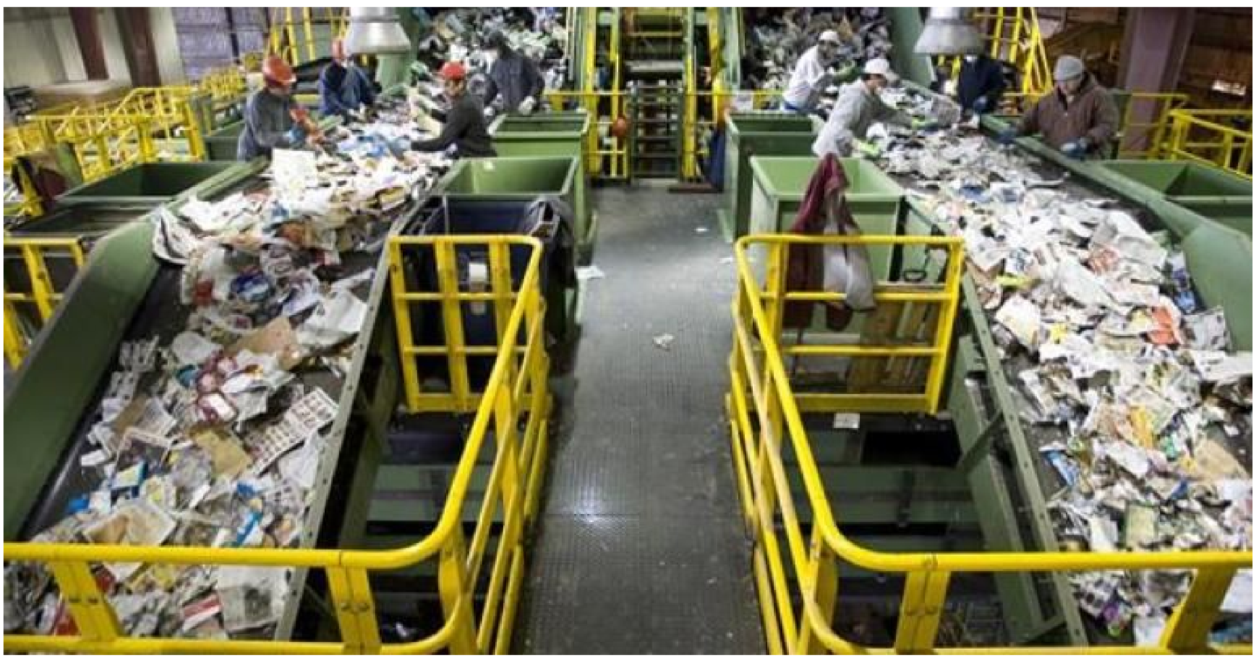
MINI-PROJECT 10

RECYCLING



ME 270: *Design for Manufacturability*

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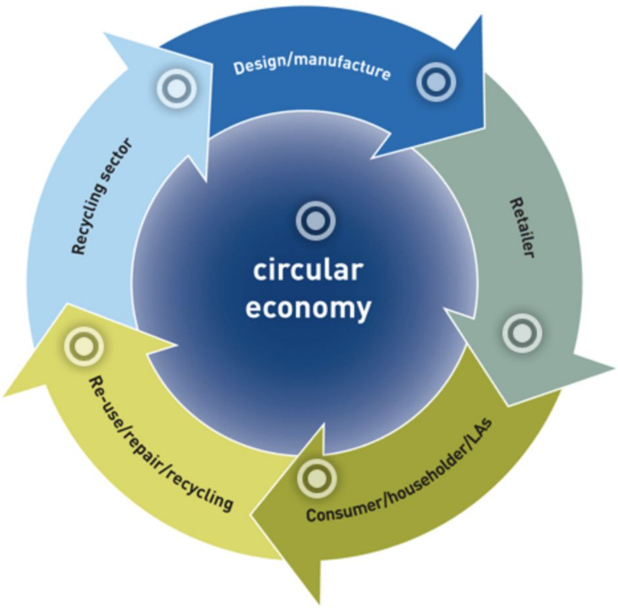
AB5_3

CIRCULAR ECONOMY[1]

A circular economy is an econoping plan that serves as an alternative to the traditional linear economies. In a circular economy, the main goal is to keep resources in use for as long as possible. Products in this economy would be manufactured, used, disposed, reprocessed, and use to create other products. This maximizes the value of material while being healthier for the environment compared to a linear economy.

The biggest benefit of a circular economy, and what is most relevant to Design for Recycling, is waste management. Designing products that are able to be reprocessable and recyclable are extremely important to the preservation and sustainability of our planet. It is part of an engineer's job to aid in the preservation of life and this newly adopted economic plan allows them to do so.



DESIGN FOR RECYCLING[2]

Collecting end-of-life products is a multi-step process. Physical products are physically labeled of when products should be disposed, but any products that run an operating system are electronically labeled and are pushed notifications when the system is nearing its end and needs to be disposed of. Cisco does an excellent job of this while adhering to all privacy laws.

Overall, design for recycling addresses the material selection of a given product to increase the recyclability and reprocessability of a product. It also is targets similar

[1] http://www.wrap.org.uk/about-us/about/wrap-and-circular-economy
[2] https://www.sciencedirect.com/topics/engineering/remanufacture

design expectations to design for disassembly. The general guideline of design for disassembly is to make joints accessible, use snap and press fits as often as possible, and create “break points” in the product. This is extremely important in the recycling process during the liberation and sorting processes as products must be fully disassembled in order to be shredded into their material fractions by hammer mills. Design for recycling is essential for engineers to follow because it is environmentally beneficial. Creating products that are well designed for recycling will not have their grade depreciate during processing which allows them to be re-used in a multitude of different ways. More importantly it decreases waste on the planet which harms our environment. After learning about design for recyclability I will make sure, in my future endeavors, that I will design products that are easily reprocessable.

TAILING, RECOVERY, & GRADE

WEIGHT & COMPOSITION OF TAILING

$1\ ton\ =\ 1000\ kg\ ||\ 70\%\ Copper\ =\ 700\ kg\ ||\ 30\ \%\ PVC\ =\ 300\ kg$

$0.74\ ton/hr\ =\ 740\ kg/hr\ ||\ 0.69\ copper\ =\ 690\ kg\ ||\ 0.05\ PVC\ =\ 50\ kg$ (post-processing)

$700 - 690\ =\ 10\ kg$ (copper lost) $||\ 300\ -\ 50\ =\ 250\ kg$ (PVC lost)

$copper\ lost\ +\ PVC\ lost\ =\ total\ tailings\ ||\ 10\ +\ 250\ = 260\ kg\ Tailing$

$Copper\ Composition\ of\ Tailing\ =\ copper\ lost\ \div\ tailing\ =\ 3.85\%$

$PVC\ Composition\ of\ Tailing\ =\ PVC\ lost\ \div\ tailing\ =\ 96.15\%$

GRADE OF COPPER

$Copper\ Composition\ =\ Copper\ post\ processing\ \div\ Total\ pre\ processing\ =\ 0.69\ \div\ 0.74\ = 93.24\%$

RECOVER OF COPPER

$Recovery\ Percentage\ =\ Copper\ post\ processing\ \div\ Copper\ pre\ processing\ =\ .69\ \div\ 0.70\ =\ 98.57\%$

POTENTIAL RECOVERABLE VALUE

LOWER RANGE (SECONDARY)

$Steel : \$0.40/kg\ \times\ 0.20\ kg\ =\ \$0.08$

$Wrought\ Aluminum :\ \$1.60/kg\ \times\ 0.10\ kg\ =\ \$0.16$

$Copper :\ \$4.80/kg\ \times\ 0.12\ kg\ =\ \$0.576$

$Polypropylene :\ \$0.80/kg\ \times\ 0.70\ kg\ =\ \$0.56$

$Borosilicate\ Glass :\ \$1.00/kg\ \times\ 0.28\ kg\ =\ \$0.28$

$Total\ Price :\ \$1.66$

HIGHER RANGE (SECONDARY)

$Steel: \ \$0.50/kg \times 0.20\ kg = \$0.10$

$Wrought\ Aluminum: \ \$1.70/kg \times 0.10\ kg = \$0.17$

$Copper: \ \$5.30/kg \times 0.12\ kg = \$0.636$

$Polypropylene: \ \$1.00/kg \times 0.70\ kg = \$0.70$

$Borosilicate\ Glass: \ \$1.20/kg \times 0.28\ kg = \$0.336$

$Total\ Price: \ \$1.94$

The range of the total recoverable value of the materials of the coffee percolator is **$1.66 - $1.94**. The reason why the secondary values are used from the table is because secondary prices are volatile based on supply and demand in the market while primary prices are fixed and tend to be higher.

THERMAL RECYCLING

The heat of combustion of polypropylene is 46 MJ/kg which is much smaller compared to its GER which ranges from 85 MJ/kg - 105 MJ/kg. When factoring in the 25% efficiency the heat of combustion changes to 11.5 MJ/kg. To calculate the thermal efficiency of the incineration of polypropylene, we take the heat of combustion with efficiency and divide it by the average GER of the material. In this case the calculation would be (11.5) / 95 which yields a 12.11% thermal efficiency.

$$11.5 \div ((85 + 105) \div 2) = .12105 = 12.105\%$$