

Introductory video

<https://youtu.be/rN0005a5USM>

Senior capstone- Crumbletech

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Metrics

Project Specifications

- · Maximum allowable temperature of 200 degrees Fahrenheit
- · Common running temperature of 100 – 150 Degrees Fahrenheit
- · Accuracy of the temperature +/- 10 -15 Degrees Fahrenheit
- · 4-20mA output signal, 0-10V, Serial (industry standard for PLC)
- · Must have a method for the verification of effectiveness of our Temperature Sensor System
- · Prototype Sensor must be testable on Forest Concepts Research Head

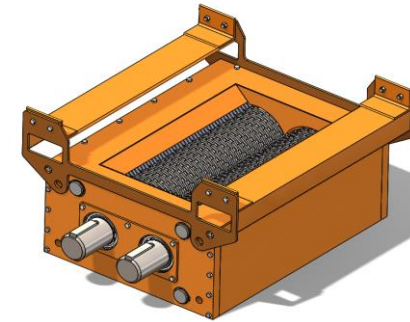


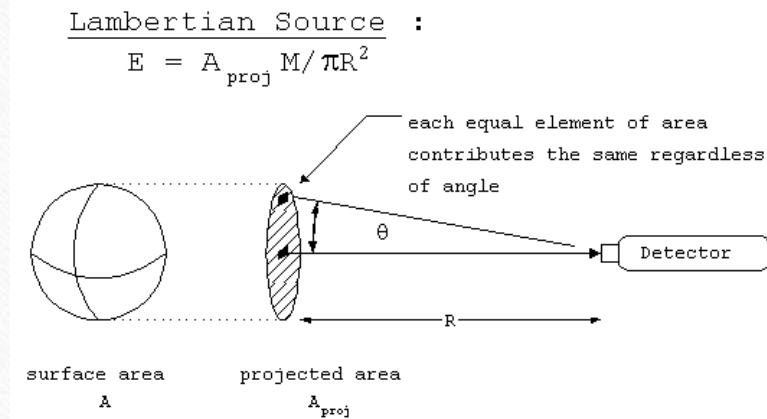
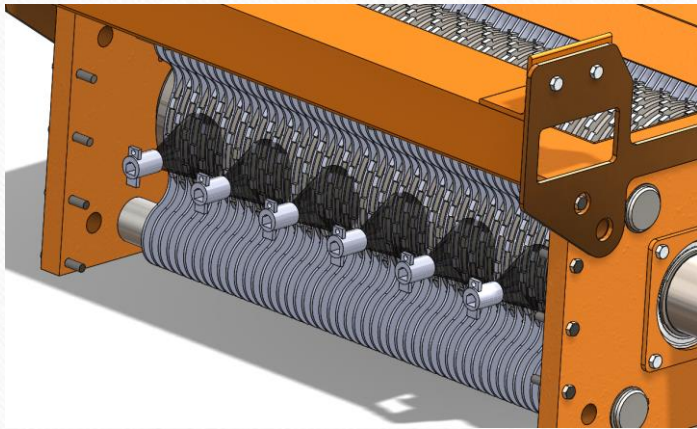
Figure 1: M Series Crumbler Head

Design Ideas

- 1. Thermocouple on the Crumbler clearing plates
- 2. IR Sensor array on the outer plate
- 3. Thermocouple array on the end product

Chosen Design

- 2. IR Sensor Array



IR Sensor Array

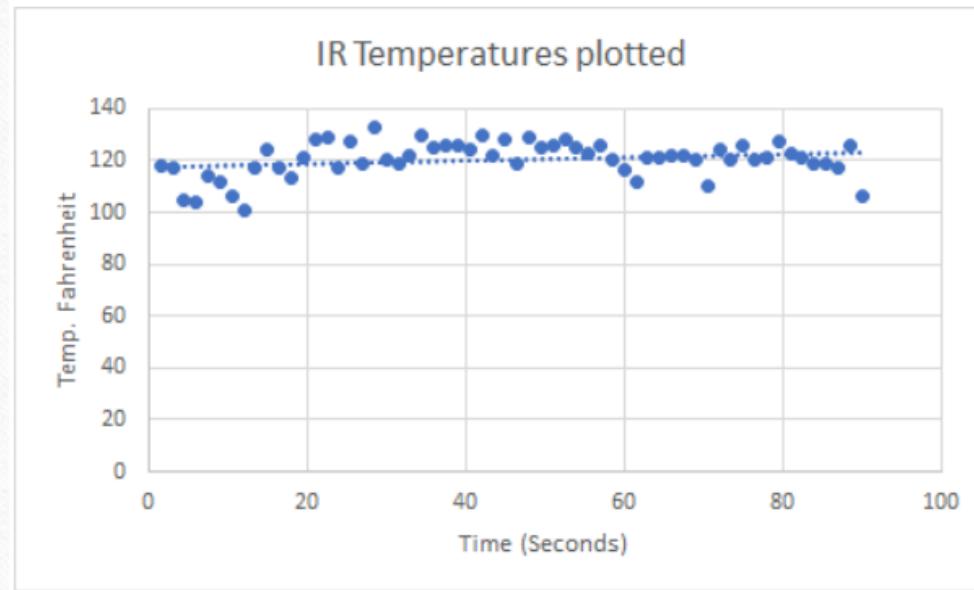
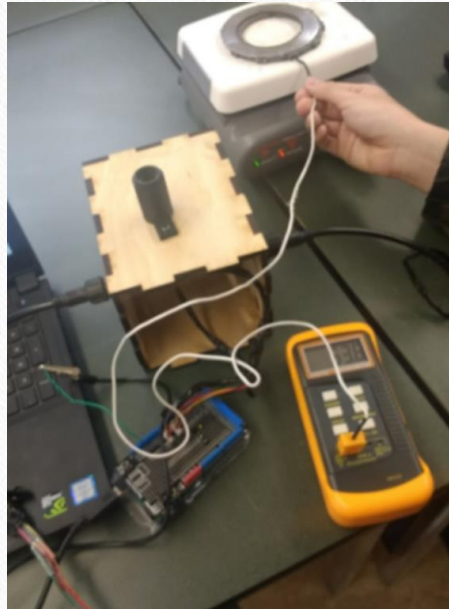
- Freetronics IR Temp module
- -Arduino output 4-40mA, compatible with Labview (serial interface)
- - $\pm 2^{\circ}\text{C}$ Full scale output
- -Adjustable emissivity settings
- -\$20 per sensor

Emissivity with our Sensor

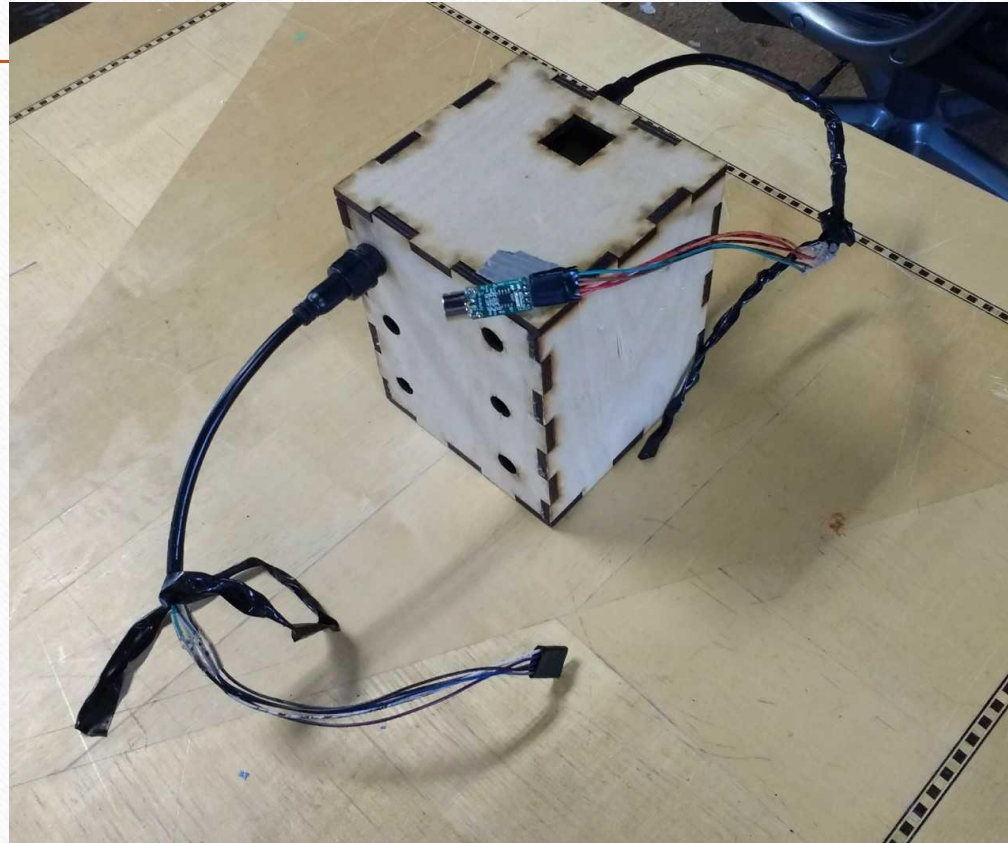
- The IR Sensor has a preset Emissivity of .95
- We will use the Stefan Boltzmann Law and rearrange it to adjust our emissivity to a desirable outcome.

$$\epsilon_1 * \frac{T_1^4}{T_2^4} = \epsilon_2$$

Emissivity Calibration

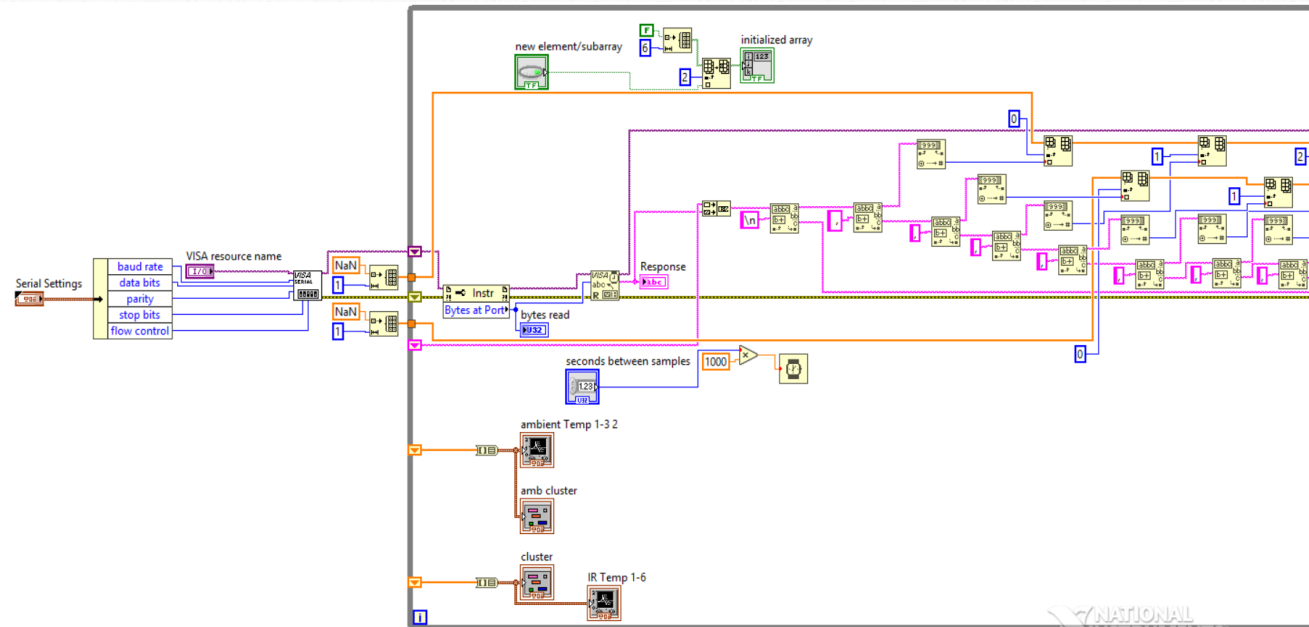


Prototype

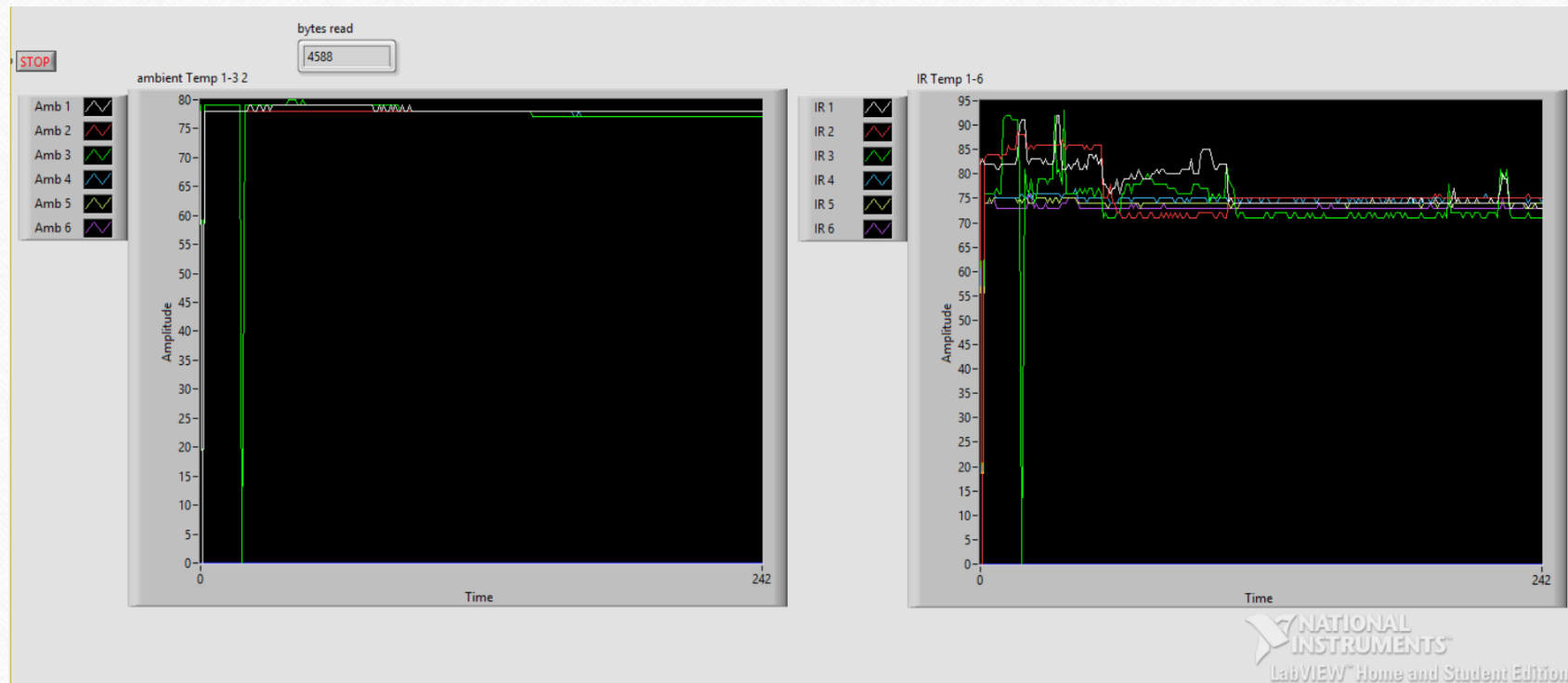


Labview and Arduino

- Arduino Serial.print string of data
- NI VISA receives the string
- String sort to place data into proper array



User Interface

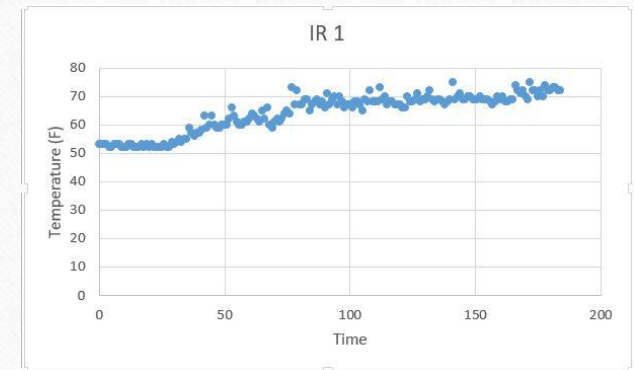


Prototype Validation



Forest Concepts tested prototype:

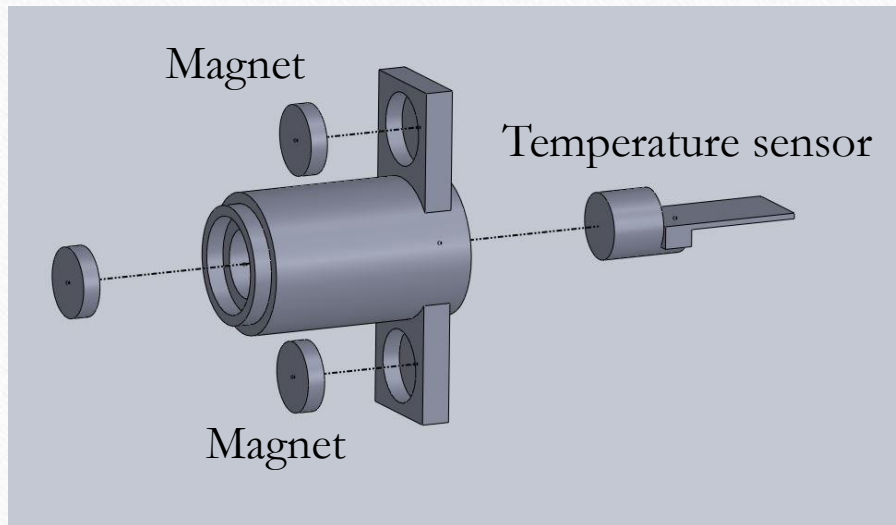
- Confirmed usability
- Confirmed Temperature accuracy with Thermal Imaging camera



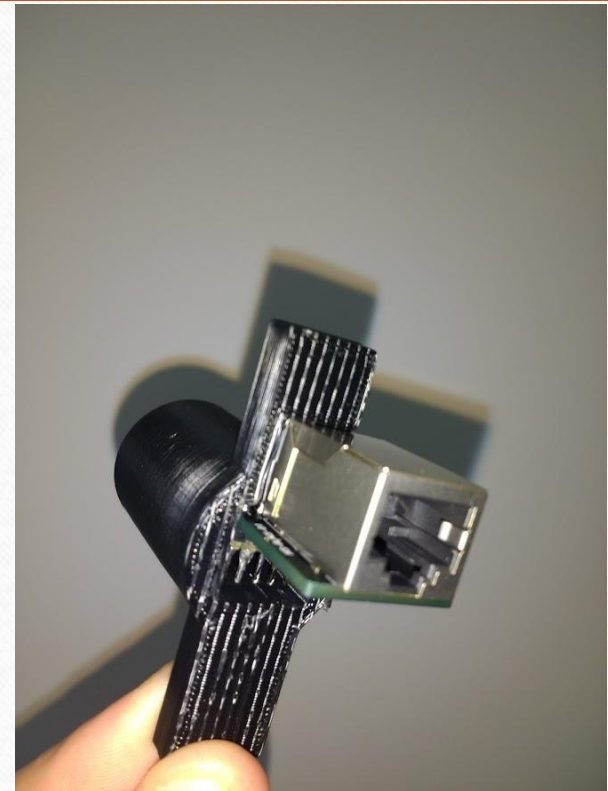
Final Hardware

- Arduino Mega Board
- Ethernet Cables/Connectors
- PCB
- IR Sensors
- Sensor Housings (3D Printed)

Sensor Housing



ABS Plastic, 3D
Printed, extrudes at
220C (well above
specified temps)

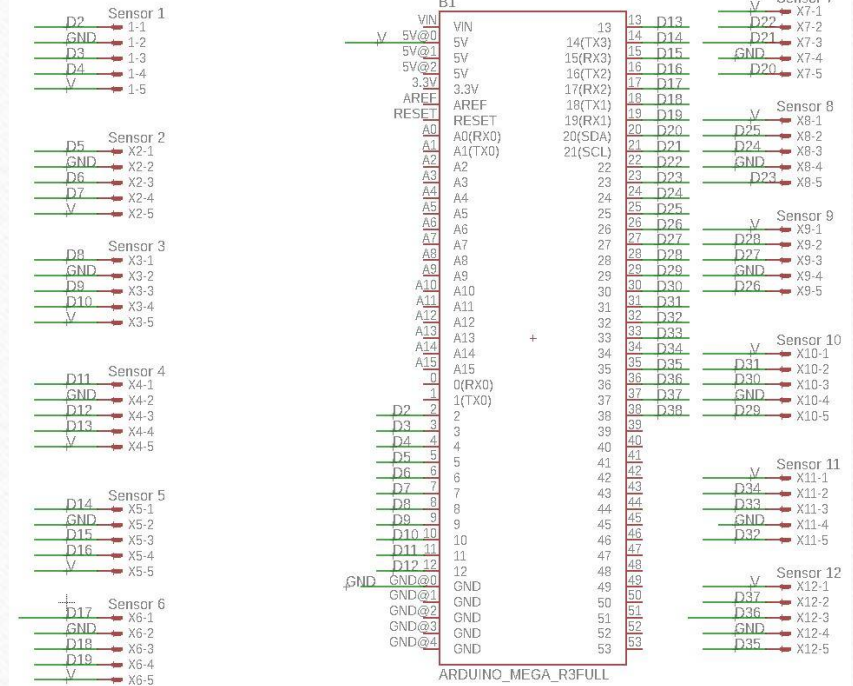
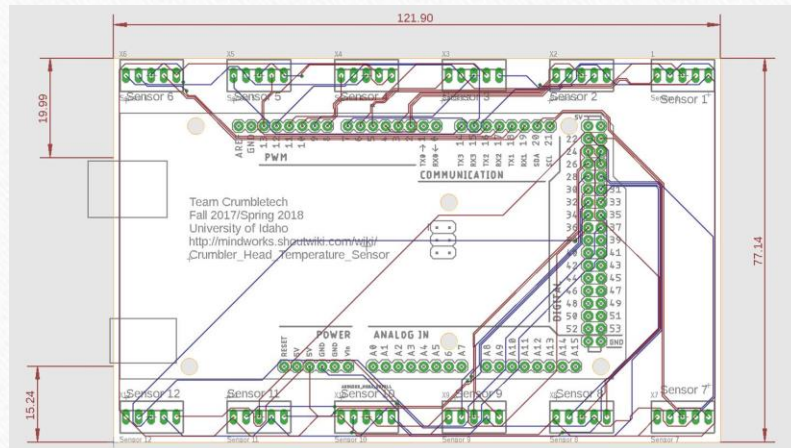


Arduino Mega, Ethernet ports/cables, and System housing



PCB (Custom Arduino Shield)

- Final build using Eagle software
- Customcircuitboards.com



Design Achievements

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- 4-20mA output signal, 0-10V, Serial (industry standard for PLC)
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Items	Item Cost	Total Cost	Status	Qty
Arduino Mega Screw terminal Shield	24.99	26.49	received	1
IR Temp Sensor	27.5	\$275	received	10
IR Temp. Sensor	\$18.70	\$37.4	shipped	2
Arduino A000067 DevBrd, ATMEGA2560 Arduino Mega 2560 R3	\$42.99	\$42.99	shipped	1
Neodymium Magnets 100 pcs	\$11.98	\$11.98	Shipped	1
120 pcs Dupont Wires with ribbon cables kit	\$0.99	\$0.99	Shipped	1
Mega ProtoShield Prototype with mini breadboard	\$0.99	\$0.99	Shipped	1
2 Pcs RJ45 8-pin Connector (RJ45C)	\$12.95	\$164.72	shipped	12
5 Wire plugs	\$11.99	\$38.13	shipped	3
Cable Matters 160021 3-Foot Cat6 Snagless Ethernet Patch Cable	\$10.99	\$23.30	shipped	2
5 pin Connectors	\$12.99	\$41.30	Shipped	3
Expo Poster	\$72.80	\$72.80	Deliver -PU	1
PCB	\$150.00	\$159.00	shipped	1
Total cost so far				\$913.09

Budget

- Total cost \$913.09

Questions?
