Portland State
UNIVERSITY

Erebus
STEM SENSORS

DESIGN SPECIFICATION

Labs
Version 1.1

1/30/2014

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VERSION HISTORY

Version #	Implemented By	Revision Date	Reason
1.1	Scott Lawson	1/30/2014	Changed to Standardized Format Added microcontroller costs
1.0	Scott Lawson	1/28/2014	Initial Release

NOTE TO READER

This is a template obtained from:
http://www2.cdc.gov/cdcup/library/templates/default.htm

Template Name: Product Design

UP Template Version: 12/31/07

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1 INTRODUCTION

1.1 PURPOSE OF THE DOCUMENT

This document describes the budget allotted and cost estimations for the Erebus Labs STEM Sensor. This document is intended to be a living document. As such, it should be updated whenever new budget-related information is available. The reader should be aware that information contained in this document may change at any time.

1.2 OBJECTIVE STATEMENT

Encourage an interest in STEM in K-12 students by delivering a working prototype of an affordable, simple and flexible device to collect environmental data.

1.3 OVERVIEW

This document is divided into two sections:

1. Development Costs

   This section contains estimated costs related to the development of the STEM Sensor. This section is further divided into two sections: a ledger to track purchases that have already been made, and expected future costs.

2. Bill of Materials Costs

   These are costs associated with the production of a single sensor unit, excluding amortized development costs. As design/part decisions are made, the BOM will be updated to reflect those decisions, and the ranges will be replaced with known values.

2 DEVELOPMENT COSTS

2.1 LEDGER

Date Entered	Item	Cost (Ea)	Quantity	Ext. Cost
Total				$0.00

2.2 ANTICIPATED COSTS

Item	Cost (Ea)	Quantity	Ext. Cost	Cost Factors
Sensor	1.00 – 25.00	5 – 8	5.00 – 50.00[1]	Type, Quantity of each type
µController	5.52	5 – 8	27.60 – 44.16	PSoC3 – CY832
Batteries	0.75 – 12.00	5 – 16[2]	12.00 – 60.00[2]	Rechargeable, composition, form factor
Passives[4]	0.05 – 2.00	50 – 100	20.00 – 30.00[1]	Values and tolerances required
Interfaces[5]	0.50 – 8.00	16 - 25	8.00 – 50.00	Wireless vs. Wired
PCBs[6]	4.00 – 18.00	4 - 6	24.00 – 48.00	PCB Area, sensor requirements
Other SI[7]	0.50 – 2.00	16 – 30	8.00 – 50.00[1]	Battery selection, sensor output
Packaging	3.00 – 75.00	2 – 3	9.00 – 225.00	Materials: laser-cut acrylic vs. 3D-printer
Software	0.00	0.00	0.00	Only utilizing free development software
Total:				100.00 – 500.00

1. Extended cost does not scale linearly with quantity because it is assumed that the maximum quantity would not be entirely comprised of the most expensive components.
2. Quantity and extended cost assume either a small amount of expensive rechargeable proprietary batteries, or a larger amount of cheap (AA or 9V) batteries.
3. Resistors, capacitors, inductors, LEDs
4. Antennas, transceivers, receivers, cable jacks
5. Assumes a PCB for the base unit as well as separate PCBs for the interchangeable sensors.
   Example: Minimum extended cost is based on a 2in x 2in base unit PCB with two 1in x 1in sensor PCBs at $2.00 per square inch, x2 prototypes.
6. Other semiconductors: op-amps, voltage regulators, discrete transistors

3 BOM COSTS

Low Price-point Example: one base unit with two external interchangeable sensors. Single unit cost assuming volume is low enough that there are no quantity discounts.

Item	Cost (Ea)	Quantity	Ext. Cost	Notes
Sensor	0.19, 5.99	2	6.18	Temperature Sensor, CO sensor
µController	5.52	1	1.36	PSoC3 CY8C3245PVI-150
Batteries	2.14	1	2.14	Standard 9v Battery
Passives	0.05 – 0.50	10	3.00	Misc resistors, capacitors, LEDs
Interfaces	0.50	4	2.00	Generic jack for sensors, USB for base
PCBs	4.00 – 8.00	3	16.00	2”x2” base PCB, 1”x2” PCB per sensor
Packaging	3.00	1	3.00	Laser-cut acrylic from EPL, hand assembled
Total:				$33.68

Note: This example makes assumptions about future decisions for the purpose of estimating the cost of a single unit, and should only be used as a general reference.

APPENDIX A: GLOSSARY

A.1 ACRONYMS

Acronym	Meaning
ADC	Analog-to-Digital Converter
BOM	Bill of Materials
CO	Carbon Monoxide
CSV	Comma-separated-value formatted file
EEPROM	Electrically Erasable Programmable Read-Only Memory
EPL	The Portland State University Engineering and Prototyping Lab
I^2C	The Inter-Integrated Circuit communication protocol
ISR	Interrupt Service Routine
K-12	Kindergarten through 12^{th} grade school
LED	Light Emanating Diode
PCB	Printed Circuit Board
PSoC	Programmable System On Chip
SI	Silicon
SPI	Serial Peripheral Interface Bus
STEM	Science, Technology, Engineering and Math
TRM	Technical Reference Manual
USB	Universal Serial Bus

A.2 SYSTEM ARCHITECTURE

Base Unit

The central device that manages power, communication, and data storage, and has one or more sensors attached to it.

Sensor

The individual data collection devices such as VOC detectors and thermometers that are attached to the base unit.

User Interface

The program that will be run on a laptop or desktop computer that allows the user to view and interact with the data collected.

System

The operational product comprised of base units with attached sensors and a user interface.