true environmental impact, they reveal a form of green consumerism. A new class that indulges in eco-conscious consumption yet continues to feed into the culture of accumulation. An eco-responsible hedonism.

Upcycling, at its core, takes what's considered waste — rubbish, garbage, discarded items — and transforms it into functional objects. What's the appeal in turning 'trash' into something useful? Projects that transform materials like plastic crates into chairs, pallets into tables, or vinyl records into lampshades are creative examples of upcycling. However, they often raise a critical question: Who genuinely needs these objects? While the ingenuity of turning old stools into balance bicycles may be admirable, the practical need for such a product can be questionable. This highlights a disconnect between the creative reuse of materials and the actual utility or demand for the product.

The overlap between need (practicality and usability) and material (what's being repurposed) is often narrow. Designers may focus more on the novelty or aesthetic of upcycling rather than ensuring that the new product has a meaningful purpose or serves a genuine need.

This issue becomes even more pronounced when considering the importance of material quality. Products made from substandard recycled materials often lack durability, directly undermining the principles of longevity and sustainability. In some cases, these upcycled objects are so poorly made or impractical that they seem destined for the landfill, simply delaying their disposal rather than preventing it.

This raises a larger question: Can there be such a thing as 'useful waste'? If waste materials are to be upcycled into new products, the focus should be on creating items that are not only inventive but also practical, durable, and genuinely valuable, aligning with sustainability goals rather than just ticking the 'recycled' box.

In *Trashion: The Return of the Disposed,* Bahar Emgin distinguishes trashion as a subset of upcycling with a raw, DIY ethos. Unlike upcycling, which may undergo more refined transformations, trashion embraces the look and feel of waste. It's a creative response to limited resources, often celebrated in its raw, unrefined form. The aesthetics aren't polished or commercialised but rather highlight the aesthetics of discarded material itself. Trashion is largely a DIY endeavour and is relatively obscure — outside of niche fashion shows or sparse online discussions, it lacks mainstream traction.

Founder of TerraCycle, Tom Szaky, argues that upcycling itself isn't commercially viable, citing issues such as a small market, niche appeal, and consumer reluctance to engage in cleaning or separating waste. However, these obstacles could also be opportunities for design innovation — expanding the market, enhancing appeal, and developing systems to simplify waste separation, could all redefine what's possible. Szaky's perspective might apply more accurately to trashion rather than to upcycling as a whole; projects like 'sewing juice pouches into backpacks' are DIY at heart and less aligned with scalable commercial production. This highlights the need for a nuanced understanding around terms like trashion, upcycling, and design.

Mezei, Péter, and Heidi Härkönen. 'Monopolising Trash: A Critical Analysis of Upcycling under Finnish and EU Copyright Law'. Journal of Intellectual Property Law and Practice 18, no. 5 (23 May 2023): 360–66. https://doi.org/10.1093/jiplp/jpad019

As upcycling grows, legal questions around material reuse emerge. Can I transform discarded Nike trainers into my own product, reuse their branding, and profit from their iconography?

In some places, such as Finland, legal restrictions make this complex.

Mezei and Härkönen's 'Monopolising Trash' delves into these issues, referencing the Finnish Copyright Council (FCC) and the 'law of exhaustion.' This law limits a copyright holder's control after the initial sale, but it doesn't automatically apply to upcycled items. If upcycled materials are recognisably branded, legal challenges arise. For example, upcycling one's own product is fine, but using branded materials from other companies, like logos or patterns, is a grey area.

Mezei and Härkönen advocate for change, suggesting that certain rules around upcycled materials could be relaxed to promote a circular economy. Their proposals include:

Relax Exhaustion Rules: Allow commercial reuse of discarded branded materials, providing the original brand's reputation isn't compromised.

Foster Collaborations: Develop partnerships between upcyclers and brands, offering legal permissions that enhance brand image while supporting upcycling.

Brand Responsibility: Hold brands accountable for their waste; if they restrict commercial reuse, they should face consequences for the waste they create.

An interesting solution might be affiliate upcyclers, which are akin to affiliate marketers. Brands could partner with upcyclers, granting access to surplus materials and permission to use branded waste. This would enhance a brand's sustainability credentials, reduce waste, and create unique, branded upcycled products. Such collaborations are already emerging, with McLaughlin and Greater Goods leading the way.

Oversights ~ Constraints

{ Korhonen, Jouni, Antero Honkasalo, and Jyri Seppälä. 'Circular Economy: The Concept and Its Limitations'. Ecological Economics 143 (2018): 37–46. https://doi.org/10.1016/j.ecolecon.2017.06.041

So far, this compendium has considered key words which are central to the discourse of design sustainability, along with practices which serve as examples, we will now consider terms that the discourse tends to neglect:

Inescapable laws of thermodynamics,

Intricacies of system boundaries,

Limitations imposed by an economy's scale,

Inertia of path-dependency and technological lock-ins,

Limits of governance and management,

Nuanced definitions shaped by social and cultural contexts.

Thermodynamics ~ Entropy

Boulding, Kenneth. 'The Economics of the Coming Spaceship Earth'. Presented at the Sixth Resources for the Future Forum, Washington D.C, 8 March 1966.

http://arachnid.biosci.utexas.edu/courses/thoc/readings/boulding_spaceshipearth.pdf

Circular economies strive for efficiency by minimising waste and maximising the reuse of resources. The second law of thermodynamics (the law of entropy) underscores the impossibility of creating a perfect circle with no waste. Zero waste is impossible because entropy within a system ensures that degradation of order is unavoidable. Kenneth Boulding cited this reality in the 1960s:

> **"In regard to matter, therefore, a closed system is conceivable, that is, a system in which there is neither increase nor decrease in material entropy. In such a system all outputs from consumption would constantly be recycled to become inputs for production, as for instance, nitrogen in the nitrogen cycle of the natural ecosystem."**

Let's take the example of the recycling of plastic bottles. Despite best efforts, a fraction escapes the recycling loop. Some are lost, recycled in the wrong place, or never returned. Even the recycling circuit itself is not a hermetic system — material is lost in the process. This creates diminishing returns on

recycled material over time. This lost material is an expression of the law of entropy — the natural disorder of stuff.

As humans, we may try to control this, but the energy and labour required to reclaim even a small percentage of lost materials will be astronomical. That small material adds up over time. If 5% of material is lost per cycle, then within 10 cycles, only 60% of the original material remains.

Entropy ~ Perpetuity

No material is perpetually re-processable. Waste is inevitable. It is disturbing that in most of the circular economy literature, waste does not exist. It is as if, by connecting waste to an input stream it suddenly disappears. Magic.

Waste is part of any inefficient process. Inefficiency here, is being anything less than a 100% hermetically sealed process. Waste can and should be minimised, but it exists, which, the EMF butterfly diagram does not acknowledge. For a model to be actionable, it must acknowledge a realistic process.

System Boundary Limits

Korhonen, Jouni, Antero Honkasalo, and Jyri Seppälä. 'Circular Economy: The Concept and Its Limitations'. Ecological Economics 143 (2018): 37–46.

https://doi.org/10.1016/j.ecolecon.2017.06.041

Strachan, Peter, and Richard Welford. Environmental Issues and Corporate Environmental Management. Pearsons, 2004

World Health Organisation, Circular Economy and Health, Oportunities and risks, WHO, 2018.

https://iris.who.int/bitstream/handle/10665/342218/9789289053341-eng.pdf

System Boundary Limits addresses how globalised production and consumption displace problems across geographies. Products are made, used, and disposed of in different countries. Strict circular economy measures in one country may overlook the transnational nature of modern supply chains. Local efficiency gains might create problems elsewhere, especially in poorer countries.

As Peter Strachan and Richard Welford point out:

> **"It has been shown that very high eco-efficiencies have been achieved in local biomass-based industries while the exports of this industry have created difficult problems at the end-management phases of the product life cycle (Korhonen and Snäkin, 2005) or the imports of this industry have violated the biodiversity of the ecosystems in the source country (Mayer et al., 2005). In a local recycling network that was**

very successful in waste and by-product utilization, the biggest environmental impacts occurred outside the local industrial park in its supply chain."

The World Health Organisation highlights a stark geographical imbalance in waste management: objects are often used in one place but discarded in another. This disparity disproportionately affects vulnerable groups, both within Europe and globally.

A WHO report notes: "Where negative impacts have been identified, their effects frequently fall disproportionately on vulnerable groups in Europe and globally. A key concern is the export of waste, such as e-waste, to dumping sites in developing countries, where the local population engaging in informal recycling is often more deprived than the general population. Conversely, the reduced global environmental pollution resulting from the circular economy will result in long-term health gains that may benefit disadvantaged groups, which are known to be disproportionately affected by environmental impacts. More detailed distributional assessment, however, is needed for each health impact identified."

This imbalance underscores the systemic inequities in waste disposal practices, where the environmental and health burdens are shifted onto those least equipped to bear them. Circular economy initiatives are ineffaceable and inequitable if they shift environmental burdens to less affluent regions. We live in a global economic system, yet no global circular economy policy currently exists.

Lock In's

Today's decisions define future paths. Once committed, there is a 'lock in' cost to any investment.

For example, say we rushed into electric cars, which requires us to build mass infrastructure to ensure the automotive grid is fully electric by 2030. 2030 rolls around and hydrogen has advanced so much that it now seems magnitudes more ecological than electric grids. Replacing the barely used electric infrastructure with hydrogen will be astronomical; an economic and ecological cost which could have been avoided. Energy infrastructure investments illustrate decisions with long-term implications and slow payback.

On the flip side, the lock in argument can be exploited by climate sceptics. For example, by reframing the high upfront costs and slow payback periods of renewable energy investments as economically inefficient and financially risky, they can argue that taxpayer money is wasted on projects with delayed returns, and push for cheaper, short-term fossil fuel solutions instead. Additionally, climate sceptics may highlight the need for grid adaptations to accommodate renewables, questioning their reliability and suitability as a replacement for fossil fuels. This narrative suggests that renewable investments divert resources from more immediate economic needs, positioning green energy as an impractical, idealistic distraction from 'real' issues. Such arguments aim to stall progress, favouring short-term gains over long-term benefits.

Jevons Paradox

Korhonen, Jouni, Antero Honkasalo, and Jyri Seppälä. 'Circular Economy: The Concept and Its Limitations'. Ecological Economics 143 (2018): 37–46. https://doi.org/10.1016/j.ecolecon.2017.06.041

Jouni Korhonen et al, have noted another unintended consequence, and a reason why the circular economy may not provide the de-growth model we hope for. Jevons Paradox, named after the English economist William Stanley Jevons, simply states increased efficiency leads to increased consumption. The increase consumption (paradoxically) cancels out the savings created by increased efficiency. For instance, a new process reduces the oil input for nylon production by 20%, lowering both the product's cost and its environmental impact. However, the reduced cost leads to a lower sale price, attracting more consumers and driving up demand. As a result, production increases by 50%, ultimately raising the total environmental impact beyond the level before the innovation. This is the Jevons' Paradox.

I wonder if the circular economy will give consumers a free pass. The ideal of *infinite consumption without damage* — which assumes that materials can be endlessly reprocessed — risks that consumption can continue without consequence. This view glosses over the reality that each cycle, even within a circular economy, incurs an environmental toll through energy use, resource extraction for infrastructure, and inevitable material degradation (entropy).

'Zero-impact' consumption may encourage overconsumption, as consumers feel less compelled to limit their purchases. This dynamic could lead to a surge in demand for circular products, amplifying product-

ion and its associated impacts, particularly in energy and logistics. For example, a ‘sustainable’ product that requires multiple recycling processes and extensive transport to achieve a circular lifecycle might, in aggregate, carry a larger environmental footprint than an item built to last and used sparingly.

Behaviour ~ Policy Making

Perceptions and definitions play a pivotal role in the viability of a circular economy. What constitutes 'good' or 'bad' waste is deeply influenced by historical, cultural, societal, and community perspectives. These definitions evolve alongside culture, reflecting shifting values and priorities. For example, in the case of upcycling, its definition is currently being shaped by an active cultural movement. Yet, despite its cultural momentum, this evolution is not adequately mirrored in policy frameworks.

Modern environmental policies are largely shaped by prevailing perceptions of waste and value. This can result in certain materials — like nuclear waste — remaining unaddressed or buried indefinitely, due to societal discomfort or limited technological solutions. Such rigid boundaries in perception can hinder the exploration of potentially beneficial solutions.

Additionally, inconsistencies in policy and reporting create further barriers. The lack of uniform definitions and categories complicates decision-making and the establishment of universal standards. Without clear and consistent frameworks, data reporting becomes unreliable, leading to flawed analyses and ineffective strategies.

To advance the circular economy, both perceptions and policies must evolve in tandem. Clear, adaptive policies are needed to reflect dynamic cultural definitions, ensuring that innovation is not hindered by outdated or rigid frameworks.

Idealism

I previously idealised the circular economy. But what happens if it fails? What if its implementation is flawed — and circularity, despite its best intentions, inadvertently leads to greenwashing or market inefficiencies — and 'circular' products become less accessible or compromised in quality due to cost constraints?

Moreover, circular economy's success depends on robust socio-institutional support and infrastructure. Without these, circular solutions risk being siloed or limited in impact, unable to address the broader systemic challenges they aim to solve.

This realisation has taken my research in an unexpected direction. Initially, I sought a balanced perspective on the circular economy but found a discourse saturated with idealism — a near-celebratory framing of circular economy as a flawless harmony between environmental sustainability and economic prosperity. Yet, this raises pressing questions: sustainable for whom, or what? Is the circular economy truly ecologically sustainable, or does it serve as a façade, sustaining profit-driven systems disguised as environmental progress?

This moment marks a vital turning point in my argument. It shifts the focus from celebrating the circular economy's potential to critically examining its foundations, implications, and overlooked complexities. From here, my compendium will delve deeper into questions of feasibility and integrity. Concepts like entropy — the inevitable loss of energy

and efficiency in any closed system — emerge as central, challenging the notion of endless resource cycles.

Additionally, this interrogation introduces the idea of a spiral economy: a 'thought experiment' that embraces regeneration and acknowledges inherent losses rather than striving for unattainable perfection. This model questions whether the circular economy's public narrative aligns with its practical realities and whether we need alternative paradigms.

Consulting

{ Mariana Mazzucato, and Rosie Collington. The Big Con. The Penguin Press, 2023

{ Mazzucato, Mariana, and Rosie Collington. 'Consultants and the Crisis of Capitalism', 6 March 2023.

https://www.socialeurope.eu/consultants-and-the-crisis-of-capitalism

Consultants and publicists propel the circular economy movement across Europe. McKinsey & Company represent a dominant force in strategy and consulting and plays a significant role within the discourse of the circular economy. As an external entity selling expertise, their involvement in the circular economy challenges my trust.

Granted, my scepticism toward consultants is combined with a true lack of personal engagement in the field. Perhaps it's Steve Jobs' infamous critique that consultants lack 'skin in the game', or the disillusionment I feel when friends and colleagues, with minimal real-world experience, pivot straight into consulting roles.

This reality clouds my perspective on the circular economy's positioning, especially when a firm like McKinsey, with vested interests in profit, dominates the discourse. Their analyses often reduce the circular economy to numbers, neglecting complex realities. Are they sincerely championing the circular economy or aligning with its rise to boost revenue? Mariana Mazzucato and Rosie Collington's *The Big Con* deepens my scepticism. They argue the consulting industry compromises business integrity, weakens government functions, and perpetuates

ty. In public sectors, this translates to privatisation and austerity. The authors' account of France's COVID-19 response highlights these failures, as France lagged in vaccine distribution compared to other European countries.

> **"By early January 2021, a mere 5,000 doses had been administered [in France], compared with 316,000 in Germany and 139,000 in Spain (all three countries started their programmes around the same time)."**

McKinsey's sustainability consulting raises significant questions when the firm simultaneously works with 43 of the top 100 global polluters. It seems contradictory to expect meaningful solutions from an industry that profits from extractive practices. Their business model thrives on delivering incremental results — providing just enough progress to satisfy clients while ensuring the need for repeat business. This approach stifles innovation, clouds public sector accountability, and is shrouded in jargon-heavy, proprietary processes that often obstruct true systemic change.

Some governments are beginning to acknowledge this dependence, turning instead to in-house models and community-driven strategies. As Mazzucato and Collington aptly state: "Battling any addiction begins with acknowledging the problem." While I am not opposed to capitalism, I question the integrity of these consulting firms' influence on economies and their genuine commitment to addressing the crises they have historically contributed to. Are they true agents of change — or simply opportunists capitalising on the green transition? For now, they appear to

be the latter: experts in progress, crafting circular claims that ultimately loop profits back to themselves.

Corporate methodologies

In a knowledge-based economy, selling expertise is understandable: "I know something you need; I'll tell you for a price." Firms like McKinsey, the Ellen MacArthur Foundation, and Accenture thrive on this model.

These firms set the circular narrative, whilst selling their guidance at a premium, naturally. While the advice from these consulting giants might benefit humanity, it's tailored to secure asymmetrical returns for themselves. Marketing, media representation, and public attention can become skewed, mirroring how powerful interests influence politics. The ones who shaped the circular economy concept now profit from steering it, wielding influence over the conversation and setting the bar for progress. As a result, industry norms and benchmarks often tilt in favour of the big players, with methodologies proving helpful for large corporations but potentially side-lining smaller, local enterprises. The homogenisation that follows risks eroding the nuance and decentralisation vital for a truly diverse circular economy.

There's also an issue with who gets to sit at the table of influence and change. It is well known that the big firms draw their hires from top-tier educational institutions and specific social circles, creating a self-perpetuating loop of homogeneous thinking and culture. This narrow pool of perspectives isn't conducive to advising on an economy that thrives on diversity. It is confusing and problematic: can we

trust the stewards of this movement to balance their profit motives with a sincere push for sustainability? Or does their narrow dominance dilute the diversity, innovation, and locality that the circular economy needs to flourish? Fundamentally, are these firms truly empowering the shift or simply capitalising on it?

Reflections

The circular economy is often presented as an unequivocal positive — a win-win solution for the planet with no apparent downsides. But when something seems too good to be true, it usually is.

What strikes me most are the gaps in the circular economy's origin story. Early thinkers like Boulding, Pearce, and Turner laid the groundwork decades ago, offering clear and robust insights. Their concepts weren't flawed, so why the delay in mainstream adoption? The answer lies in systemic resistance and the slow evolution of our economic values. The circular economy challenges entrenched profit-driven structures, requiring fundamental shifts in production and consumption that are far harder to sell than the superficial appeal of sustainability slogans.

So far, this compendium has examined some key principles of sustainable design and the circular economy. Given this, it is critical to confront a fundamental truth: while the circular economy is built on admirable principles, it has been fantastically spun into a narrative that often serves corporate interests more than environmental realities. Behind the glossy rhetoric of closed loops and perpetual renewal lies a system constrained by economic imperatives, physical limits, and societal inertia. Laws of physics, sunk investments and a variety of lock ins and paradoxes prevent a full realisation of the circular dream.

Despite my initial naïve optimism of the framework, I still believe designers play a pivotal role in any shift toward a more sustainable society. Not by blindly adopting corporate narratives but by questioning

and reshaping them. Concepts like adaptability, repair, and upcycling offer practical pathways that align with ecological realities rather than idealised visions of endless cycles. However, these strategies must be wielded with integrity, recognising the limits of resources, the inevitability of entropy, and the broader social and environmental contexts in which they operate.

The circular economy, as it's presented by its biggest proponents, often glosses over the complexities and realities of every day sustainable acts. Someone must do the repairs, order spare parts, understand the skills. Upcyciling at scale requires a change in physical and legal structures, the market interest, and so forth.

Instead of clinging to the fantasy of perpetual renewal, sustainable design must embrace a philosophy of sufficiency and stewardship. Quality, longevity, and adaptability are not just design principles but acts of resistance against a culture of disposability and greenwashing. They remind us that progress lies not in chasing endless growth but in cultivating deeper relationships with the objects, materials, and systems we depend on.

The path forward is neither simple nor easy. It requires reconciling idealism with realism, addressing entrenched systems, and challenging the narratives that dominate design and industry. So, if the circular economy has good foundations, but is presented poorly, what is the alternative? I think it is in rethinking the portrayal of the circular economy. Adjusting the form rather than the function. Thinking of circles, as spirals…

Spiral Economy

Why is the circular economy, as commonly understood, fundamentally unachievable? Beyond systemic lock-ins, boundary limits, and the Jevons paradox, the core issues lie in material entropy and material value. The prevailing narrative dismisses the laws of thermodynamics and efficiency findings, refusing to acknowledge the near impossibility of consistently reusing materials without degradation. The idea simply doesn't hold up.

The circular economy is always depicted as flat, a two-dimensional circle, looping on the same plane — the plane of value. This implies that materials can cycle endlessly without degradation, but we have established this isn't possible, this representation of the circular economy cannot exist in the real world.

Now, imagine taking that two-dimensional circle and giving it depth, transforming it into three dimensions. What looks like a circle from above becomes something different when viewed from the side.

The circle is revealed to be a *spiral economy*. Or the shape of a corkscrew, as coined by Nathalie Gontard — a respected research director at INRAE and a leading expert on packaging and polymers.

The spiral is not a perfect loop but a forward-moving trajectory with losses along the way and new material added. This is a truer model of the economy.

The Corkscrew Economy ~ Rethinking Plastic Recycling

Gontard, Nathalie. "Déchets plastiques : la dangereuse illusion du tout-recyclage." La Tribune, 29 Jan. 2018, https://www.latribune.fr/opinions/tribunes/dechets-plastiques-la-dangereuse-illusion-du-tout-recyclage-766498.html?id=2559249393989714

Salvo. 'Reiner Pilz. Thinking about a Greener Future.' Salvo, 10 1994, sec. Pg 11. https://www.salvoweb.com/files/sn99sm24y94tk181119.pdf

Gontard, Plastique, le grand emballement, 2020; The Conversation, 2018

Nathalie Gontard's work is centred around plastics, as reflected in the examples she provides. Her concept of the "corkscrew economy" (*économie tire-bouchon*) speaks about about the circular economy when thinking about the tragedy, and dishonesty of plastic recycling.

Gontard explains that plastics do not behave in the idealised manner of repeated recycling with minimal waste. With each cycle of reuse, recycling — or rather, downcycling — plastics degrade. Their chemical structures weaken and additives accumulate, meaning that a plastic bottle rarely returns to its original state. Instead, it is transformed into lower-value products — from clothing fibres to public benches — that will eventually deteriorate and become waste. The majority of plastic waste is repurposed into items that inevitably contribute to environmental pollution. As a result, the current system not only fails to reduce the production of new, virgin plastic but also creates a false sense of security, encouraging continued overconsumption

Gontard coined the term “corkscrew economy” to vividly illustrate this flawed process. The metaphor suggests that rather than closing a perfect circle, the recycling of plastic is more like a spiralling twist. With every loop, virgin plastic must be added to maintain material properties, while persistent waste continues to accumulate in the environment. This continuous extension contrasts starkly with natural biogeochemical cycles, such as the carbon cycle, where materials are fully reintegrated without loss of quality. Note the link here between Gontard’s vocabulary and that of Renier Pilz’s 1994 Interview: "I call recycling down-cycling. What we need is up-cycling, thanks to which old products are given a higher, not a lower, value.”

Moreover, Gontard warns that the recycling narrative often serves as a form of greenwashing. By reassuring the public that our plastic waste is being “recycled”, the system effectively removes the incentive to reduce plastic consumption. This, she argues, deepens our reliance on plastic while obscuring the long-term environmental and health risks posed by persistent microplastics and toxic additives.

Translated from French, Gontard writes of the “mirage of recycling” in le Tribune:

> **“ Only plastics such as PET (polyethylene terephthalate) bottles — which represent only a very small percentage of the plastics consumed — can comply with the constraints of closed-loop recycling and be regenerated for identical use.**

However, if one in two PET bottles in Europe is recycled, less than one in 10 will become a bottle again. For reasons of consumer safety (risk of contamination) and technological (different properties of the virgin polymer), the closed-loop recycling rate is thus extremely low; it can theoretically reach a maximum of 5% of used plastics."

To repeat, it can theoretically reach a maximum of 5% of used plastics. Absolutely not the optimism in technology and innovation I was hoping for. Thus, for plastic's at least, the reality is very much in considerably reducing usage, at least until there is a more prominent innovation in recycling.

From Corkscrew to Spiral ~ Reimagining Material Value

The corkscrew economy is a cycle that fails to close, continually necessitating the infusion of virgin material to keep the process going. Gontard relies heavily on plastic recycling to convey the concept, yet there is so much more.

I'd like to expand on the corkscrew idea, and begin by suggesting an alternative name as the spiral economy. I prefer the term spiral economy over corkscrew economy because it encapsulates a more dynamic and nuanced understanding of material value over time. Corkscrew conveys a relentless downward degradation. Spiral recognises that the journey of a material is not necessarily one-way. It allows for the possibility that value may be retained or even enhanced through restorative interventions such as innovative design, preservation, or cultural reappraisal. A broader perspective is an opportunity to nurture and recover value, making the term spiral economy a more comprehensive and hopeful framework.

The concept of a spiral economy treats every material as occupying a specific value position on a dynamic spiral. The pitch of the spiral — the vertical distance between consecutive loops — symbolises how rapidly a material's value diminishes with each cycle of use and reprocessing. A tight pitch suggests that a material, like aluminium, retains much of its

value through successive cycles; a wide pitch, on the other hand, is characteristic of materials such as nylon, which quickly lose their utility and depreciate steeply.

Crucially, the value position on the spiral is not a one-way descent. While Gontard's corkscrew highlights the inevitable decline of many recycled materials, the spiral framework recognises that an object's value is not fixed — it can be modified by external factors, positively and negatively. For example, at an object level, materials may even travel back up the spiral. Vintage furniture, rare clothing, and culturally significant artefacts can appreciate over time, their value enhanced by preservation, restoration, or simply the passage of time. Whilst the object continues up the spiral in value, so does the invidious materials it contains.

The Spiral ~ Fundamentals

At its core, the spiral economy rests on a few fundamental principles, already covered in this compendium. First, every material possesses intrinsic properties — its inherent durability, adaptability, and potential for reuse — that determine how much value it can retain or even enhance over successive cycles. This potential is not fixed; rather, it evolves with each iteration of use and reprocessing.

Second, every cycle represents an opportunity. While physical processes may degrade a material's quality, external interventions — be they considered design, careful restoration, or reinterpretation — can alter the trajectory, slowing down the loss of value or even pushing it upward on the spiral. In this sense, sustainable designs essence is actively nurturing and transforming value. Whatever, value may be.

Lastly, the spiral economy reminds us that material value is subject to both technical and social forces. It requires a holistic approach: technological advancements in recycling, supportive policies, and shifts in consumer behaviour all play a role in determining whether a material's cycle tightens or widens. By breaking the idea down into its basic elements — what a material can naturally do, how it changes over time, and how outside factors affect it — the spiral economy provides a flexible way to understand both the risk of losing value and the chance to regain it.

Anti-Entropic Actions

The inevitable wear, decay, or loss of quality in materials moves products closer to disorder, degradation or a less desirable state as time passes. As does our actions, losing objects, breaking them, or not disposing of them in the correct places. Taking actions to maintain or restore utility and value could be called 'anti-entropic'.

For designers, anti-entropic actions include strategies such as design for disassembly and modularity, repair, and refurbishment, using biodegradable and regenerative materials, developing advanced recycling and end-of-life processes, and implementing take-back schemes where manufacturers reclaim products to reprocess, refill, or remanufacture them. Upcycling is another strong example, as is designing objects that stand the test of time — both physically and aesthetically.

Something not yet placed in our compendium, is material reinforcement and additives. These are additives and alloys that improve the durability and quality of materials over their life, and during recycling. Examples of polymer additives are common: stainless steel, reinforced concrete and ceramic coatings are non-plastic examples.

For the consumer, anti-entropic actions are synonymous with care. Maintaining objects so they last a long time and repairing broken objects. If disposing of something, put it in the right bin — glass, card-

board, batteries, electronics etc. Prioritise second hand donations rather than throwing away; buy second hand rather than new.

Quality

Pirsig, Robert. Zen and the Art of Motorcycle Maintenance: An Inquiry into Values. HarperTorch, 2006

In *Zen and the Art of Motorcycle Maintenance*, Robert Pirsig redefines 'Quality' as a living concept, more than a standard to be met. For him, quality is the interplay of care and craftsmanship — a reflection of the integrity and attention one brings to a task. As he writes:

> **"Care and Quality are internal and external aspects of the same thing. A person who sees Quality and feels it as he works is a person who cares. A person who cares about what he sees and does is a person who is bound to have some characteristics of quality."**

Pirsig positions quality as a relationship — a dialogue between the maker, the object, and the world, woven through care and intention. In design, true quality goes beyond flawless execution or visual appeal. It encompasses aesthetics, functionality, ethics, longevity, and emotional resonance. True quality reveals itself in every detail: the choice of materials, the production method, and the underlying purpose, all of which connect objects to enduring values.

This relational perspective requires designers to go beyond technical precision or industry standards. To create with quality is to embody it. It is a commitment to craft something that matters, something that lasts in every sense: materially, functionally, and

emotionally. Sustainability and quality are inherently intertwined. To create with true quality means to consider an object's lifecycle, from sourcing materials to production, use, and eventual disposal or reuse. Thoughtful design choices — such as using renewable resources, working with local craftspeople, or designing for repairability — embody this commitment to a symbiotic relationship with the environment.

But I think quality's reach goes even further. It transcends the physical object and speaks to the experience it fosters. Objects designed with care and intention invite users into a relationship, encouraging them to value, maintain, and cherish what they own. In this way, quality becomes an antidote to disposability, inspiring a culture of respect and connection rather than exploitation and waste. True quality resonates emotionally, leaving an imprint that endures. It is fulfilling for both the maker and the user because it satisfies more than utilitarian needs — it satisfies the human need for meaning, for connection, and for beauty. When a designer infuses care and thoughtfulness into their work, the result is not just an object but an experience, a story, a legacy.

Philosophically, quality is a way of engaging with the world. It is a practice of mindfulness, where each action and decision are, is a matter of intention and respect. To create with quality is to foster a relationship — not just between people and objects, but between past and future, tradition and innovation, and humanity and nature.

Material ~ Agency

Material is imbued with meaning, both sentimental and cultural. Matter has agency. If enabling is central to the design ethos, then acknowledging the agency of matter — recognising it as something beyond a mere instrument for human ends — forms a crucial part of this philosophy. This approach requires a shift away from seeing material as inert. The traditional, linear economic, view holds that materials exist solely to be acted upon, shaped, and controlled. Seeing material as an active agent invites designers to recognise materials as participants in a dynamic exchange. Materials have unique characteristics, behaviours, and figurative voices.

When designers recognise that matter has agency, it transforms how they approach creation. Stone, wood, metals (even synthetic materials) are no longer passive; they 'speak' through their textures, limitations, resilience, and reactions to time and their relation to other materials. This approach is based on listening to materials rather than imposing upon them, allowing their qualities and idiosyncrasies to guide the design process. By embracing materials as active participants, designers move toward a collaborative process — design without a pre-ordained form. This is what upcycling's godfather, Pilz, suggested — design to suit the material available.

{ Glăveanu, Vlad Petre, Lene Tanggaard, and Charlotte Wegener, eds. Creativity — A New Vocabulary. London: Palgrave Macmillan UK, 2016. https://doi.org/10.1057/9781137511805

This view aligns with an understanding that matter, like ecosystems, has its cycles, tendencies, and ways of interacting with its surroundings. Therefore, design — made of matter — like ecosystems, has its cycles, tendencies, and ways of interacting with its surroundings. We come to understand that ‘timeless design’ is not possible.

Viewing materials as active agents — shaping and shaped by their contexts — is the first step toward practices such as preservation, repair, refurbishment, and reclamation. I favour the term 'active' over 'valuable' because 'value' often implies financial worth and it implies that some parts of the world have no value. Yet, a material or object might deserve saving for cultural, sentimental, or other non-economic reasons, it may have affordances outside of human considerations altogether, making 'active' a more inclusive and fitting descriptor.

Craft

I've come to realise that increasing artistry is a profound path to sustainability. This is my craft enlightenment: the answer lies in craft. Quality is an artistry, a form of craft.

Artistry is creativity, curation, and craftsmanship combined with a deep respect for materials. It prioritises quality and longevity over speed and volume. Artistry is about precision, care, and understanding the inevitable passage of time — accepting that steel will rust, paint will chip, and wood will warp. It is not about resisting these changes but working with them.

Artistry lives in the act of making and the art of maintaining. It's found in a well-thumbed maintenance manual, the fine grit of sandpaper, and tubs of grease. It reveals itself in the repair of old chairs, where the effort and skill of preservation become a modern artistry. This effort, in turn, honours ancient artistry: the craft of repairing what others have created, preserving its utility and spirit.

Artistry is stewardship. It's about consciously selecting materials — local, natural, and sustainable — and valuing their inherent characteristics, their origins, and their eventual destinations. It's about elevating the ordinary, finding beauty in the daily, and recognising that artistry is not in extravagance but in the well-made and mindfully designed.

Craft is an answer. Not just as a practice, but as a philosophy — a way to engage with the world responsibly, creatively, and sustainably.

Yet, amidst this pursuit of artistry lies a paradox in the messy relationship between art, craft, and industrialisation. On one hand, industrial mass production has democratised access to well-made goods for the less privileged, offering functional objects at affordable prices. On the other hand, the true craft — the kind that is steeped in heritage and meticulous care — often becomes the exclusive preserve of those with the means to afford bespoke pieces. This divide underscores a tension: while mass production can serve as a bridge to quality for many, it sometimes dilutes the rich, nuanced essence of craft that bespoke objects carry. Reconciling these differing paths remains a challenge, inviting us to seek a balance where sustainability, accessibility, and true artisanal excellence coexist.

Tractors ~ Mechanical Design

I have a fondness for old tractors. They're mechanically straightforward, easy to understand, maintain, and repair. I once fixed my cousin's old Ford tractor, a simple engine with basic parts.

Tractors built before 1980 are currently a 'hot commodity' at auctions in America. Modern, post 1970s tractors, are loaded with electronics and endless features. Diagnosing problems has become complex, requiring specialised tools and experts, which drives up costs and increase frustration. Many modern tractors are fitted with encrypted systems that shut down if tampered with by non-authorised users. This sparked the Right to Repair lawsuit against the agricultural machinery manufacturer John Deere. While Deere has since allowed more (though not full) access, many farmers still prefer the simplicity of older mechanics, allowing them to maintain their equipment themselves without relying on costly repairs.

Mechanical designs resist obsolescence. They invite interaction and build skills that last a lifetime. This encourages a DIY culture, where completing a job brings satisfaction, pride and care (an emotionally durable relationship with an object) — *quality*.

{ National Agricultural Law Center. 'Update on Right-to-Repair', 7 November 2023. https://nationalaglawcenter.org/update-on-right-to-repair/

In the age of the Internet of Things, everything is going online, but not everything needs to be digital. Smartphones are useful, but my fridge doesn't need WiFi. I still use a 1970s Moccamaster because coffee machines used to be simple. My car once had twisty plastic dials, and now adjusting the AC feels like operating a spaceship. Even bicycle gears are wireless now — completely unnecessary when a cable was perfectly fine. Simple mechanics are lacking in modern, digitised design. Simple mechanics are a lost joy.

Timelessness

Timelessness is a pursuit for many designers and is often regarded as the highest achievement in object creation. Designing something that transcends fleeting trends and resists the cycles of taste speaks to a broader vision of sustainability. Timelessness is the antithesis of the disposable, the opposite of planned obsolescence. The concept itself — time-less-ness — implies a state of existing without the decay of fashion or functionality, resisting change and limiting the effects of entropy.

When we say an object is timeless, we usually mean it doesn't fall victim to trend-based shifts, the seasonal winds that push objects in and out of relevance.

What we associate as timeless principles like the golden ratio, fractal geometry, the rule of thirds, and symmetry are culturally specific. While they are often presented as universal, their relevance varies across cultures.

For instance, the golden ratio has roots in Western aesthetics and mathematics, but it might not hold the same importance in other design traditions, such as Japanese wabi-sabi, which values imperfection and asymmetry. Similarly, the rule of thirds, a staple in Western art and photography, isn't a universal guideline and may not align with visual traditions prioritising balance or narrative over strict proportions.

Thus, the concept of "timeless aesthetics" is not universal but reflects the cultural values and aesthetic norms of the time and place where it's conceived. A design may feel "timeless" to one culture while appearing irrelevant or alien to another. This suggests that timelessness is less about specific principles and more about creating objects deeply resonant with their cultural and environmental contexts. In that sense, "timeless" might be better reframed as "enduring"—rooted in connection rather than rigid rules.

If timelessness is not purely about appearance, functionality plays a large role. Objects that are adaptable, repairable, or upgradeable achieve a form of durability that transcends the aesthetic. Think of the cast iron skillet, the bicycle, the hammer — each designed to last, not just in material but also in purpose. Their form and function are distilled over centuries where the object remains largely unchanged. This duality — detachment from trends and functional permanence — creates objects that are not just made for today but for generations. In this way, creating enduring or culturally timeless pieces is a design ethic. It asks designers to consider whether their work will survive both the judgment of taste and the wear of time.

Timelessness ~ Re-domestication

{ Wallner, Theresa S., Lise Magnier, and Ruth Mugge. 'An Exploration of the Value of Timeless Design Styles for the Consumer Acceptance of Refurbished Products'. Sustainability 12, no. 3 (January 2020): 1213. https://doi.org/10.3390/su12031213

{ Flood Heaton, Rachel, and Deana McDonagh. 'Can Timelessness through Prototypicality Support Sustainability? A Strategy for Product Designers'. The Design Journal 20, no. sup1 (28 July 2017): S110–21. https://doi.org/10.1080/14606925.2017.1352671

The concept of timelessness in design, particularly in the re-domestication of forgotten objects, is not purely about aesthetics — it is about cultural relevance and resonance. Wallner, Magnier, and Mugge's in-depth interviews with 21 participants from different socio-economic backgrounds and ages (28–76) reveal that objects with neo-retro or simplistic styles, especially electronics, are more appealing when refurbished to align with contemporary tastes. This distinction is key: refurbished designs reimagine objects for today, while restored designs recreate their original state. The former engages with renewal and adaptation, while the latter is tethered to preserving history.

Flood, Heaton, and McDonagh expand on this, exploring subjective qualities such as 'exceptional beauty' and 'nostalgia evoking'. However, these attributes are far from universal; they shift across eras, cultures, and individual experiences. Nostalgia, though compelling, may anchor objects too firmly in the past, challenging their ability to remain adaptable across different contexts. Similarly, minimalism — often lauded as "timeless"—risks being perceived

as culturally neutral or even austere, eroding its connection to specific identities and traditions. True timelessness cannot exist without recognising its cultural specificity and the ways in which it evolves.

Timelessness, then, is not about universal permanence or erasing cultural nuance. Instead, it reflects a balance between enduring qualities and cultural fingerprints. Designers play a critical role in crafting objects that resonate within their time and place while remaining adaptable to future contexts. Adaptability ensures that objects can be cherished in their present form, evolve as needs shift, or be responsibly re-domesticated — or even discarded — when their relevance fades.

Ultimately, timelessness anchors objects in a continuum of cultural and material relevance. By balancing rootedness in their origins with the flexibility to adapt, timeless designs contribute to a sustainable, meaningful legacy. This approach honours the cultural and temporal specificity of timelessness while embracing its dynamic potential.

Collecting ~ Top to Bottom

To not be hypocritical, given my own critique of the circular economy, the downside should be acknowledged. What implications does my speculative spiral economy bring that need attention?

As materials retain value for longer, business practices will adapt. Already ownership is shifting from consumers to companies. From big objects like sharing cars to small objects like glass bottles. As seen in the rise of deposit schemes where beverage companies maintain ownership of bottles. Essentially, companies are becoming resource banks, leasing services while retaining ownership of the materials.

My key questions are:

In a world driven by profit and control:

Q: Who controls material flow?

A: Often large corporations with resource monopolies.

Q: Who paces material flow up and down the spiral?

A: Companies that own and manage material stock.

Q: Who stockpiles material at certain value thresholds?

A: Entities aiming to influence market value and strategic supply.

Q: What happens when one company controls a significant share of a material?

A: They gain market leverage, influencing supply and prices. If one individual can control such a company, their influence can extend to a monopolistic hold over a key resource.

We already see parallels in the financial world. If materials increasingly gain value, we might face a scenario where one company could control the world's wood supply, or a single recycler could monopolise the aluminium. Even if that aluminium resides in physical objects — such as your bicycle — you could own the bicycle, but the aluminium may be owned by *World AluCycling Ltd*.

Just as in financial markets, if a company owns a significant share of a material, it can shape market dynamics, control supply, and dictate prices, echoing the power held by central banks and federal reserves. The rise of material monopolies would alter economies, and the very essence of ownership and usage rights.

Parallels ~ Financial Markets

Just as you might own stocks, you could own reserves of aluminium or lithium. Known as Commodities. However, a shift in value dynamics of commodities is worth considering, and the rollercoaster that comes with it.

Inflated investor expectations can lead to corrections in the stock market. Will we experience similar material value corrections in a commodities market?

Imagine a scenario where Tesla holds 80% of the world's lithium supply, which they lease through consumer battery schemes. Though consumers use the batteries in their cars, Tesla retains ownership of the lithium, anchoring significant company value to this resource. Now, imagine a technological pivot to sodium batteries that renders lithium less valuable. The drop in lithium's worth would directly impact Tesla's valuation, possibly causing a drastic fall in its share price. What happens next?

The deeper threat is clear. If a company controlling critical resources becomes 'too big to fail', its collapse could trigger systemic repercussions. Mauritius, a circular economy blogger and Energy Transition lead at Gemeente Haarlemmermeer, cautions against allowing concentrated resource control. He draws parallels to the 2008 banking crisis, when excessive speculation and risk exposure led to a financial meltdown. The political clout and economic weight of

banks compelled governments to intervene. Governments bailed out banks, causing heightened social and financial pressures in subsequent years.

If such a company is too big to fail, what happens when it does? There are substantial risks associated with the private accumulation of critical materials. If major actors stockpile and monopolise essential resources, their failure could destabilise the economy, much like the banking system did.

Mauritius points out that while we strive for sustainable solutions to meet fundamental needs, we must be vigilant in preventing organisations from becoming indispensable to the point where their downfall jeopardises the entire economic framework.

> **"That we are about to roll into a generally accepted system of which the derivatives and dependencies are not incalculable. Sounds familiar? Indeed, that happened as well in the system that we are getting out of and of which the most recent crisis was its result. That was an economic system in which banks became too big to fail. And when they did fail they either went bankrupt, and many lost their savings (Lehman), or they were saved by states through loans and debts causing increased taxes and social pressure. Especially when we want to keep meeting our physical needs (food, shelter, healthcare, mobility) in a sustainable**

way, we should prevent that organisations on key positions within that economic system become too big to fail."

Conclusion

Reframing the circular concept to a spiral economy provides a more realistic and dynamic understanding of material flows and value. While a circular economy suggests a perfect loop where materials endlessly cycle without loss, a spiral economy recognises that each cycle involves changes — both in material quality and in the energy required for reuse.

To begin, a spiral economy reflects the reality that materials degrade over time due to wear, contamination, or entropy. Unlike a perfect circle, which ignores these losses, a spiral acknowledges that the pitch of each loop may be narrower, requiring innovation to preserve value or redirect materials into new applications or indeed back up the spiral.

A spiral introduces the idea of progression or evolution. Materials and processes don't endlessly repeat in the same way — they adapt, evolve, and change over time. For instance, materials might transition from high-value uses to lower-value applications before ultimately being reabsorbed into the biosphere or disposed of. This dynamic flow mirrors natural systems, where cycles are never truly closed but are regenerative.

This reframing may also stimulate more realistic design solutions. The thinking in spirals encourages designers to account for inevitable losses and inefficiencies. It also includes designers considering where the material they choose currently sits on the spiral; are they utilising material at the top of its spiral or halfway down the journey?

Rather than merely maintaining materials in an endless loop, a spiral economy emphasises regeneration. Energy inputs, resource replenishment, and innovation become key drivers to keep objects travelling up and down their spirals. This approach aligns more closely with circularity's original goals, but with a dose of practical realism. Acknowledging that actions require energy.

The circular economy often feels utopian, suggesting that waste can be eliminated entirely. A spiral economy, by contrast, integrates the imperfections and challenges of the real world. It retains the aspiration of circularity while providing a more feasible framework for implementation. Of course, it is not without challenges, material collection and monopolisation. The challenges also faced by the circular economy such as wider adoption, legislation, greenwashing, and infrastructure requirements. However, by adopting a spiral metaphor, we can move beyond the oversimplified and misleading narrative of the circular economy. It allows for a more honest, adaptive, and resilient model — one that reflects the complexities of material flows, the realities of entropy, and the need for ongoing regeneration. A spiral economy offers a clearer and more accurate path toward sustainable practices that align with both ecological limits and human ingenuity.

Colophon

Author

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MetaAccanthisAlternate by Amélie Dumont (with custom emdash, **Caladea** by Andrés Torresi and Carolina Giovanolli, PT Sans by ParaType

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Circles to Spirals is a designer's journey from blind optimism to critical engagement, from circular economy idealism to the pragmatic realities of material flow. This compendium navigates the essential concepts of sustainable design — repair, upcycling, adaptability, and longevity — while unpicking the promises and pitfalls of circularity.

Ollee Means explores the myth and reality of the circular economy, questioning whether waste can ever be truly designed out of the system. With sharp analysis and personal insight, he proposes an alternative: the *spiral economy*, a model that acknowledges material entropy, value shifts, and the role of design in prolonging utility.

A thought-provoking and engaging read for designers, makers, and anyone curious about the intersection of craft, sustainability, and economic reality.