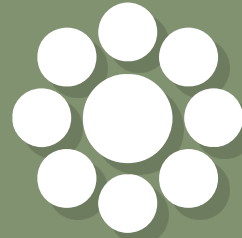


# Waste is a Design Flaw

UVA Sustainability Guest Speakers - Week 6



# Attendance





# Cville TimeBank Repair Café

Don't toss it – FIX it!

## Toss it? No Way! FIX IT!

At a Repair Café, folks bring their broken stuff to be repaired by volunteers for free. It's a fun, friendly way to keep perfectly good stuff out of the landfill and spend some quality time together as a community.

## Don't toss it. FIX it!

Chairs. Fans. Lamps. Toasters. In the Charlottesville area, these are the things most likely to end up in the trash when they break. Let's make them useful again!

## When's the next event?

Charlottesville's Repair Café program is paused until 2024.

Sign up for our mailing list so you don't miss it!

Stay in the loop: [Click here to join the Repair Café mailing list.](#)

**Please do NOT bring:**

**Computers – Phones – Gas engines – Microwaves – Televisions**

# Today's Agenda



1

TEAR DOWN  
DISCUSSION

2

SAFETY

3

DISASSEMBLY

# Course Objectives



- **Learn how waste creation is designed into our linear economy**
- **Understand engineering frameworks for designing “out” waste and designing with waste**
- **Explore what main components make up electronics and how to work them**
- **Create a Circular Engineering outline for an E-waste product**

# Hobbyist Teardown Analysis



Find a teardown of your selected e-waste (or a product like it)

Discuss the

- Expertise needed
- Tools needed
- Time and effort
- Parts of interest
- General list of parts you see extracted

Identify an aspect of the design that made the disassembly more difficult for the user

# E-waste Disassembly and Parts List



Please reflect on your hands-on disassembly and how it compared to the one you found online

List out all components that are recovered (more specific the better, can be for a specific model)

Tools required

Expertise needed

Briefly note any design areas that created difficulty or added ease to your teardown

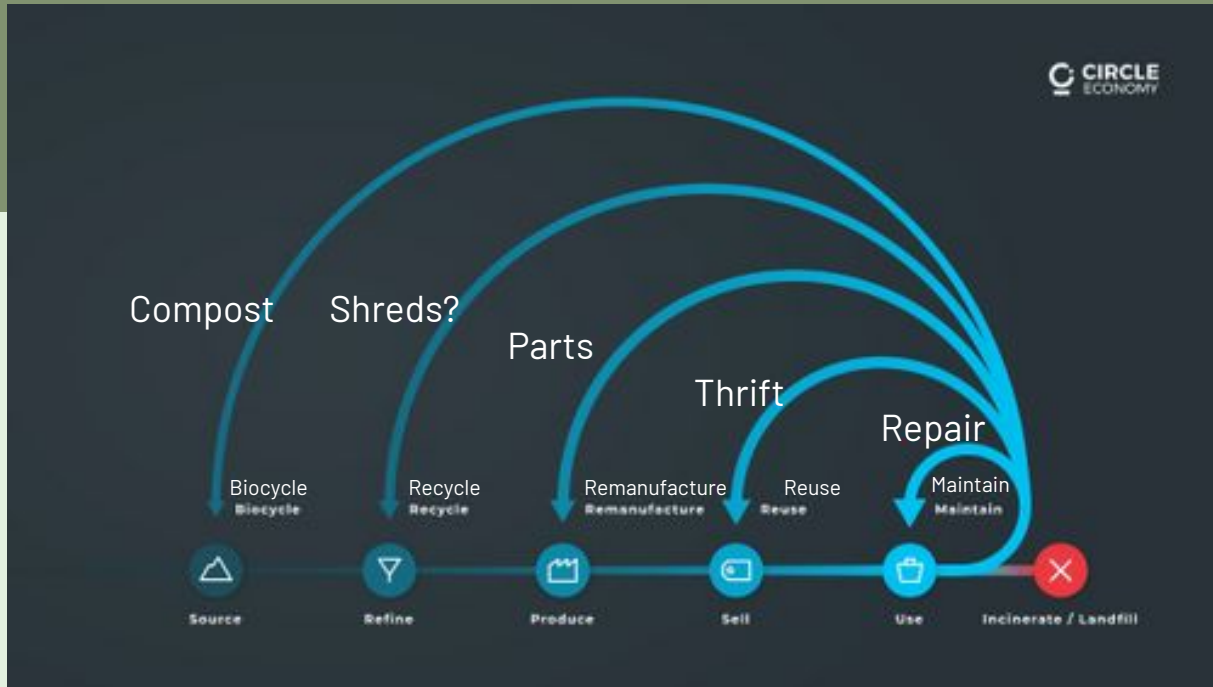


## E-waste lifecycle

1. When a device becomes waste
2. How a device becomes waste
3. Available waste streams

# CIRCULAR ECONOMY

Common Language for reintegration process



# HOW TO REDUCE E-WASTE





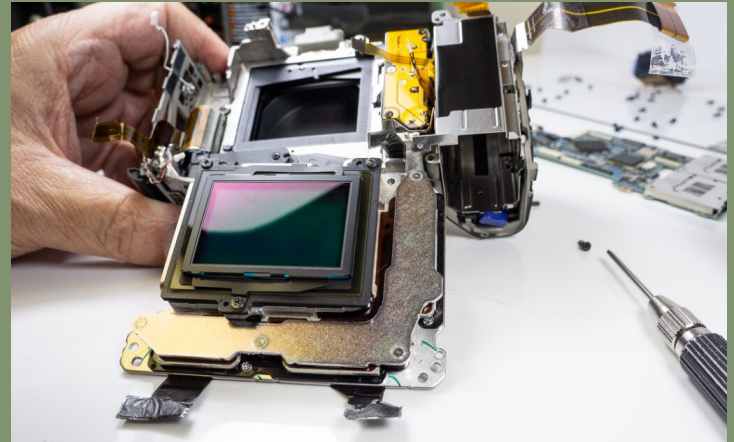
## HOW TO REDUCE E-WASTE

1. Designing devices so they don't become waste (**Pre-waste**)

2. *Turning waste into material streams (Post-waste)*

# What did you find interesting about your disassembly?

- How hard did it look?
- Could you put it back together after?
- Any cool components you wanna use?
- Are you confused about the tear down in any way?



# Disassembly Safety

1. Glasses
  - a. ALWAYS.
2. Gloves
  - a. Recommended when prying, handling devices with ink/oil, generally a good call
3. Masks
  - a. Needed for soldering, recommended for devices with ink/oil
4. Electricity
  - a. Products may hold a charge for weeks after they are unplugged. Gloves assist in reducing risk of shock. Let products sit for a month to de-charge
5. Breaking
  - a. Many pieces are glued, mechanically connected, or stuck. You may need to break an item so aim to limit destruction with prying tools (flat head screwdriver)
  - b. You may (not today) need to melt/saw a product





Thought for the class:

**“Any idiot can take things to bits; putting them back together again is what counts.”**

**This was how my ever-present muse, James May, described his new BBC4 show, James May: The Reassembler in the publication RadioTimes.**

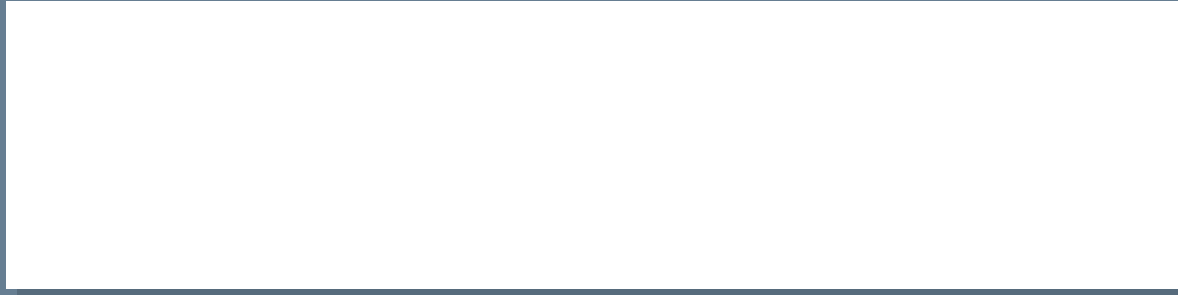
**This three-series special features May’s meticulous passion for learning how things work, and sharing his love for ingenuity with others, as he takes the “bits” and pieces from everyday items like a lawnmower, old-school rotary telephone, and (the one I am most eager to see), an electric guitar and reassemble them – in working order.**

Recommended Media:

James May: The Reassembler (youtube)



# Appendix Slides



# Sustainable Design (Pre-Waste)

Hardware

Software

System



What is your process of identifying a principle of sustainable design?



## Sustainable Design

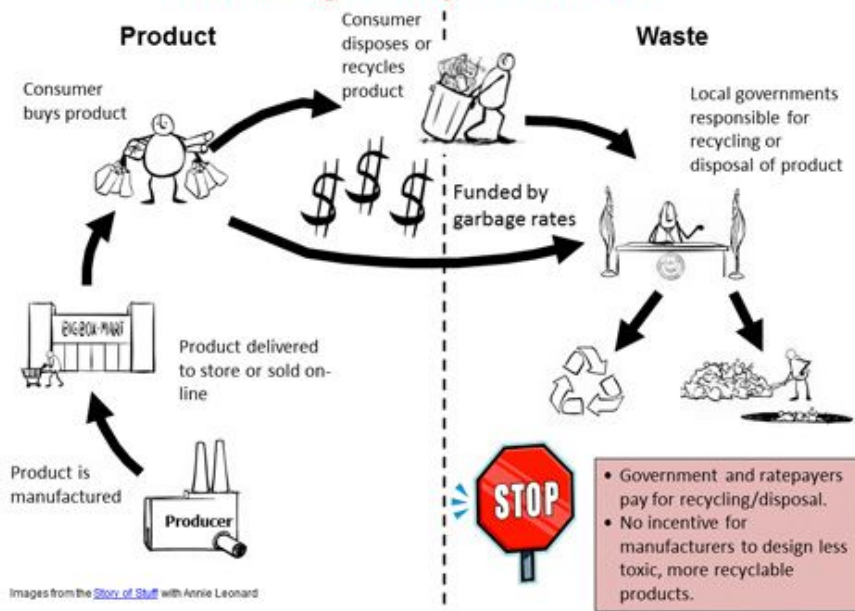
[ sə-ˈstā-nə-bəl di-ˈzīn ]

A design approach that seeks to minimize negative environmental, social, and economic impacts.

# Sustainable Design

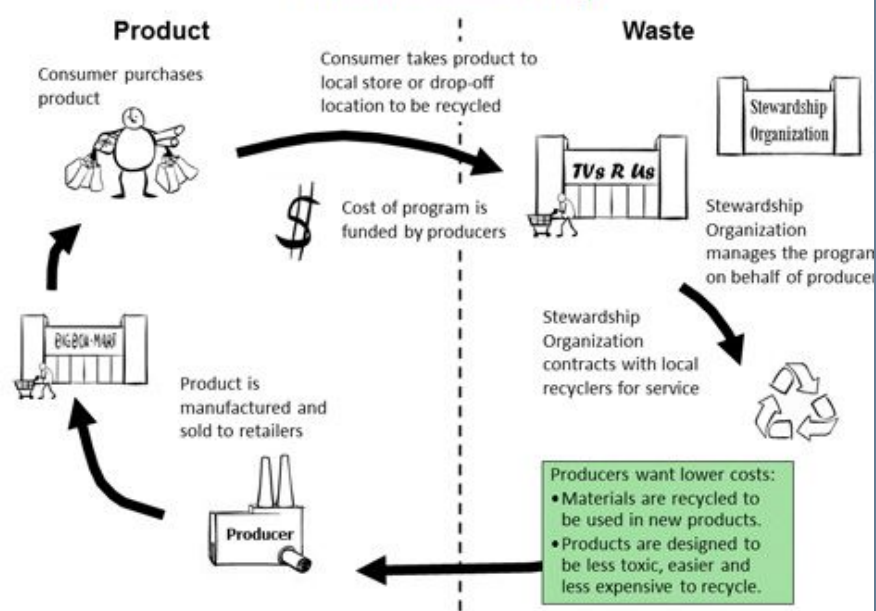
## Product Stewardship

### Waste Management System in the U.S.



- Government and ratepayers pay for recycling/disposal.
- No incentive for manufacturers to design less toxic, more recyclable products.

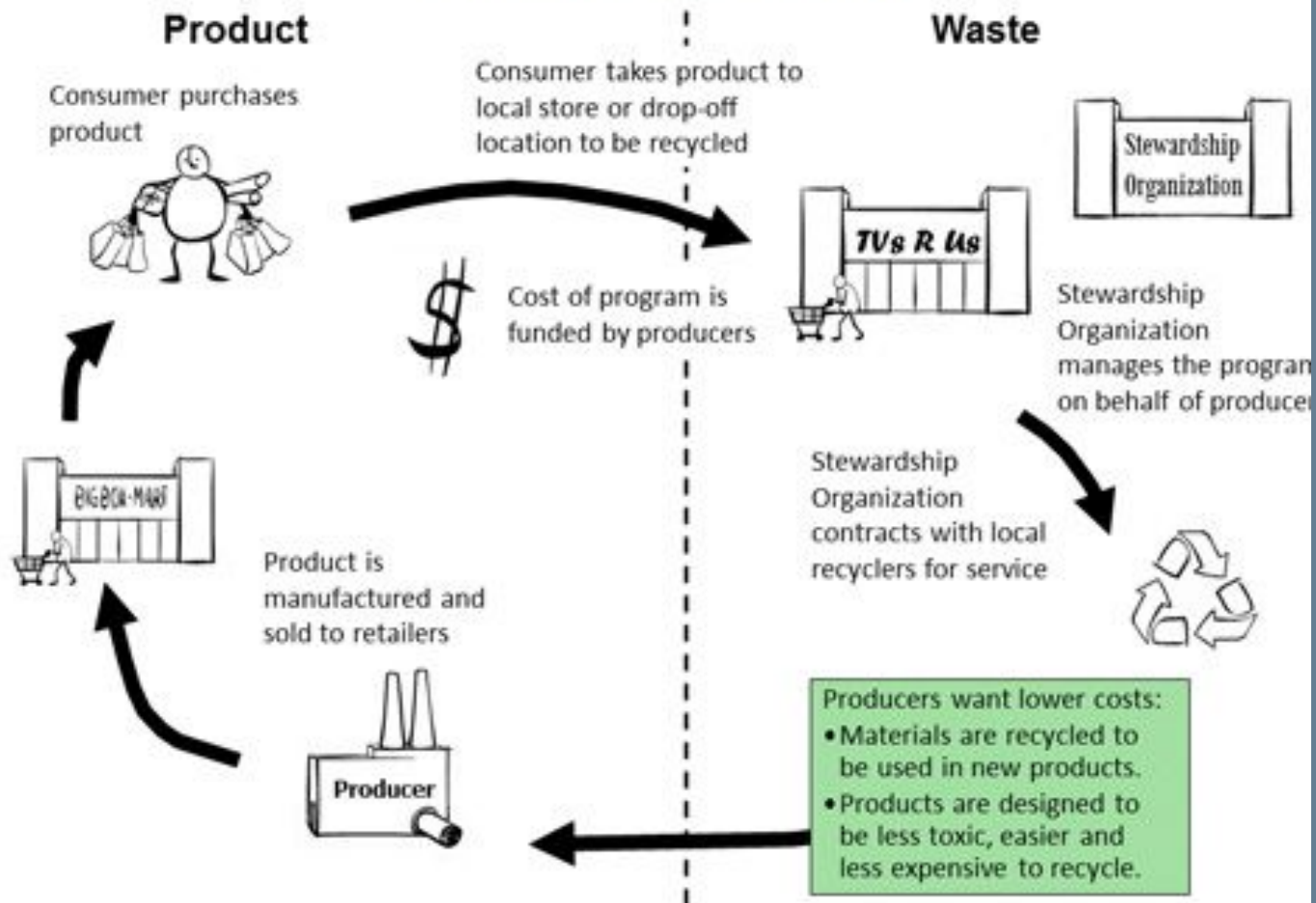
### Product Stewardship

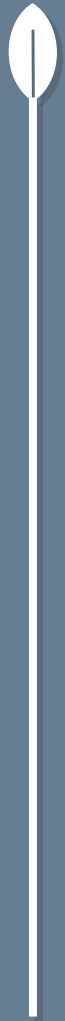


## Waste Management System in the U.S.



# Product Stewardship





## Product Stewardship

Companies design products WITH  
an end-of-life plan.

How?

# Product Stewardship



## The 12 Principles of Green Engineering

- Principle 1:** Designers need to strive to ensure that all material and energy inputs and outputs are as inherently nonhazardous as possible.
- Principle 2:** It is better to prevent waste than to treat or clean up waste after it is formed.
- Principle 3:** Separation and purification operations should be designed to minimize energy consumption and materials use.
- Principle 4:** Products, processes, and systems should be designed to maximize mass, energy, space, and time efficiency.
- Principle 5:** Products, processes, and systems should be “output pulled” rather than “input pushed” through the use of energy and materials.
- Principle 6:** Embedded entropy and complexity must be viewed as an investment when making design choices on recycle, reuse, or beneficial disposition.
- Principle 7:** Targeted durability, not immortality, should be a design goal.
- Principle 8:** Design for unnecessary capacity or capability (e.g., “one size fits all”) solutions should be considered a design flaw.
- Principle 9:** Material diversity in multicomponent products should be minimized to promote disassembly and value retention.
- Principle 10:** Design of products, processes, and systems must include integration and interconnectivity with available energy and materials flows.
- Principle 11:** Products, processes, and systems should be designed for performance in a commercial “afterlife”.
- Principle 12:** Material and energy inputs should be renewable rather than depleting.

# Through *the* **12 Principles** **GREEN** *Engineering*

Let's make a memorable summary phrase/word for each principle so they can be easily referenced

We will also go through any questions you all have on the principles for how to implement and what they mean.

We will be testing Miro for this, so please go to the announcements page on Collab



## The 12 Principles of Green Engineering

**Principle 1:** Designers need to strive to ensure that all material and energy inputs and outputs are as inherently nonhazardous as possible.

**Principle 2:** It is better to prevent waste than to treat or clean up waste after it is formed.

**Principle 3:** Separation and purification operations should be designed to minimize energy consumption and materials use.

**Principle 4:** Products, processes, and systems should be designed to maximize mass, energy, space, and time efficiency.

**Principle 5:** Products, processes, and systems should be “output pulled” rather than “input pushed” through the use of energy and materials.

**Principle 6:** Embedded entropy and complexity must be viewed as an investment when making design choices on recycle, reuse, or beneficial disposition.

**Principle 7:** Targeted durability, not immortality, should be a design goal.

**Principle 8:** Design for unnecessary capacity or capability (e.g., “one size fits all”) solutions should be considered a design flaw.

**Principle 9:** Material diversity in multicomponent products should be minimized to promote disassembly and value retention.

**Principle 10:** Design of products, processes, and systems must include integration and interconnectivity with available energy and materials flows.

**Principle 11:** Products, processes, and systems should be designed for performance in a commercial “afterlife”.

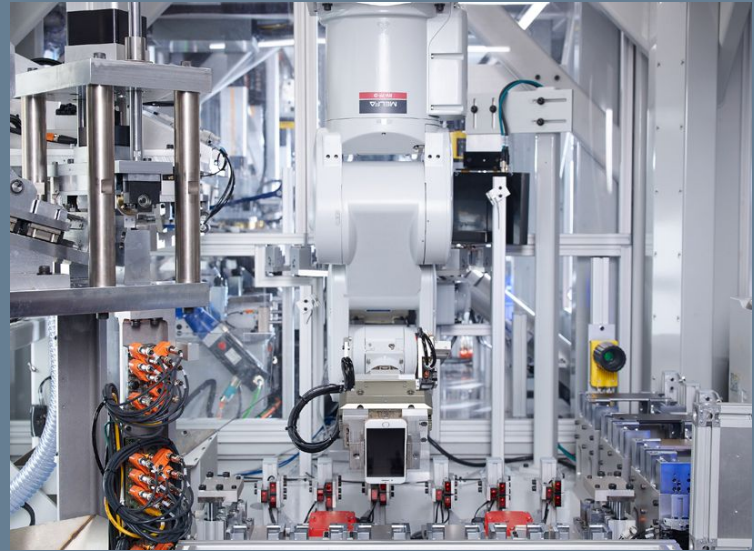
**Principle 12:** Material and energy inputs should be renewable rather than depleting.

---

# Examples of Product Stewardship

## Apple Recycling their Own Phones

- How? What is the success rate?
  - What defines success?
  - What feels fishy?
  - What would you want to see?





Store

Mac

iPad

iPhone

Watch

Vision

AirPods

TV & Home

Entertainment

Accessories

Support



## Environment

[2023 Report \(PDF\)](#)



Carbon Neutral

**A first for Apple.  
A major step toward 2030.**



---

# Examples of Product Stewardship

## Apple Recycling their Own Phones

- How? What is the success rate?
  - What defines success?
  - What feels fishy?
  - What would you want to see?

## Refill Products

## Modular Products

## Recyclable Products (?)

---

---

# Sustainable Design with Waste (Post)

Input pushed design.



---

## **Sustainable Design with Waste (Post)**

Input pushed design.

We can identify waste streams and reorient them so the “waste” becomes a material input for a new product/process!

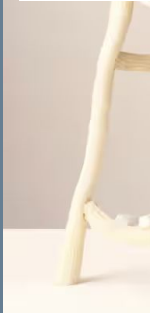
---

---

# Sustainable Design with Waste (Post)

Simone Post - Post Adidas

## The age of waste: five designers modelling a 'circular economy'





## Finix Citrus Fiber

Finix Citrus Fiber is a fiber with nutritional value that fulfills technical functions in food, such as thickener, binder, emulsifier, and water retention.

It is a powder with no orange smell or taste, making it widely applicable in food products as well as non-food products.



## Five Fold Oil

Five Fold Oil is concentrated orange oil that can provide food and personal care products with a delicious orange aroma.



## Cold Pressed Oil

Cold Pressed Oil is pressed directly from the orange peel and purified with minimal further processing.



## D-Limonene

D-Limonene is a degreasing and natural solvent that is used to make cleaning products, among other things.



## We keep developing

In our (in-house) innovation lab we are constantly doing research on what more ingredients we can extract from citrus peel. In addition, we also carry out various tests to build knowledge on the functionality of our ingredients in the different applications. There is still so much potential! We continue to develop together with our partners.



## Orangeade

When everything has been removed from the orange peel, the peel is cut into cubes. When the cubes are dried, they become Orangeade. This

## Finix Citrus Fiber

Finix Citrus Fiber is a fiber with nutritional value that fulfills technical functions in food, such as thickener, binder, emulsifier, and water retention.

It is a powder with no orange smell or taste, making it widely applicable in food products as well as non-food products.

## Five Fold Oil

Five Fold Oil is concentrated orange oil that can provide food and personal care products with a delicious orange aroma.

## Cold Pressed Oil

Cold Pressed Oil is pressed directly from the orange peel and purified with minimal further processing.

## D-Limonene

D-Limonene is a degreasing and natural solvent that is used to make cleaning products, among other things.

## We keep developing

In our (in-house) innovation lab we are constantly doing research on what more ingredients we can extract from citrus peel. In addition, we also carry out various tests to build knowledge on the functionality of our ingredients in the different applications. There is still so much potential! We continue to develop together with our partners.

## Orangeade

When everything has been removed from the orange peel, the peel is cut into cubes. When the cubes are dried, they become Orangeade. This

---

# Sustainable Design with Waste (Post)

Input pushed design...

AND output pulled.

Recycling with a purpose vs. making to use. We should design products to serve a purpose.

The designed product  
life-cycle should be



---

# What to make with waste?

Ship of theseus

- Aluminum cans, glass bottles, clothing, etc.

New products!

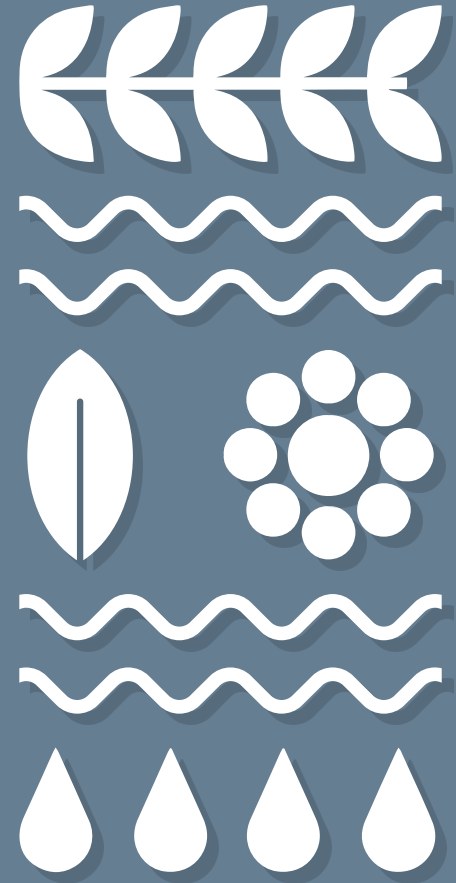
- Creating an existing product out of sustainable materials (cheaper and sustainably sourced)
- Identifying community need
- Fun!



How do you envision how your product can be reused/refurbished rather than recycled in this “grinding” technique?

What limits do you see?

How could you see your product redesigned so it is more easily repaired, reused, recycled?



## The 12 Principles of Green Engineering

- Principle 1:** Designers need to strive to ensure that all material and energy inputs and outputs are as inherently nonhazardous as possible.
- Principle 2:** It is better to prevent waste than to treat or clean up waste after it is formed.
- Principle 3:** Separation and purification operations should be designed to minimize energy consumption and materials use.
- Principle 4:** Products, processes, and systems should be designed to maximize mass, energy, space, and time efficiency.
- Principle 5:** Products, processes, and systems should be “output pulled” rather than “input pushed” through the use of energy and materials.
- Principle 6:** Embedded entropy and complexity must be viewed as an investment when making design choices on recycle, reuse, or beneficial disposition.
- Principle 7:** Targeted durability, not immortality, should be a design goal.
- Principle 8:** Design for unnecessary capacity or capability (e.g., “one size fits all”) solutions should be considered a design flaw.
- Principle 9:** Material diversity in multicomponent products should be minimized to promote disassembly and value retention.
- Principle 10:** Design of products, processes, and systems must include integration and interconnectivity with available energy and materials flows.
- Principle 11:** Products, processes, and systems should be designed for performance in a commercial “afterlife”.
- Principle 12:** Material and energy inputs should be renewable rather than depleting.

# Through *the* 12 Principles **GREEN** *Engineering*

Let's make a memorable summary phrase/word for each principle so they can be easily referenced

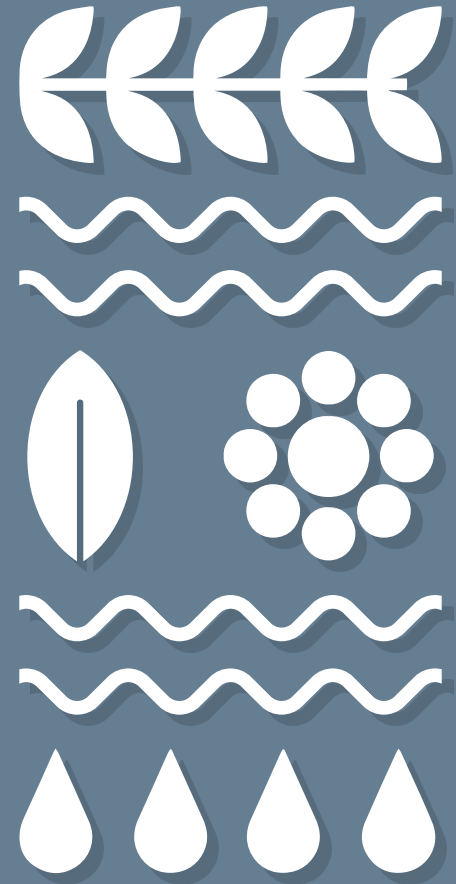
We will also go through any questions you all have on the principles for how to implement and what they mean.

We will be testing Miro for this, so please go to the announcements page on Collab

That means each year we waste 90 billion tons of resources. This also means that we create 90 billion tons of potential resources.

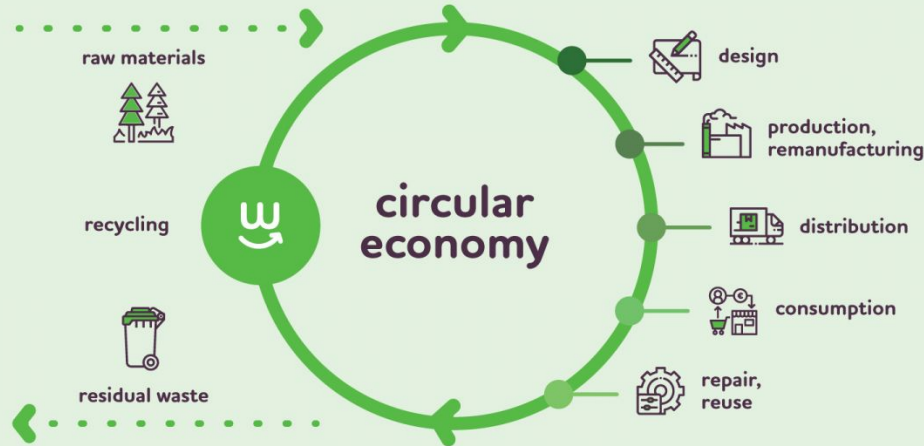
The current dominant economy is linear in its processes: it takes resources, makes goods, and quickly wastes them.

**-CIRCLE REPORT, 2021**



# CIRCLE ECONOMY

The circular economy is an economic system where waste is designed out, everything is used at its highest possible value for as long as possible and natural systems are regenerated.



# These 2 will be our main focus



## USE **WASTE** AS A RESOURCE

Utilise waste streams as a source of secondary resources and recover waste for reuse and recycling.



## **STRETCH** THE LIFETIME

While resources are in-use, maintain, repair and upgrade them to maximise their lifetime and give them a second life through take back strategies when applicable.

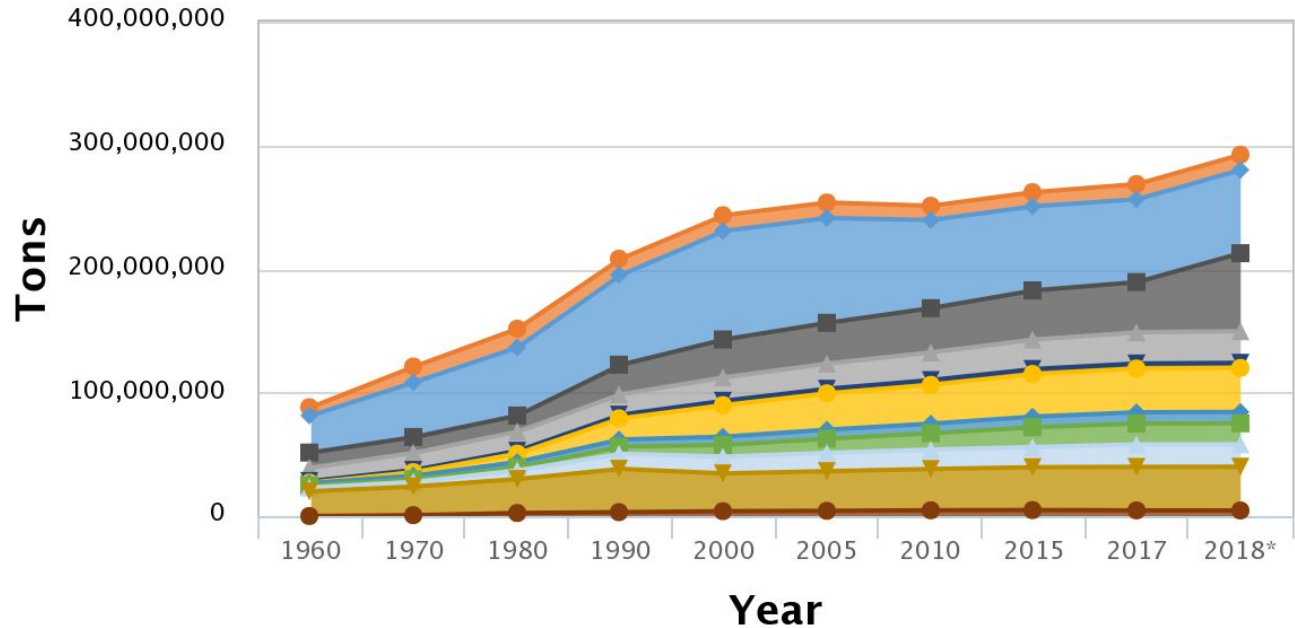


# Class Naming Convention of 12 Principles

1. Safety First
2. Prevention
3. Low resource separation and purification
4. Optimization
5. Limit Extraneous thinking
6. Hard Work to Salvage Gold
7. Realistic Design Goals (Durability)
8. Necessary design
9. Minimize material diversity
10. Integration and interconnectivity of resources
11. Long-term designing
12. Renewable sources

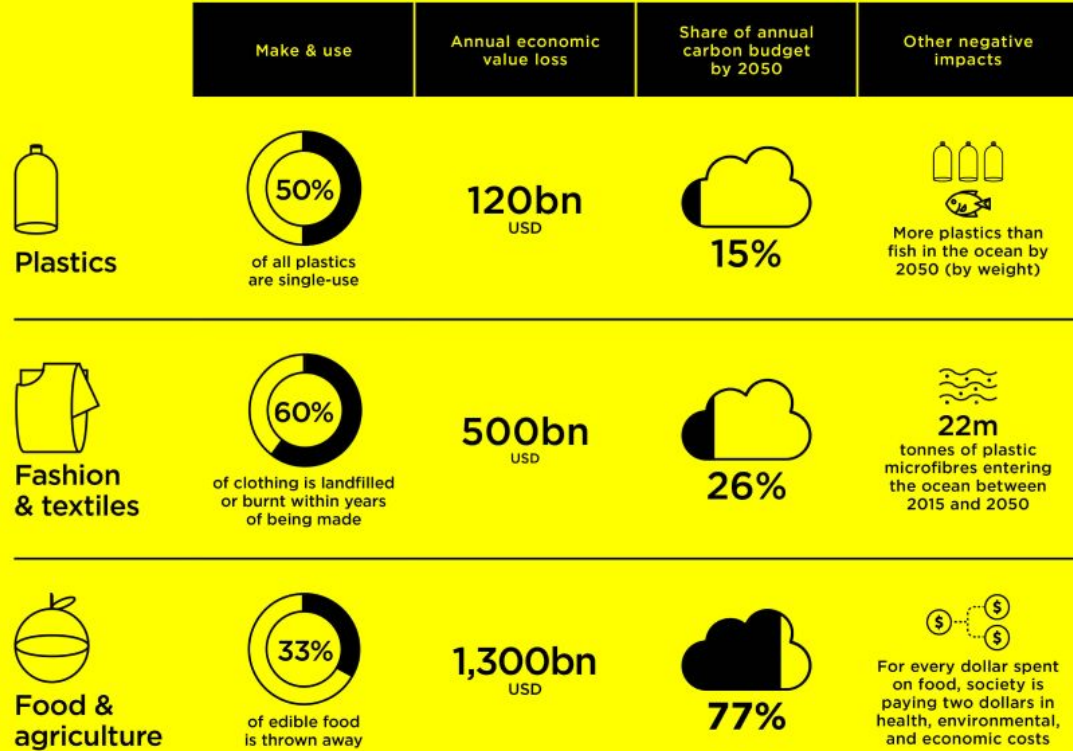
- Average U.S. person produces 4.9 pounds of waste per day
- That's 1,788.5 pounds a year. Almost a full TON per person.

## Generation Tonnages, 1960-2018



*Click on legend items below to customize items displayed in the chart*

- Glass**
- Paper & Paperboard**
- Food**
- Metals**
- Misc Inorganic Waste**
- Plastics**
- Rubber & Leather**
- Textiles**
- Wood**
- Yard Trimmings**
- Other**



Source: Ellen MacArthur Foundation, *Financing the Circular Economy: capturing the opportunity* (2020)

# CIRCLE ECONOMY

Common Language for reintegration process

