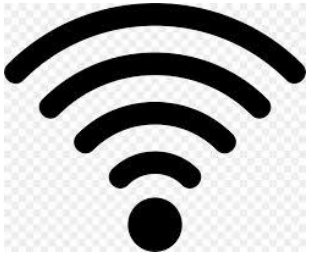
Smart Toaster Oven For The Future

Ryan Nolan - Electrical Engineering
James Chorma - Electrical Engineering
Alexander Tsangarakis - Electrical Engineering

Overview - How is it Smart?

- What Makes a Toaster Oven Smart?
  - Easy user control
  - Connection to networks by things such as wifi, bluetooth, NFC, etc…
  - Safety features to prevent the user from starting fires.



Motivation

- The love of toast
- The ability to expand upon our limited programming skills
- The ability to improve our circuit design skills
- The opportunity to have creative freedom while constructing and selecting the features for the project.
- The ability to make a common use item more fun and easier to use.

Goals & Objectives

For our toaster oven we will be implement a digital timer through arduino software that is controlled by a number pad as well as a gauge to control the temperature.

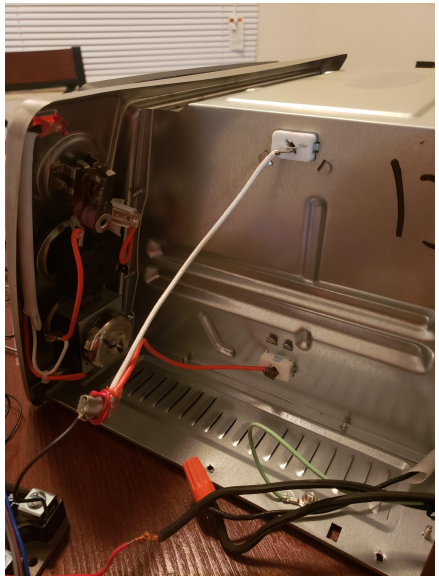
As electrical engineers, we will design our own PCB, Control AC power with DC, and sensors in order to make the toaster oven more efficient and innovative.

As an extra design innovation we will also be implementing a smartphone application for the toaster. This website will be able to control certain aspects of the toaster oven such as: powering on or off, temperature readings, and time left on the toast.

Specifications

1. The toaster oven should be able to operate with a desired time between 1 second and 1 hour.
2. The toaster oven needs to be able to heat/ preheat to a minimum of 300 degrees.
3. The toaster oven will need to be able to be turned off by a smartphone device within 5 seconds of issuing the command from the smartphone
4. The user will receive a notification from the toaster oven to their smartphone device within 30 seconds of completed tasks.

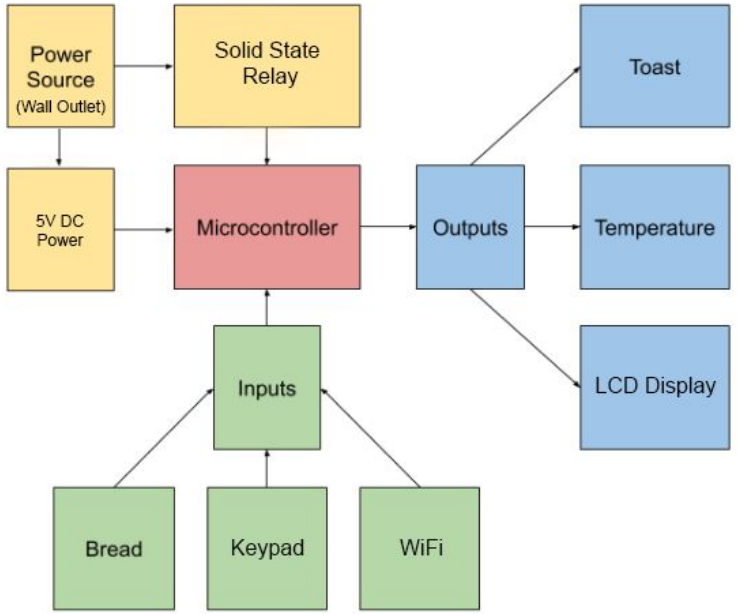
Current toaster ovens Vs Ours



- Basic toaster ovens are directly AC powered (120 V 60 Hz from the wall outlet).
- Analog dials are used to control temperature and set times
- Since the controls are not digital, it will be less accurate with time and temperature
- Our toaster oven will remove all the dials, give it a way to select options digitally, and provide smartphone control.

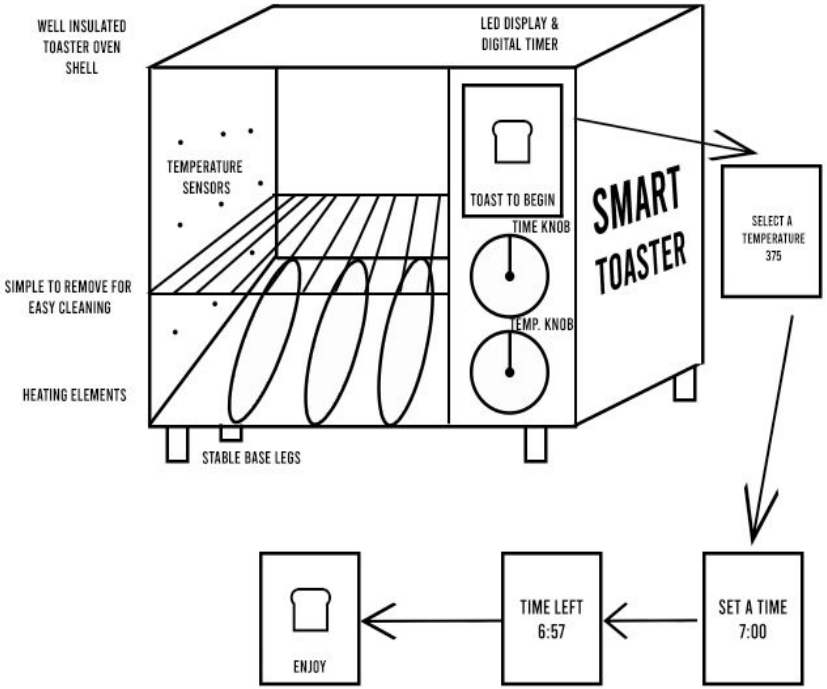
Block Diagram

- AC power comes into SSR as well as the heating elements. DC power opens and controls the circuit in between to allow to control.
- Input commands come from the keyboard or from the wifi into the PCB
- Commands outputted on the LCD display as well as heating element control



Revamped User Control

- We have selected a touch pad for the most user friendly interface.
  - This can turn the toaster on and off, as well as input temperature and time
  - A kill switch is readily available in case anything goes astray
  - Further Time can be added or temperature can be modified after initial toasting
- Furthermore we are working on a website
  - Includes all properties mentioned above



Cell Phone Control

We will be building a website which controls the toaster oven & showcases our senior design project. For the CMS we will be using WordPress.

WordPress Elementor

For the page builder, we are going to be using Elementor. It has a lot of customization options and allows for custom code to be inserted on the page.

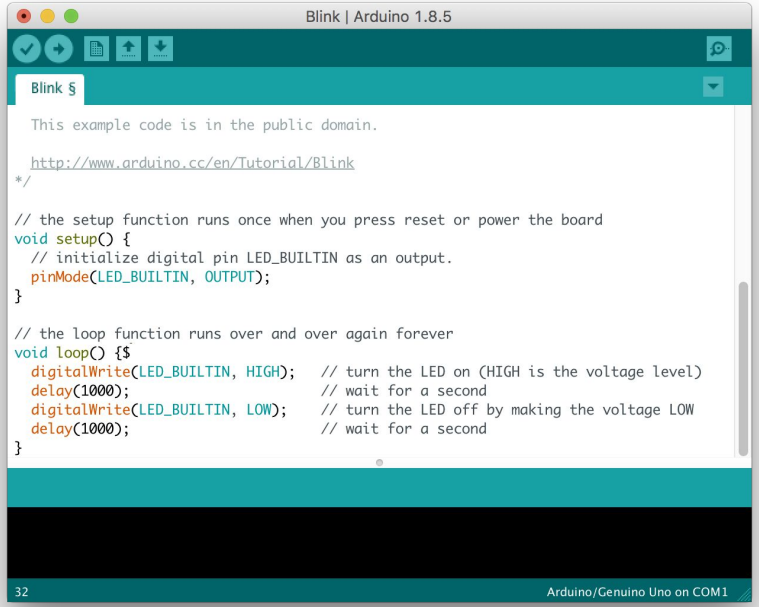
Software Selection

Arduino IDE Code simple and easy to use.

Uses C++, courses we have all taken.

Each part is compatible with arduino and has the libraries available online.

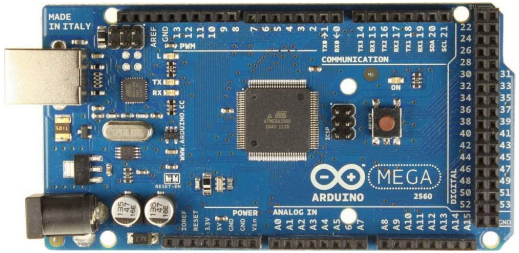
All of us are Electrical Engineers so the coding is a bit on the weaker side; however, all the resources online have made the process fairly straight forward.



Microprocessor Selection

Feature	Atmega328	ATmega2560	MSP430G2553	BCM2837
Voltage Range	1.7- 5.4 V	1.8 - 5.5 V	1.7 - 3.5 V	2.5 - 6.1 V
Temperature Range (Celcius)	-40° - 86°	-40° - 85°	-40° - 85°	-25° - 80°
Low Power	Yes	Yes	Yes	Yes
Power Consumption	200uA at 1MHz	500 uA at 1MHz	330uA at 1 MHz	3500 mW
Clock frequency	20 MHz	16 MHz	16 MHz	1.2 GHz
Analog I/O	Input	Input	Input/Output	Input/Output
Digital I/O	Input/Output	Input/Output	Input/Output	Input/Output
Memory	32 KB Flash	64 KB Flash	16 KB Flash	512 KB Cache
GPIO Pin Count	20	100	24	40
Avg. Board Price	$16.72	$40.40	$18.94	$34.98

Atmega 2560 processor



Voltage Range: 1.8 - 5.5 V

Temperature Range: -40° - 85°

Power Consumption: 500 uA at 1MHz

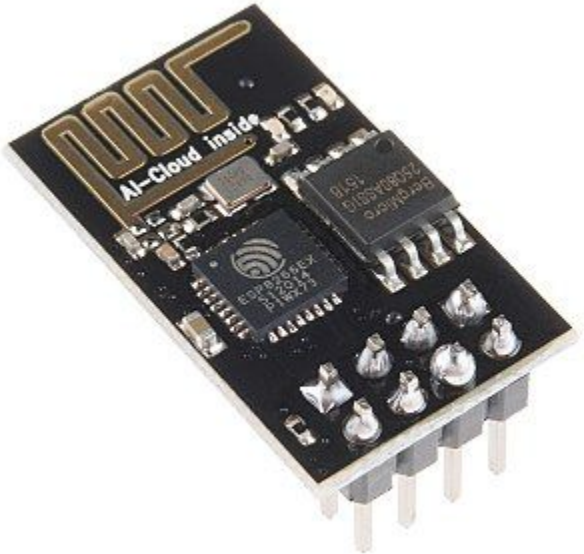
Clock frequency: 16 MHz

Memory: 64 KB Flash

GPIO Pin Count: 100

Avg. Board Price: $40

Wifi chip: ESP8226



1MB Flash Memory

Integrated TCP/IP protocol stack

Power down leakage current of <10uA

VCC-3.0-3.6V

802.11 b/g/n

2.4GHz

Ardunio 4x4 keypad

Membrane Switch

Membrane Keypad Switch

Matrix Array 4x4 16 Keys

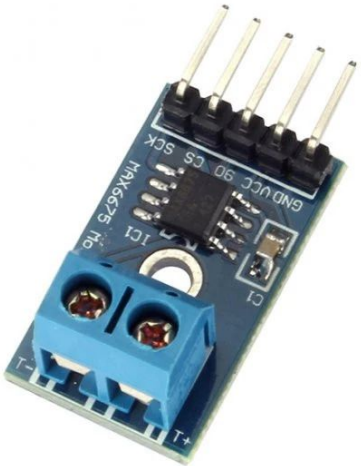
8 pins connector Switch Keypad

Switch Keypad for Arduino/AVR/PIC

Oven Temperature Sensors

Sensor	Pros	Cons
Negative Temperature Coefficient (NTC) Thermistor	Price, Accuracy, and Linear	Out of our temperature range
Resistance Temperature Detector (RTD)	Accuracy, Operating Range, & Linear	Most Expensive
Thermocouple	Widest Operating Range	Low accuracy and nonlinear
Semiconductor-based sensors	Linear	Out of our temperature range with slow responsiveness

Sainsmart max6675 module with k type thermocouple



Temperature Range: 0 to 1024 °C

Avg. Price: $15

Size: 25.0mm x 15.0mm x 13.0mm

Weight: 4g

Type of Sensor: Thermocouple

Sunfounder I2C 1602 LCD display

Display: 4 lines x 20 characters

Backlight: Blue with white character color

Pin Definition: VCC/ GND/SDL and SCA

Working Voltage: 5V

Default Address: 0x27, 0x3F

Black and decker toaster oven

Exclusive Even Toast Technology

120 volts

1150 watts

14.5 x 8.8 x 10.8 Inches

Removable crumb tray

Opto 22 solid state relay 240D25-17

Nominal Voltage Line - 240VAC (Ports 1 and 2)

3-32 VDC Control (Ports 3 and 4)

Turn-on Time: ½ Max Cycle

Turn-off Time: ½ Max Cycle

Operating Frequency: 25 - 65 hz

Can be turned on and off with a 5V DC output from PCB

DSD TECH SH-U09C2 USB to TTL Adapter Built-in FTDI FT232RL

Transfers code without a USB connection.

Uses 6 pins that connect to the GPIO pins available on the arduino board

Flash ATmega 2560 with arduino code

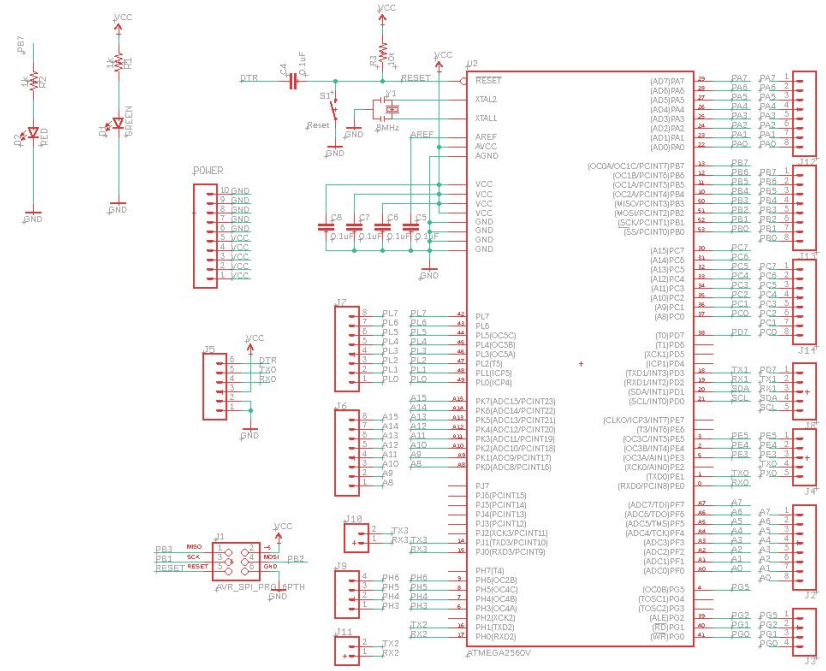
Supports 5V, 3.3V and 1.8V Logic TTL levels

Easy to use than ICSP (In circuit serial programmer). Requires another device, more complex.

Testing Schedule

- Many of the parts have been tested already individually, but as we continue with our project we must test certain devices together to make sure none interfere with each other.
- Each Part will be testing on a development board and eventually tested on our on PCB
- The Keypad, LCD Display, and Temperature Sensors have been tested and work well by themselves
    - They have also been tested will toaster oven is on
    - Next step is to test them while mounted to the toaster when its on
- Power testing will be done with Solid State Relay.
- PCB will be tested once it comes in shortly
- Website will be tested once created

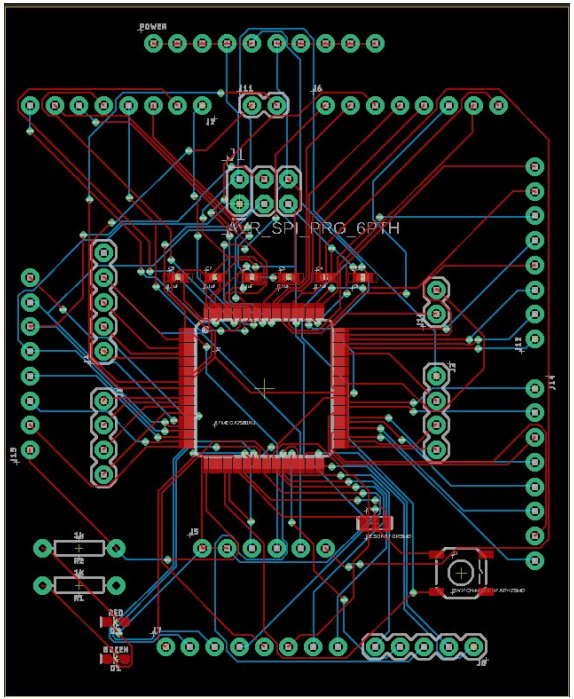
PCB Schematic



Coded through Eagle PCB Software.

Took Junior Design with the man, the myth, the legend The Dr. Richie, so it has not been difficult using eagle tools to design the PCB.

PCB Layout

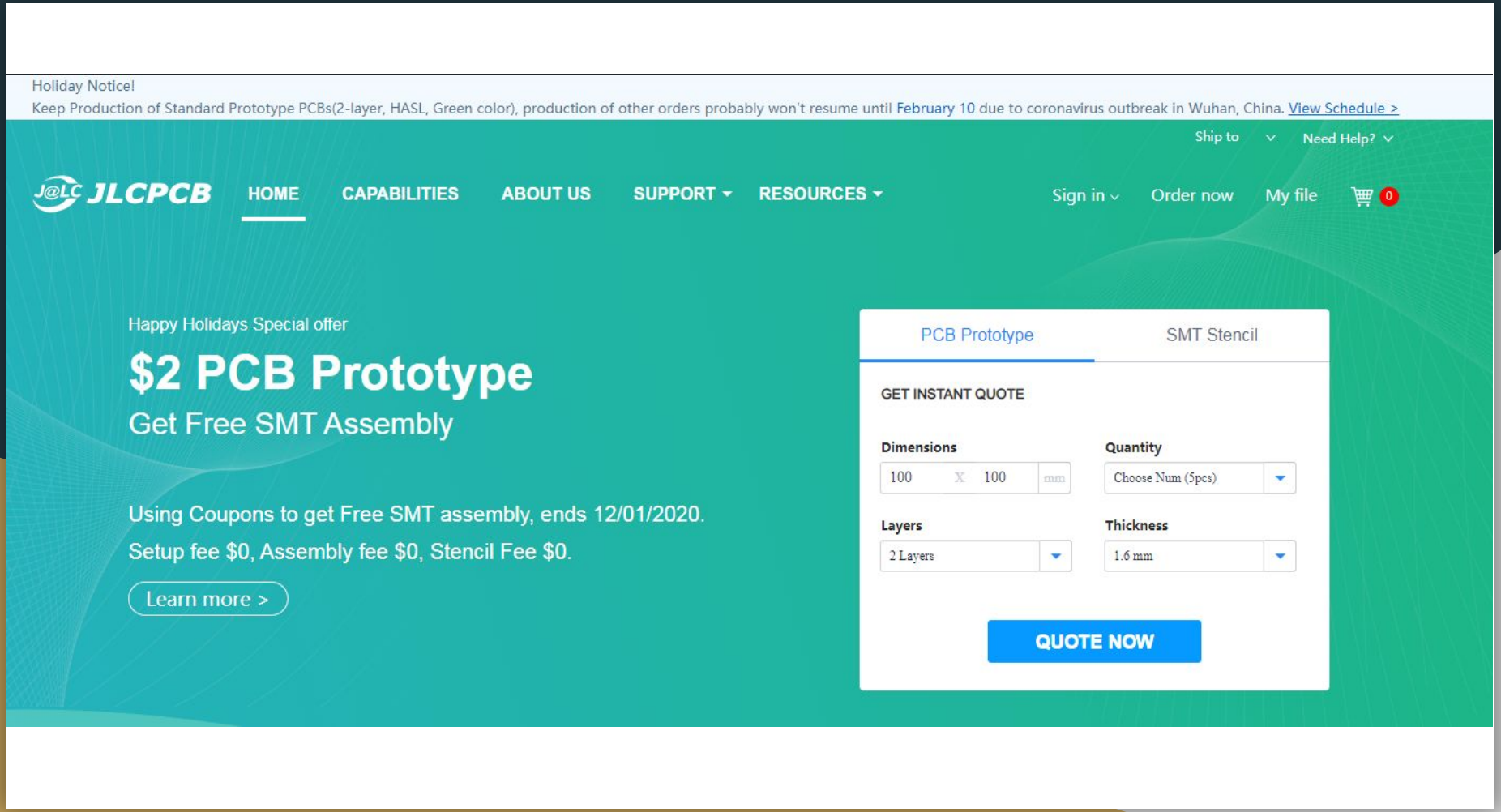


JLCPCB

PCB manufacturer we are using from China.

Verified to be Coronavirus free

*PCB Got Delayed Because of the Virus


Holiday Notice!
Keep Production of Standard Prototype PCBs(2-layer, HASL, Green color), production of other orders probably won't resume until February 10 due to coronavirus outbreak in Wuhan, China. View Schedule >
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Dimensions
100
X
100
mm
Quantity
Choose Num (5pcs)
Layers
2 Layers
Thickness
1.6 mm
QUOTE NOW

Mechanical aspects

- Since we bought a toaster and are remodeling it, many mechanical changes must be made
- This begins by gutting everything out, leaving only the shell of the toaster
- The knobs are of no use to us to that must carefully be removed as well
- The amount of space required for all of the electrical components must remain in mind
    - This is why we are making a toaster oven and not just a toaster
- Electronic components must not be affected by the heating of the toaster oven
- A flat service must be available for the touchpad and display

Work Distribution

Ryan Nolan - Electrical Engineering

Ryan will focus primarily on developing the software for the LCD display. He's taken a few extra computer engineering courses as his senior electives so this will be the best task for him in this project. Also will be working on the website since he has experience building them.

Alexander Tsangarakis - Electrical Engineering

Alex is going to focus on the PCB design and all of the wiring associated with the project. He's the best at the hardware side of things so he will be taking the lead in that side of things.

James Chroma - Electrical Engineering

James will figure out how to connect the smart toaster oven to the phone. He's going to figure out the wifi connection and the best way to communicate the info over to the user that is using the smart toaster oven. Also in charge of any mechanical aspects needed for the project.

Budget Estimated

Item	Budgeted Cost
Arduino Board	$20
Toaster Oven	$200
LCD Display	$50
Sensors	$80
PCB	$20
Other Supplies	$125
Total	$495

Total Cost

Item	Budgeted Cost
Arduino Test Board	Free
Toaster Oven	$40
LCD Display	$9
Sensors	$14
Solid State Relay	$28
PCB	$15
Processor	$30
Keypad	$7
Surface Mount PCB Parts	$5
Total	$148

Financing

We will be paying out of pocket for this project.

It’s budget friendly and we didn’t want to work with a sponsored project.

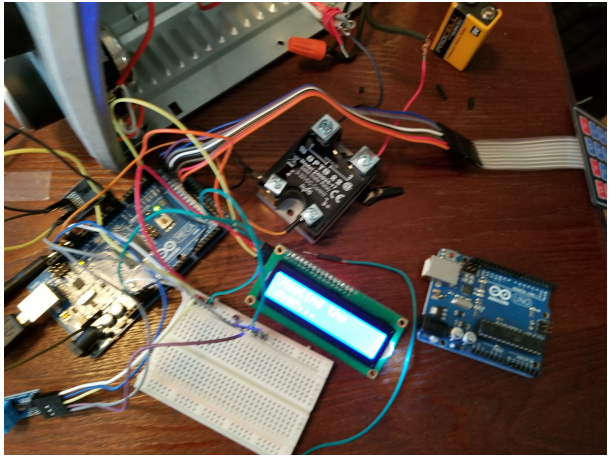
Current Issues

WiFi Chip works, struggling to code the correct functions.

Ordered the PCB, still need to solder all the components & test the arduino code.

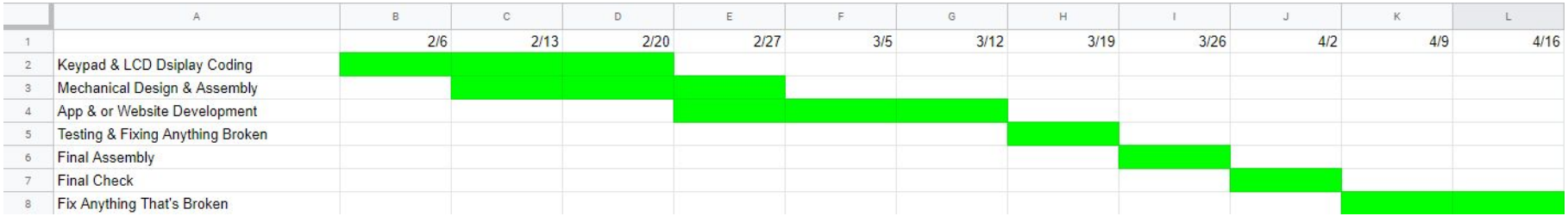
Have not removed dials or mounted LCD Display

Current Progress



Progress Chart

Final Steps



	A	B	C	D	E	F	G	H	I	J	K	L
1		2/6	2/13	2/20	2/27	3/5	3/12	3/19	3/26	4/2	4/9	4/16
2	Keypad & LCD Dsiplay Coding											
3	Mechanical Design & Assembly											
4	App & or Website Development											
5	Testing & Fixing Anything Broken											
6	Final Assembly											
7	Final Check											
8	Fix Anything That's Broken											

Questions?