

Proposal for the design and construction of a temperature sensor and datalogging platform for teachers and students

Cambridge School of Weston

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Abstract

The Cambridge School of Weston (CSW) is looking to develop lessons plans that use firsthand, experimental investigation of greenhouse gases and global warming as a springboard for broader discussion and deeper investigation of the issues involved. As part of this, they need an accessible, durable datalogging system that allows them to capture temperature at regular intervals.

An initial estimate of the work necessary to build this to their specifications indicates that it will require at most, sixty manhours of work and produce a product whose unit, wholesale cost is around sixty dollars.

This project requires a rugged, weatherproof enclosures; plug-and-play datalogging; and extensive documentation. We will be designing and building both a product version (intended for users who just want to purchase a solution) and a kit version (intended for users who are willing and able to build the product from scratch).

CSW's classes start September 3rd; they've requested that this be ready by early October. We have not secured payment or agreed on a price with them, yet.

1 What are we doing?

We want to design and build a setup to allow easy, temperature sensing and datalogging for students and teachers.

2 Who are we working for?

Cambridge School of Weston, a private school in Massachusetts who is looking to develop a set of lessons around the simulation and experimental investigation of global warming.

2.1 Contacts

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3 What are their needs?

- 0.1° resolution
- Indoor/outdoor datalogger
- 0 – 100° range
- Extremely durable
- Easy-to-use, outputs CSV/Excel files
- Battery powered
- Sample rate from once every 30 seconds up to once an hour
- Low noise
- Ability to measure the temperature of glass
- Easy to mount on any surface
- Easy to calibrate (/calibration process)
- Possible wireless capability for remote data{sensing, logging}
- User manual and extensive documentation

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- They do not *need* this project to promote or facilitate “cross-disciplinary” integration; however, CSW is enthusiastic about the possibility that one day students could build this product in their physics class, bring it to their biology class, use it, etc.

4 How does it help us?

Cambridge School of Weston will pay for our time and material costs; they are funded by an endowment from Prof. Eric von Hippel at MIT³. This is a product that—particularly given that everyone is excited about energy and global warming—had the potential to appeal to a broad range of teachers and students interested in getting a firsthand sense of the issues.

At the end of this project, we’ll have a product we could sell. Not only will we have the datalogging platform and temperature sensors designed and documented, but we’ll also have a project which lends itself to being converted into a kit.

By designing our datalogger carefully, we can lay the foundations for a platform spanning a wide variety of instrumentation. Furthermore, if we use a platform like the Arduino⁴, we open doors to further involvement and engineering projects for the school, given the flexibility of the platform.

5 When does this need to be done?

October 1.

6 What do we have to do to make this work?

- Design a circuitboard that can convert analog to digital values, store data, and load the data onto a computer (via USB or wireless)
- Program microcontrollers
- Find some sensors
- Work with kids and teachers, finding how to make the product [more] usable.
- Design and build a weatherproof enclosure for it

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⁴<http://arduino.cc>

- Write clear, well-illustrated documentation for its use
- Figure out how to mount sensors to glass and measure the glass's temperature
- Find low noise cables to be used with the sensors.

7 What materials are needed?

- Circuit board components
- Circuit board revisions
- Material for weatherproof case
- Materials for mounting sensors
- Sensors
- Low noise cables

8 How much will a unit cost?

Here is an unsourced breakdown, *i.e.* a guesstimate:

- Circuit board components \$30 without wireless, up to \$55 with wireless.
- Circuit board \$5
- Weatherproof case \$10
- Mounting materials \$2
- Sensors \$10
- Low noise cables \$3

Total cost: \$60-\$85

9 How long will it take?

- Design a circuitboard that can convert analog to digital values, store data, and load the data onto a computer (via USB or wireless): 10 hours
- Program microcontrollers: 2 hours
- Design kit version of circuitboard: 2 hours
- Find some sensors: 2 hours
- Work with kids and teachers, finding how to make the product [more] usable: 8 hours
- Design and build a weatherproof enclosure for it: 5 hours
- Write clear, well-illustrated documentation for its use: 30 hours
- Figure out how to mount sensors to glass and measure the glass's temperature: 5 hours
- Find low noise cables to be used with the sensors: 1 hour

10 How do you plan to make this?

1. Revise time and material estimates
2. Check with Cambridge School of Weston regarding budget and secure payment
3. User interface design: mockup of unit and use cases
4. Design and build enclosure
5. Design, fabricate, and test board
6. Complete first prototype
7. Complete initial documentation
8. First field testing (document feedback)
9. Revise and redeploy until CSW is satisfied
10. Polish documentation
11. Deploy

11 What documentation needs to be written?

11.1 Product version

1. How does it work?
2. Annotated, thoroughly explained diagram of circuit board
3. Illustrated workflow/protocol
4. Walk through collection and analysis of a day of data
5. Common problems and their solutions

11.2 Kit version

1. How does it work?
2. Annotated, thoroughly explained diagram of circuit board
3. Illustrated guide to assembly
4. Walk through collection and analysis of a day of data
5. Common problems and their solutions