Tyler Colenbrander
Michelle Frid
Alexa Funahashi
Sophia Galleguillos
STEM - 2

Reverse Engineering Project - Dancing Flower Pot

Abstract: Through the process of a teardown, we analyzed the components of a solar powered dancing flower pot from the Dollar Tree. The flower pot is made up of several very simple parts, therefore making the retail price a mere $1. We took apart all the plastic pieces, which reveals a circuit inside that creates a magnetic field from a copper coil to move the plastic petals back and forth. We did a functional, structural, material, and manufacturing analysis of the dancing flower pot and recorded our thoughts along the way.

Purpose/Hypothesis: The purpose of this project was to learn about conceptual sketches and how to break an object apart and put it back together. Through this project we learned about the reverse engineering process and how it is used in the real world. If we did a teardown of the solar powered dancing flower, then we believed that we would be able to fully understand how it works.

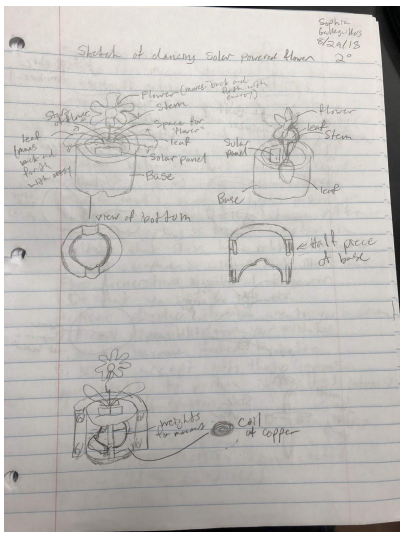
Procedure:

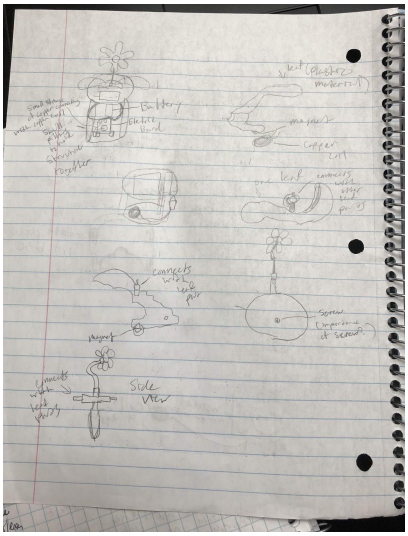
1. Pick an object to break apart that's complex and has many parts
2. Take the object apart
3. While breaking it apart, make detailed conceptual sketches of the outside and the inside of the object
    a. Take measurements of parts and object itself
    b. Label parts
    c. Title sketches
    d. Materials
    e. Motion (how the parts work together)
4. Put the object back together based on the conceptual sketches
5. Test object and see if it still works

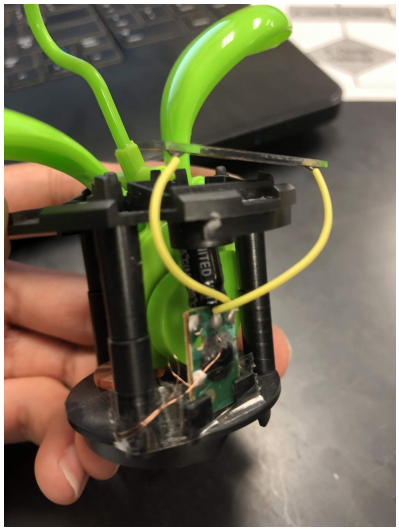
Data:

Here are sketches created when disassembling the dancing flower pot.

Tyler Colenbrander
Michelle Frid
Alexa Funahashi
Sophia Galleguillos
STEM - 2







As you can see in the sketches, the outer pink casing was taken off to take the picture above. In the sketches, the flower is broken down further and taken out of the black structure.

Dimensions:
Solar Panel: 1 ⅛” (w) by ½” (l)
Overall dimensions: 4 ½” (w) by 2 ½” (l) by 4” (h)

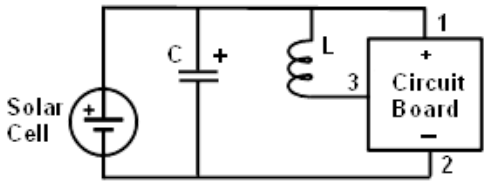
Analysis:

Functional Analysis:

The solar panel collects the energy from the sun and stores it into the 10 volt capacitor. The capacitor is directly connected to the circuit board, where two small copper wires are attached from a larger coil of copper. The copper coil generates energy in the form of a magnetic field which moves the magnet that is hanging above one side of the copper coil. The magnet moves away from the copper wire and the magnet is attached to a part of the plastic “flower”. The

Tyler Colenbrander
Michelle Frid
Alexa Funahashi
Sophia Galleguillos
STEM - 2

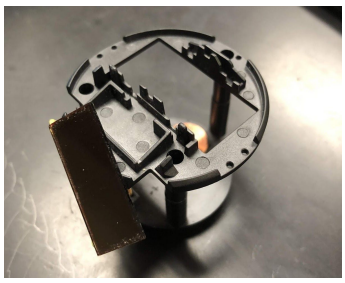
plastic pieces are interconnected as there are small pins and holes to hold the structure together. Each of the plastic parts One of the plastic pieces that is closest to the magnet contains a small metal screw that's sole purpose is to react with the magnet and to make the main plastic flower dance back and forth. However, this metal screw can be removed and the plastic parts are still able to move.



Manufacturing Analysis:

The ABS plastic can be processed three different ways. The first way is called the emulsion process. This process is more flexible in its product range and can be used to make more high impact grade plastic. The second way is called suspension. During this process, high rubber content medium is blended with Styrene-acrylonitrile resin. The third way is called continuous mass which is the prefered method of producing ABS plastic. It requires less energy than the other two methods and can produce resins with color. This means that not painting of the plastic is required because the plastic is already colored.

The low light, amorphous silicon type solar cell takes a long process of manufacturing. First, the silicon is made of sand that was put through the furnace at 1,800 degrees celsius. It is then put through a chemical refinement through distillation. It is then laser patterned. The ingots are cut thin and laser patterned. The TCO glass substrate is laser patterned, then added to the silicon and ingots. The wires are added to the panels and laminated and cured. Once the pieces are put together, it is blackened and put into a simulator to test.



Copper is usually extracted from ores that contain 0.5-2.0% copper. The first step of extracting the copper is to crush and powder the ore using a ball or rod mill. The ores are treated by smelting and put through the froth flotation. The powder is mixed with reagents so it will

combine with the copper particles. The mix is added to water and foaming agents to separate the unwanted materials and copper. The copper floated to the top and is strained. Later it is oxidized with liquid matte to burn off iron. This makes blister copper which can be electrolytically refined to make it market-grade.

Structural Analysis:

The dancing flower pot is a very simple, yet sturdy object. Despite the many connected parts, there are actually no connecting screws; all the parts are connected by pins that either sit in a groove or fit in a hole. Because the product is fairly light, these pins are able to hold the loads put on them and the stronger connections of metal screws are not required.

The main functional system in the flower pot is the mechanism to make the flower and petals dance. The green ABS plastic parts are all a part of this system and they are connected to each other with small pins in holes (see functional analysis above for more information on specific function). The plastic is an ample choice for this system, as it is lightweight and fairly sturdy. As visible in the picture below, each green part has a pin sticking out on each side. On the back side, the right leaf is connected to the center stem and left leaf by another piece of plastic with holes in it. This makes it so that when the right leaf is moved, the plastic connecting piece pulls on the pin from the other two pieces as well and makes all three pieces dance together.

This flower system connects to the rest of the product through the same pins that connect the individual pieces. These pins sit inside grooves on the black plastic structure. The choice of this connection is perfect for this design because it allows free movement and rotation of the flowers, because the pins are not restricted at all. Additionally, this very minimal connection is possible because all the materials involved are plastic, and therefore light, and do not require strong support to hold them up. The black plastic structure is made up of two pieces of molded plastic that are one again held together with pins.

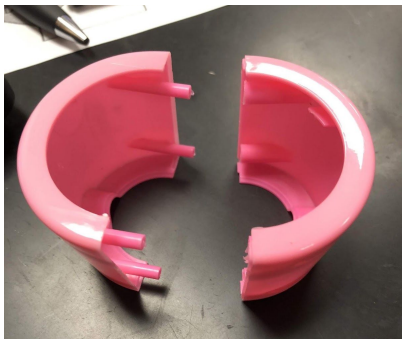
Tyler Colenbrander
Michelle Frid
Alexa Funahashi
Sophia Galleguillos
STEM - 2

The flower petals and leaves system also connect to the rest of the system through the magnet and copper coil that provides the energy for the flower to dance. However, this is not a physical connection. The coil, when current runs through it, creates a magnetic field that interacts with a magnet attached to the bottom of the right leaf. This interaction between the parts causes the magnet to swing back and forth, therefore moving the leaf (and other flower parts by association) with it.

The copper wire is connected directly to the black plastic structure with tape and glue. Two copper wires then attach to the circuit board through soldered connections and there is a circuit-on-board blob on the integrated circuit (see functional analysis for more). These connections all seem sturdy and because of the small size and simple design, do not require more elaborate connections.

The solar panel, which sits in an opening made in the black plastic structure. This once again just sits in the plastic, there are no screws or glue to hold it in place. The solar panel has two yellow wires (a + and -) that then attach to the circuit board through more soldered connections, similar to the copper wires from the coil.

The last part of the product is the pink plastic pot that provides a covering around the insides of the flower. This is formed to fit around the black plastic structure, and once again just uses pins to slide together. The purpose of this piece is not only to provide a nice completed aesthetic, but also to protect the inner parts of the flower. The ABS plastic material it is made of is strong and light, so the product can withstand impact from the outside, like if it was dropped. Overall, when all the pieces are put together, this is a very light, simple, and sturdy product.



Material Analysis:

The flower pot is made almost entirely out ABS plastic. Acrylonitrile Butadiene Styrene combines the strength and rigidity of acrylonitrile and styrene polymers with the toughness of polybutadiene rubber. It can be heated to its melting point cooled, and reheated again with minimal damage. ABS is a thermoplastic which means it liquifies at high temperatures rather than burning. This allows ABS to be easily injected into molds and recycled later on. It is also

inexpensive, has a strong resistance to corrosive chemicals and physical impacts, and its easy to produce. ABS is the most common plastic found in toys because of its aesthetic qualities, price, and durability.

The solar panel within the pot is made out of amorphous silicon. The silicon has a thickness of 1 micron and is made out of multiple layers including flexible steel substrate, black reflector, red, green, and blue cells, and transparent conductive oxide film. Silicon solar panels are developed in a way that makes them less susceptible to breakage during the transport or setup process. The last large material in the dancing flower pot is copper. Copper has electrical and thermal conductivity, ductility, and corrosion resistance. It is nonmagnetic and recyclable which makes it a good material to work with.

Conclusion:

Overall, we found that the seamingly simple object had multiple systems making it work. The different systems included the energy source and how it powered the dancing flower, the magnets that moved the leaves of the flower, and the plastic frames holding everything together. The solar panel seemed simple at first, but after research we now know that the manufacturing process of it and the materials needed are very complicated. The solar powered design of the flower was simplified and shrunk down and was still able to work. Usually when one thinks of solar power, they think of a complicated and large scaled object. The same solar power concept was able to be placed into a simple toy that can be retailed for just $1.

Bibliography:

- http://www.matweb.com/search/DataSheet.aspx?MatGUID=3a8afcddac864d4b8f58d40570d2e5aa&ckck=1
- http://www.plasticsintl.com/abs.htm
- https://www.creativemechanisms.com/blog/everything-you-need-to-know-about-abs-plastic
- https://copperalliance.org.uk/knowledge-base/education/education-resources/c

opper-properties-applications/
- https://www.icis.com/resources/news/2007/10/18/9071053/acrylonitrile-butadiene-styrene-abs-production-and-manufacturing-process/
- https://tomy.com/copyrights
- http://diymanufacturing.mit.edu/?page_id=431
- https://en.wikipedia.org/wiki/Flip_Flap