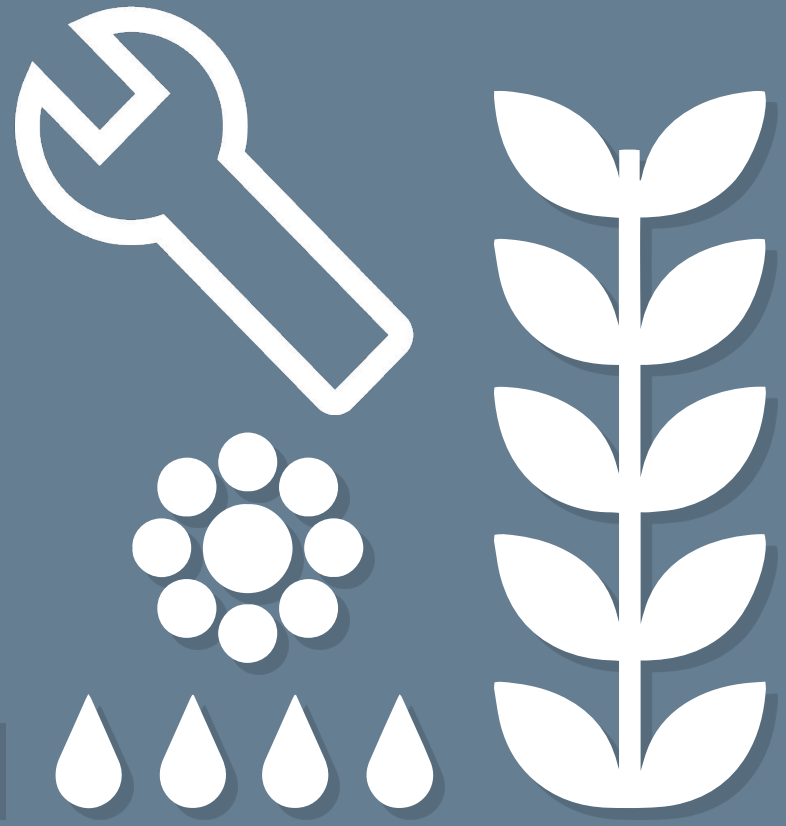
Waste is a Design Flaw

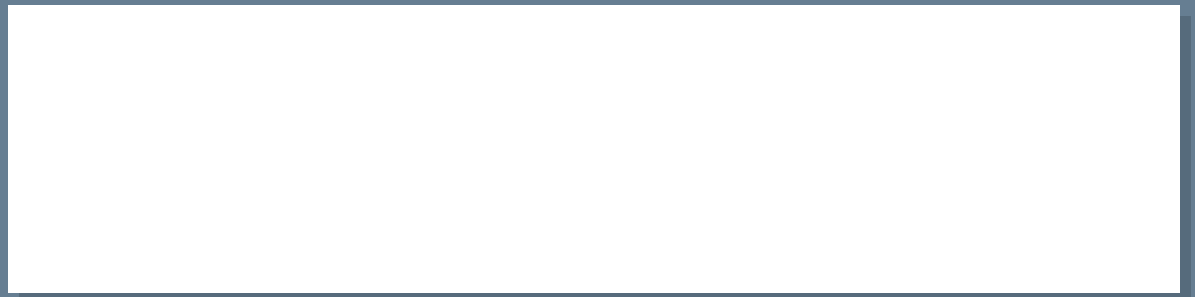
ENGR 1501 FALL 2023 - Week 1



Today's Agenda

1. COURSE OVERVIEW
2. ELECTRONIC WASTE
3. CLASS SCHEDULE
4. PROJECT OVERVIEW

1) Course Overview



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

Class Norms

- Encouraged to be on laptops during class (but keep them on mute)
- Attendance is a grade, participation is not (but it is encouraged)
- Defer judgement! All ideas are ideas.
- Be respectful to all! Classmates and yourself!

Participation Time!

Our first brainstorm

Ideation Session

Name:
Year:
Intended Major:

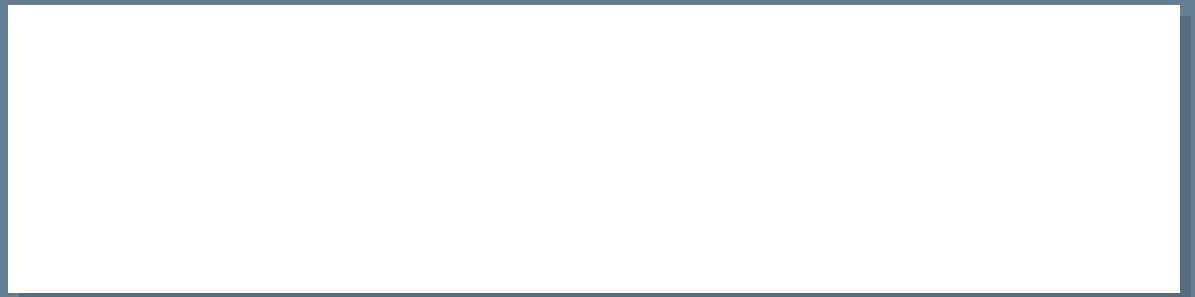
Answer one of these:

1. What electronic frustrates you the most?
2. What “waste” product do you wish was recycled?
3. What was your favorite lesson plan in school?

(No wrong answers! Ideation involves gut feelings and practice!)

Instructor Intro

2) Electronic Waste



The inspiration of this class:

By 2000, global waste production per year was at 54.9 billion tons and as of 2019, it surpassed 100 billion tons,

Of the 100 billion tons of resources used by the global economy each year, only 8.6% are cycled back.

Electronic Waste: Gold Mine

What makes up landfill waste?

A big contributor: E -waste

In 2009, discarded TVs, computers, peripherals (including printers, scanners, fax machines) mice, keyboards, and cell phones totaled about **2.37 million tons**

E-waste represents 2% of America's trash in landfills, but it **equals 70% of overall toxic waste.**

E-waste is still the **fastest growing municipal waste stream** in America, according to the EPA.

What makes up landfill waste? E -waste

- Cell phones and other electronic items contain high amounts of precious metals like gold or silver. Americans dump phones containing over $60 million in gold/silver every year.

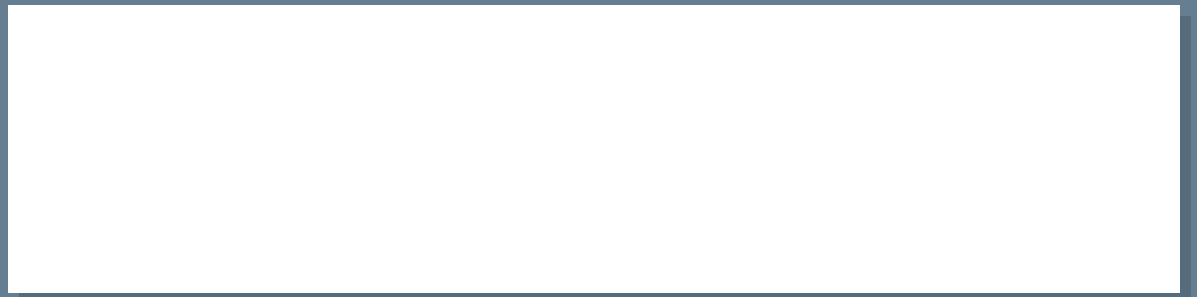
- Only 12.5% of e-waste is currently recycled

- The average American creates 1700 pounds of trash a year. Roughly a metric ton.

Let’s look at some examples:

- What examples of E-waste can you think of?
- What are some difficulties that may arise in recycling e-waste?
- What are some components you would expect from e-waste?
- What are initial ideas you would build from e-waste?

3) Course Schedule



What you will get out of this course:

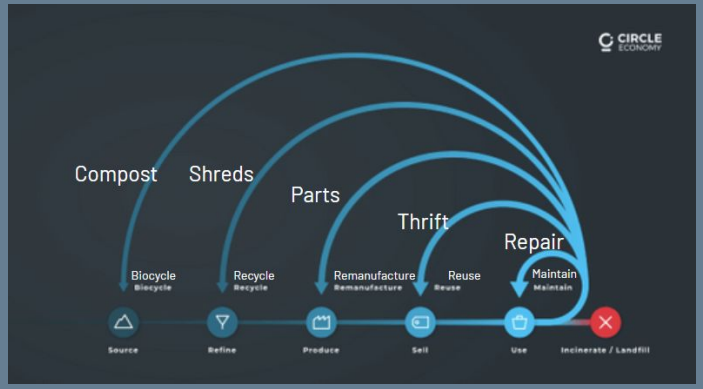
1. Basic toolkit for implementing sustainable design
2. Hands-on workshops and exposure to different skills
    a. 3d printing/3d modeling, disassembly, tinkering, graphic design, and presentation skills
3. A basic life-cycle assessment project to have in your portfolio!
4. Creativity training! Engineering design is a process!

This course can be thought of as a workshop group. You will have the opportunity to engage as much or as little as you like.

It is a great way to learn basics in design research.

Class Summary: Foundations

- Class 1: Introduction to Class and Syllabus
- Class 2: E-waste
- Class 3: Waste is a Design Flaw
- Class 4: Life of Waste
- Class 5: Sustainable Design
- Class 6: Sustainable Psychology: Guest Speakers



Review: Framework's latest modular laptop is one I could stick with for years

Devin Coldewey @techcrunch / 11:31 AM EDT • July 23, 2022 Comment

Image Credits: Framework

Class Summary:Workshops

- Class 7: Disassembly Workshop
- Class 8: Identification, Extraction, Use Workshop
- Class 9: Creativity Workshop
- Class 10: Creativity Workshop 2
- Class 11: 3D Modeling Workshop
- Class 12: Design Workshop
- Class 13: Review

Course Assignments

1.	Disassembly and Design Project (deadline)	30%
2.	Presentation (Last Class)	20%
3.	Slides (Before Every Class)	10%
4.	Attendance (Beginning of each class)	30%
5.	Blog Posts (2 due dates)	5% each

Course Assignments

Presentation & Slides

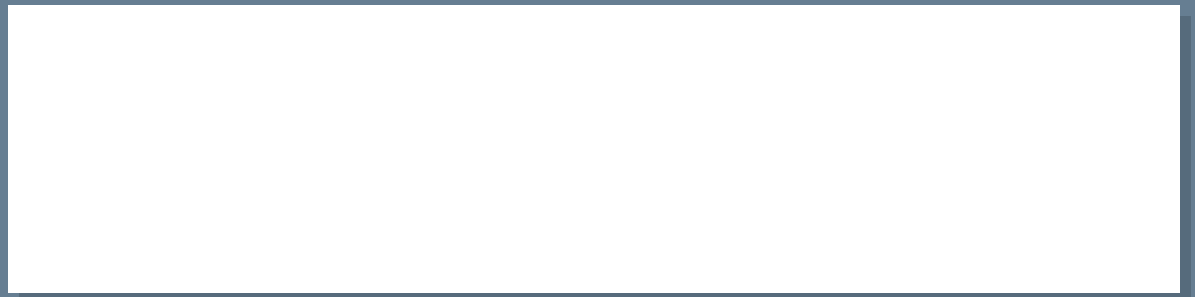
- Every class, the slide from the previous week is due
- The goal is to build out the guide and presentation as the semester goes
- At the end of the semester each student will present their guide to the class

Course Assignments

Blog Posts

- **(Due Date) : Post a Disassembly/Tear-Down Guide you Find**
    - As well as valuable components you identify from the tear down
- **(Due Date) : Post 2: DIY Example Analysis**
    - Find a DIY guide that uses parts from a salvaged piece of e-waste or has materials that are found in your e-waste. Discuss the difficulty of the build, the tools needed, the materials needed, how the build improves circularity of materials, and any changes you would make.

4) Project Overview



Course-Long Project

Circular Engineering outline for an E-waste product:

- This guide will identify a piece of electronic waste, how it was designed to be wasteful, the components of disassembly, a guide on how to build a product from the components, and how to market the assembled product and/or guide
- The idea is to show how waste was designed into the product and how you can create a second life with the “waste”

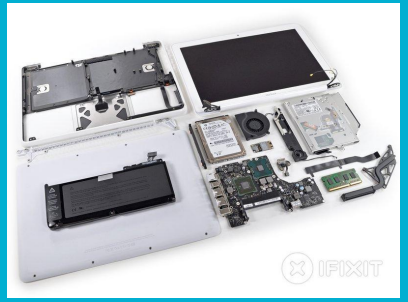
Project Outline

- E-Waste Product
  - What is it?
  - What did it originally do?
- How was waste designed?
  - When did it become waste?
  - What design aspects encourage waste?
- Design out waste
  - How would you have improved the design?
  - How would you improve current design
- Disassembly Guide
  - Can find online
  - Goal to endorse through testing
- Components: Design with waste
  - What is in there?
  - How can each be used?
  - For any toxic materials, how can they be disposed of?
- Collection
  - How would you encourage consumers to recycle this piece of e-waste?
- DIY Ideas
  - What can you do with what you have?
- Assembly Guide
  - What is your product?
  - How do you make it?
- Value Generated
  - What is the impact?
  - Why should we do this?

Example slides from previous student projects

- Simone
- Elijah
- Brendan
- Ria
- Natalie
- Geoffrey

Disassembly Guide



Teardown for Apple's MacBook Unibody Model A1342 Mid 2010

Skill level for disassembly: minimal (must have access to specific Apple screwdrivers but teardown is mostly just de-attaching parts)

Estimated Time for teardown: 1-2 hours

Safety: do not mutilate individual parts, especially parts containing potentially hazardous chemicals (ex. battery)

- Unplug device and power off for several days/weeks before teardown

LIGHTBULBS AND THEIR DESIGN FOR WASTE

- Hardware –
  - Main electronics reside in glued or "welded" plastic base – Blackbox system
  - A Hacksaw is the main way to disassemble, but this also raises risk for breaking the fluorescent bulb
  - Limited repairability since design is a vacuum and operates at high temperatures
    - Can't restore evaporated metal internally
    - Electrolytic capacitors not optimized in high temperature environment
- Software is not very complex, so waste is not designed around phasing out previous processors
- System –
  - Long-lasting products make it difficult for businesses to profit
  - Has caused companies to diversify products in a similar fashion to Apple based around appearance of lights, thus flooding the market (See Cree Lighting)

How each component can be used

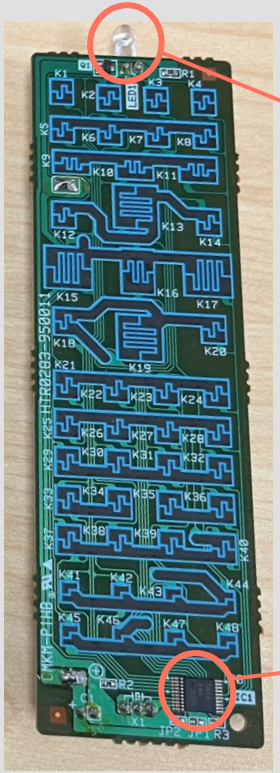
I believe I could use almost everything already included in the phone. Extra wires or circuit boards could be donated to schools for robotics classes or companies for parts. Unneeded keypads could be used for art projects or simply recycled as needed, as they are often just plastic buttons.

Assembly Components

- Plastic casing
- Battery Pack
- Phillips-head or Torx Screws
- Circuit Board
- Motors
- LED lights
- Extra plastic
- Microprocessor
- LCD Screen
- Front bezel

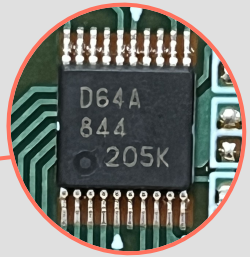
I will most likely remove the number keypad and replace it with another screen, or even just plastic, but it may be a good resource to keep and help give the phone more features. Maybe if there are questions for the servers or even the manager, then the users could call from the phones they've been given (but that could just as easily be done with the simple push of one button).

Parts of Interest

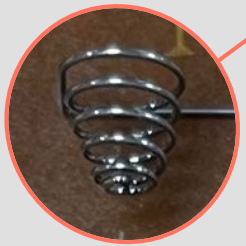


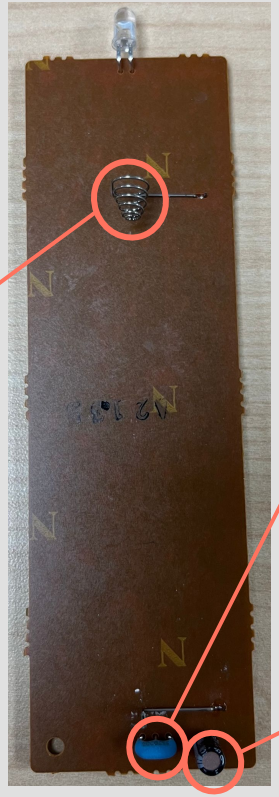
LED

microcontroller



spring





ceramic resonator

radial electrolytic capacitor

Elements Designed for Waste

Hardware

- rubber printer belts break easily
- plastic parts aren't durable
- stepper motors have a 10,000 hour lifespan, but this can be shortened by irregular use

Software

- consumers have to purchase diagnostic software, making buying new easier
- page-alignment software isn't super accurate

System

- certain printers aren't compatible with all paper types, limiting uses
- variety of models makes it hard to find compatible replacement parts

E-Waste Disassembly and Parts List

Difficulty of Teardown:

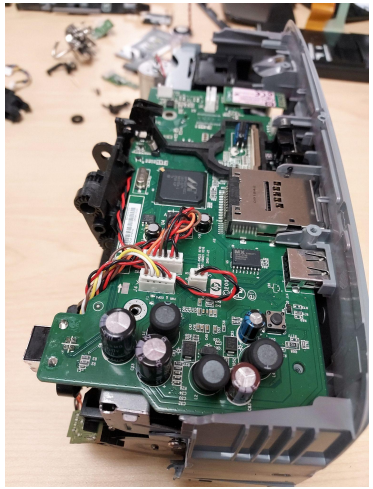
★ ★ ★ ★ ☆

General components salvaged:

- brushed DC motors
- stepper motors
- fans
- sensors and switches
- power supplies
- solenoid actuators
- wires
- mechanical parts such as springs, belts, and gears

Tools needed:

- pliers
- screwdrivers
- gloves (ink)

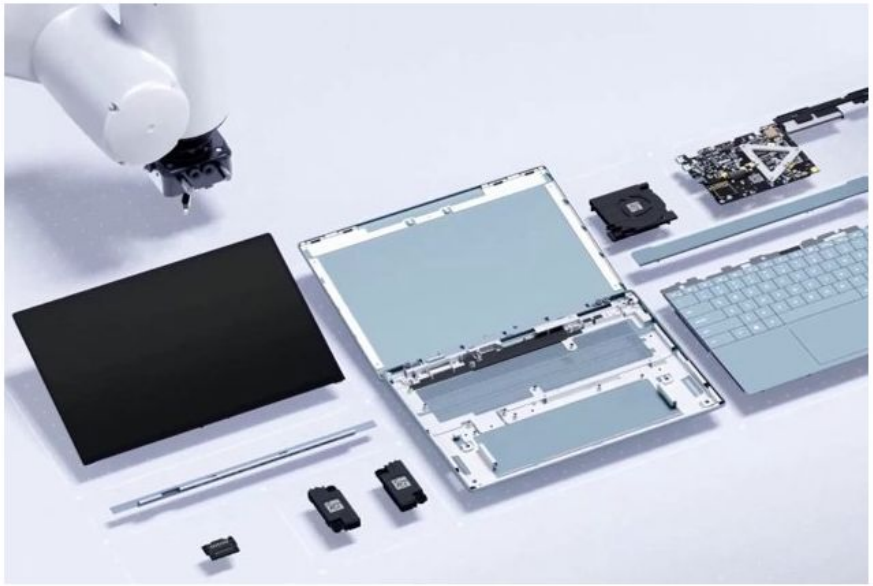


How the Design Impedes Disassembly:

The hard outer plastic made the printer difficult to disassemble, but once those piece were snapped off it was fairly straightforward. Didn't have to cut any wires, but the amount of pieces made the teardown a tedious process.

SUSTAINABILITY IN DESIGN

- A bio-based printed circuit board made with flax fiber and water-soluble polymer as the glue.
- Removing glue and using only a few screws.
- Advanced deep cell battery that can be refurbished and reused.
- (2) Concept Luna: The evolution of sustainable PC design - YouTube



Attendance

Example attendance form in course materials

QR CODE FOR
ATTENDANCE FORM

Thought for the class:

“Everybody needs a passion. That’s what keeps life interesting. If you live without passion, you can go through life without leaving any footprints.”

-Betty White

Recommended Media:

(Spotify) How to Save a Planet:

Why is it so hard to fix our electronics, and what can we do about it? (32 mins)