Reverse Engineering of Toaster

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STEP 1: Identify the purpose

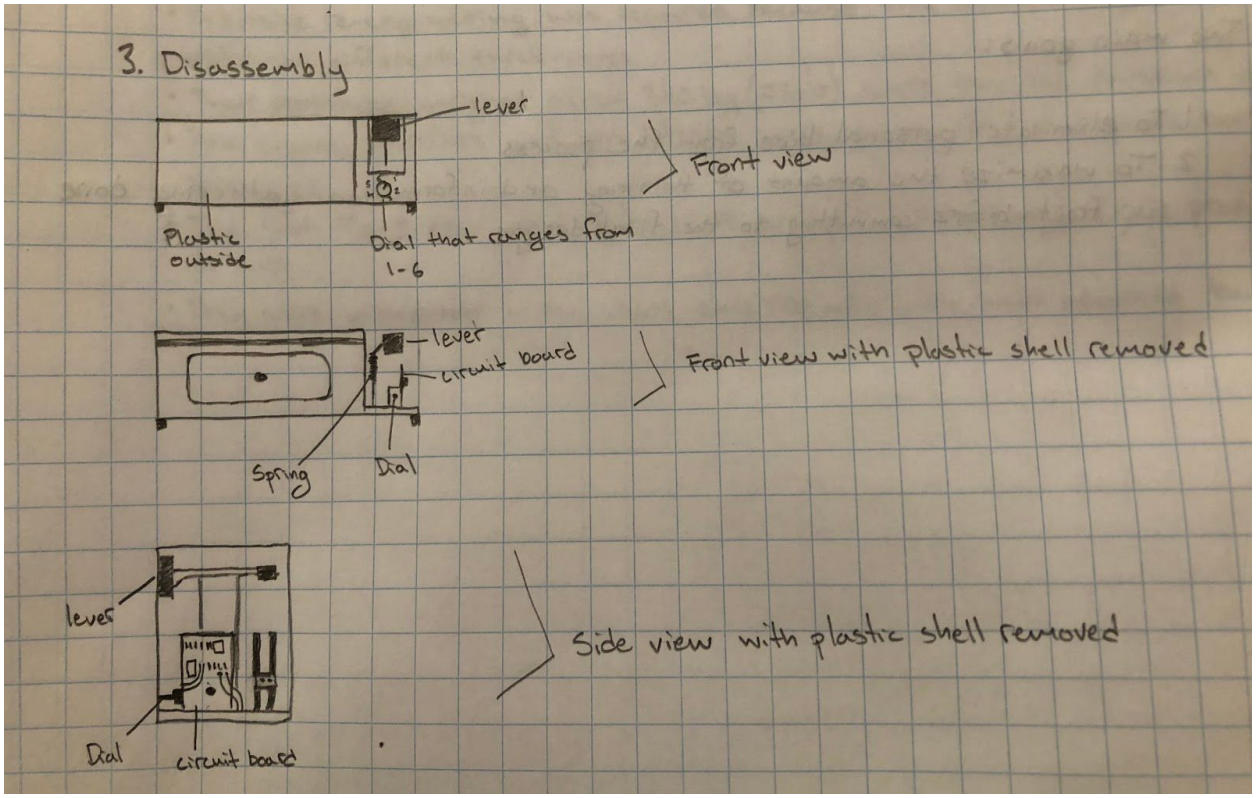
- The purpose is for our group to figure out how a toaster works. We first want to learn about all the different components that make up a toaster and then how each of the components work together.

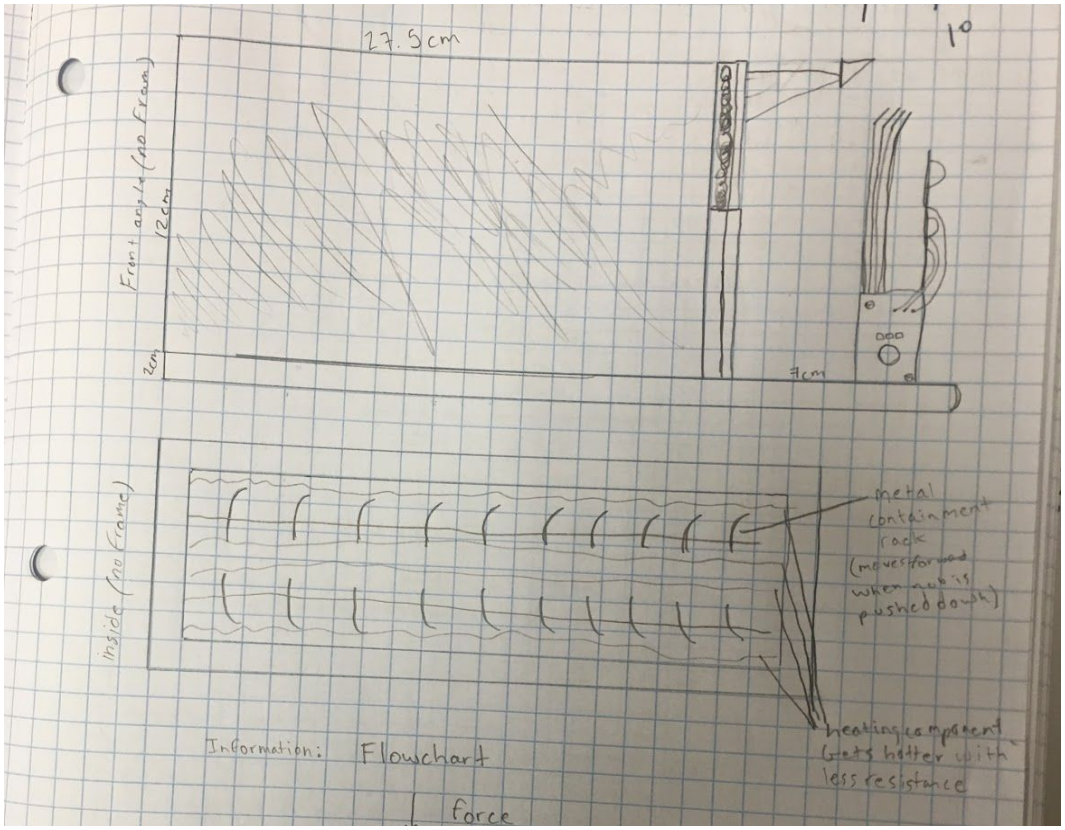
STEP 2: Develop an Hypothesis

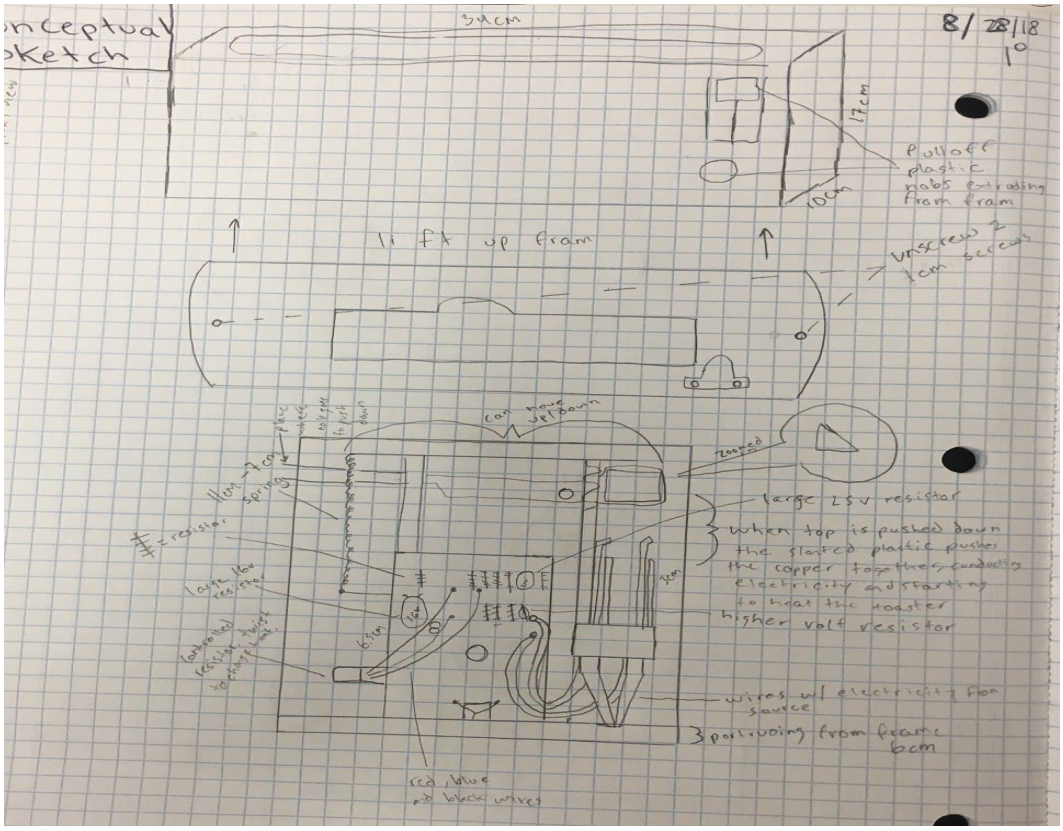
When you press down on the lever located on the side of the toaster, an electrical connection is made, therefore transferring energy in the form of heat into the toaster.

STEP 3: Disassembly

- The disassembly was very basic. All we had to do was unscrew the plastic cover surrounding the outside of the printer.
    - Dimensions: 36cm x 10cm x 15cm

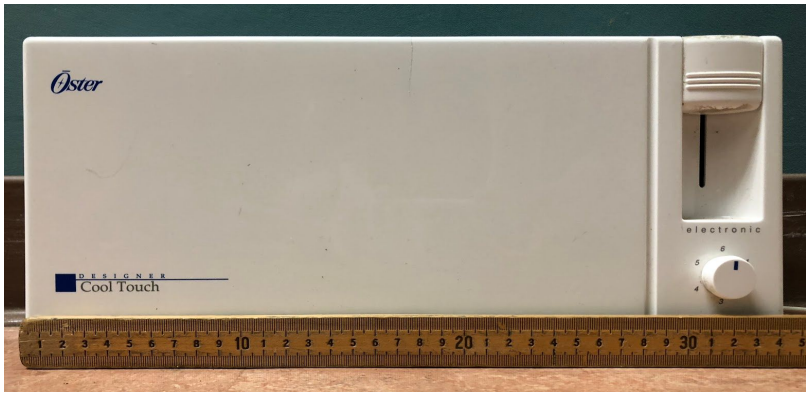


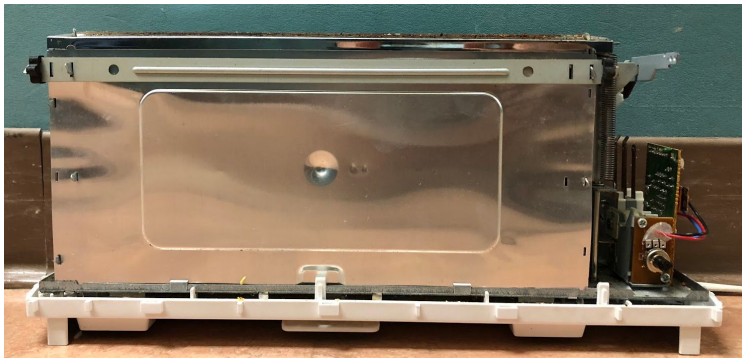

27.5cm
Front angle (no frame)
12cm
2cm
7cm
inside (no frame)
metal containment rack (moves forward when sub is pushed down)
Information: Flowchart
force
heating component (gets hotter with less resistance

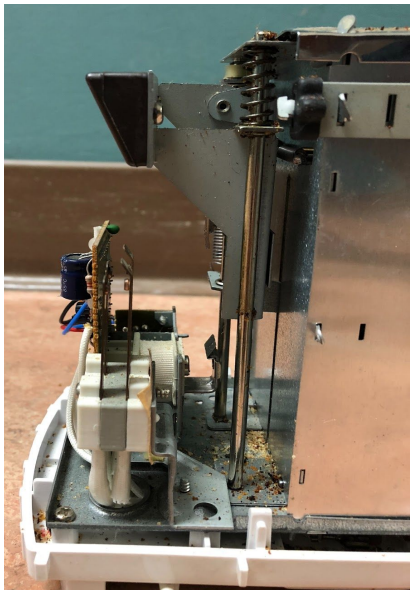

Conceptual Sketch
8/28/18
17cm
10cm
Pull off plastic slabs extruding from fram
lift up from
unscrews 2 screws 1cm
can move up/down
zoomed
large 25v resistor
when top is pushed down the slanted plastic pushes the copper together conducting electricity and starting to heat the toaster higher volt resistor
wires w/ electricity from source
3 part wiring from frame 6cm
red, blue and black wires

STEP 4: Analyze the Elements

- A toaster, a common household item, is constructed with many parts that tie into the operation of the whole system.







-Functional analysis:

- Power source: plug
- Dial controls the amount of electricity that is let in
- Timer controlled by a bimetallic switch
    - Two metals that expand in heat break the circuit after a certain amount of time
- The switch is connected to a spring loaded pop up tray
- The heat comes from nichrome wire
    - Resistant to oxidation
    - High electrical resistance
    - Very high melting point
- The wire gets hot because its resistance is so strong
- Heats up and cools down very quickly
- Metal grills make sure the bread doesn't touch the nichrome wire
- Amino acids and sugars react, creating new chemicals that aren't in uncooked bread
- This type of reaction is called a Maillard reaction
    - Only occurs between 285°F/ 140°C and 320°F/ 160°C

-Structural analysis:

- Most parts are connected by small aluminum screws
- Resistors and wires are attached to the circuit board with hot glue

- The toaster is surrounded with an exterior plastic shell to protect the internal mechanisms

-Material analysis:

- Plastic knob: Used to regulate the time/path of resistance.
- Switch: pushed down to complete the circuit.
- Resistors (16V and 25V): regulate how much voltage is transferred through the system.
- Copper rods: when pushed together activate and close the circuit.
- Screws: Connect the frame and shell.
- Plastic shell: designed to not contract heat; safe to touch.
- Copper/Steel Cage: conducts heat; helps make toast.
- Nichrome wires: main heating component; heat up more with higher voltage.
- Timer: set to open the circuit when done.

-Manufacturing Analysis:

- Most products are made in the U.S. but there are some manufacturing facilities in Mexico, Venezuela, and Peru.
- It is constructed from a spring, bread rack, heat sensor, trip plate, level, timing mechanism, electromagnet, and browning control
- The outer case is made from pressure molded plastic
    - Plastic pellets are heated to 350°F and poured into a mold
- The various parts are constructed from a variety of metals and molded plastics. Screws, nuts, bolts, and washers are used to connect the parts
- There are very few byproducts produced but there is occasionally excess waste from the plastic molding
    - Excess plastic is collected and reused and excess aluminum is recycled

STEP 5: Prepare the report

-How does it work?
-Use our hypothesis to design a thorough analysis of how the inner parts of a toaster work alone and as a system
-What motion, information and energy is applied in reverse engineering the toaster?

STEP 6: Product Redesign

-What would improve the toaster?

- More energy efficient
- Metal casing
    - Safer in case of an accident
- Add a thermometer element, so the toaster can regulate the heat on its own
- Rework the timing element into a smart-toaster design, where the toaster itself can identify when the bread is perfectly brown

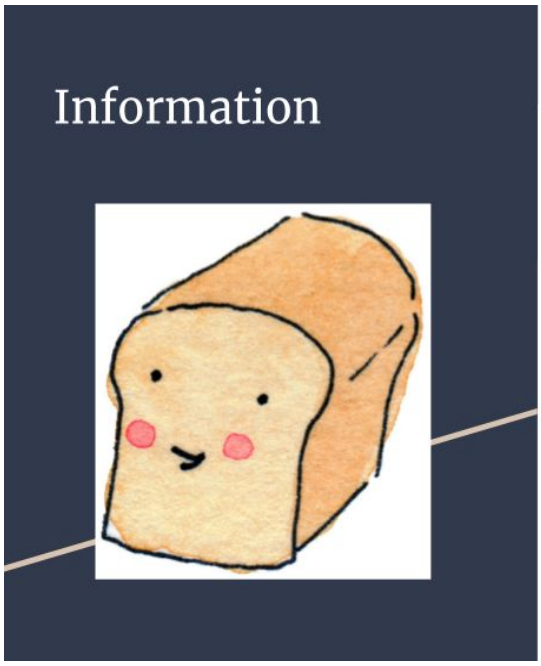
Motion

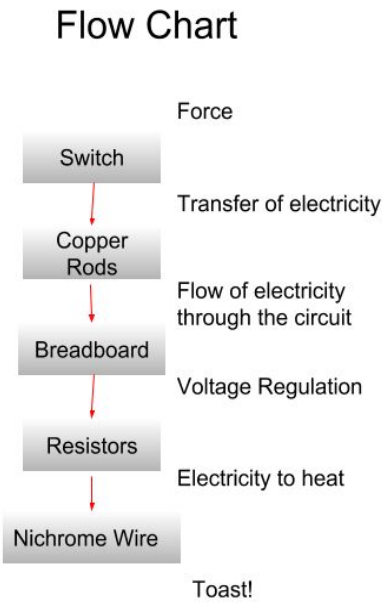
The motion in the toaster is the movement of the electricity though the different parts of the toaster and through the nichrome wire, creating heat. As well, motion starts the closed circuit, by requiring a human touch to pull down the lever, closing the circuit.

Energy

The energy source for the toaster is from the plug, which connects to another power source, which allow the toaster to function. The electricity from the wall plug in flows through the circuit, and the voltage of the circuit heats up the inner chamber of the toaster, making toast.

Information





Our hypothesis was correct
Toasters work by pushing down the lever which creates an electrical connection that allows energy to be transferred into heat.

Contacting Oster
Due to the complexity of the resistors on the breadboard, we could not determine every part. Matt decided to contact Oster in hopes of identifying missing parts, but Oster instead replied with a bot and gave us no information. It has been over a week and we have yet to get a response.

Sources
https://www.explainthatstuff.com/electrictoasters.html
https://www.cnet.com/news/appliance-science-the-well-done-physics-chemistry-of-the-toaster/
https://sites.google.com/students.nusd.org/stemse/home?authuser=1