Design Issues

Battery Cell Testing Chamber

Design Team 7

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# Contents

Introduction .................................................................................................................. 3

Product Lifecycle Management .................................................................................... 3
  Design .......................................................................................................................... 3
  Production ................................................................................................................ 4
  Distribution ............................................................................................................... 4
  Consumption ........................................................................................................... 5
  Retirement ............................................................................................................... 5

Safety .......................................................................................................................... 5
  High Temperature .................................................................................................... 5
  Electrical shock ........................................................................................................ 6

Universal Design Principles ....................................................................................... 6
  User interface ........................................................................................................... 6
  Alarm system .......................................................................................................... 7
Introduction

The goal of any engineering project is to safely and effectively implement a solution to a problem. Engineers strive to produce solutions to real world problems safely and cost effectively. During the engineering process it is important to consider several issues other than design requirements. Some of these issues are lifecycle management, safety concerns, and universal design. The following document assesses some of these issues.

Product Lifecycle Management

Design

The design starts with gathering customer needs and requirements. The customer XG Sciences wants the design team to deliver a modified environmental chamber to keep a constant temperature within a $\pm 1 ^\circ C$ range. To accomplish this, the team will implement a PID controller. The customer also requested that the system should be able to communicate with their computers so they can monitor any variations in the temperature and to verify the product operated within the limitations of the design. The controller logic and the computer monitoring system will be done with a microcontroller. The microcontroller will read from a temperature sensor and perform the required calculations to tell the chamber to apply more or less power depending on the cycle setting. The temperature sensor will be attached to the microcontroller and read through an analog-to-digital converter. The chamber also needs to be modified in order to hold the battery cells being tested. The cell holders will need to be easily accessed and connections to monitor these batteries should also be quick to make. When all of the needs stated have been met, the project is then ready for delivery.

As of right now the testing of battery cells in XG Sciences’ lab is being done with a large variance in temperature. The overall goal is to make a high accuracy temperature
chamber that will increase accuracy in testing of the batteries. The major cost the team will endure is time for this functionality. When the project is complete it should be easily implemented into the labs at XG Sciences for their scientists to get accurate results from testing.

The modified environmental chamber will not require significant upgrades. The key point for XG sciences is to have a chamber within this one degree of accuracy. A more accurate system can be produced with better quality parts. The analog-to-digital converter would need to have a higher bit resolution. Also an upgrade on the sensor could be made to get a higher accuracy within a tenth of a degree instead of one degree. These improvements would require a larger budget as well as more time to include these devices into the design but provide an unneeded amount of detail for the application.

Production
The production of this project requires an environmental chamber, PIC microcontroller, a voltage regulator, actuators, keypad, and LCD display. The environmental chamber has both heating and cooling elements inside, so all that would need to be built is the connections from the microcontroller to the inputs of the heating/cooling elements. PCB boards to hold the battery cells will need to be produced as well. Production time will only take as long as the connections to the chamber, maybe a few hours. In order to design this for the PIC microcontroller, an MPLAB ICD 2 was obtained. The cost of the project ensured that every component was developed properly and double checked because there was little room for design errors in both the budget and project timeframe. Energy consumption and environmental considerations were not a factor in this design project because of wall outlet voltage being readily available to the customer.

Distribution
Our product would be available online or by any scientific or industrial distributor. It would require no installation and would be ready to use as soon as it was
plugged in. Because of the size and weight of the product there would need to be some shipping fees, but these would vary between distributors. If the customer is within range to pick up the chamber themselves they may do so to avoid the fee, but we recommend the use of a large vehicle.

Consumption
Our modified chambers are built for industrial and laboratory settings. They will be offered with a standard 5 year warranty that would include free maintenance if part of the chamber were to experience problems.

Retirement
Since the environmental chamber was built to last, it will likely outlive its warranty. After its warranty is expired and it breaks down, customers still have the option to repair the chamber for a fee including parts in labor. We recommend that customers take this route because it would be both cheaper and better for the environment. If the customer is done with the product and would not like it repaired, due to its size and weight, we urge them recycle the mostly metal chamber.

Safety
High Temperature
The chamber we work on has a capability to reach a temperature as high as 500 °C. It is a dangerous temperature range and we need to take this into consideration. Our designed control system will make the chamber always work under 120 °C, even under this, the temperature range is still not safe and the chamber will be possible to hurt people who use it. In order to avoid such kind of things to happen, a temperature alert and self-protection system might be introduced. First, a high-temperature alert light might be added. When the temperature inside the chamber goes over a certain threshold temperature like 50 °C, the high-temperature alert light will illuminate, which indicates that protections, like gloves, are needed for working inside the chamber. Second, though we have our control systems that can control the chamber always
working under 120 °C, there might be situations that our control system malfunctions, which might probably lead to a really high temperature inside the chamber. For now there are safety fuses in our system; however they are all dealing with high currents. Unexpected high temperature inside the chamber might hurt the sensors and other elements we implemented into the chamber, for the reason that those things are designed to work under a certain temperature. Also unexpected high temperature can also hurt the testing samples, which might cause explosion and emission of chemical hazards. The chamber will probably need a self-protection system which is based on the temperature. Several temperature sensors could be used together to monitor the temperature (in case that one sensor does not work correctly). When the temperature goes over 160 °C for a continuous period of time, for example fifteen seconds, the self-protection function will be activated and the whole system will be turned down.

**Electrical shock**

The chamber that our control system is working on is powered by wall outlet, which means that it uses 120 Volts and it can generate current in tens of Amperes. Any type of unexpected operation can be extremely dangerous. In order to avoid electrical shock, several things need to be done. First, the chamber’s working circuit needs to be sealed and high voltage warning message should be made. Secondly, we need to do with our control system. The control system we designed is completely separated from the chamber’s circuit by using alternistor. As a result, any type of operations on our control systems should not have the high voltage danger. However, alternistor might break down and a detailed instruction on how to replace it needs to be introduced and warning message of high voltage needs to be made on alternistor.

**Universal Design Principles**

**User interface**

There are several aspects of the existing interface that could be improved to make ease of use possible for a wider range of people with disabilities. The current design has a small keypad and a small screen, which would make it difficult for people
with lower visual abilities to use the product effectively. In order to make the design usable for people with lower visual ability, the user interface could be improved to make the product more accessible. The key features that could be improved are the keypad and the screen. By having a larger screen and keypad, people with lower visual ability can use the keypad more efficiently, and they can read the screen more capably. Also, the design could be developed in order to be accessible by people with no visual ability. This could be done by using two additional features to the design, by adding the braille letters to each key at the keypad. Also, a sound feature is needed to confirm that the pushed key was transmitted successfully to the system. The sound system could also periodically speak the current temperature, or could have a stability warning that is only alerted when the temperature deviates past its set point. This system would be able to tell if temperature has deviated from its boundaries and if the system malfunctioned.

*Alarm system*

It would be helpful if some visual alarm system is implemented into the design. Such a system would make it more efficient for people with hearing difficulties to know if the system malfunctions at a given time or if the temperature deviated from its selected boundaries. To implement such a system, some lighting would need to be added. An efficient way to do so is to make an LED alarm which is color coded for system malfunctions and temperature deviation. Also, it is important to implement some sound alarm system that tells the user if the chamber is sealed or not. This would make it easy for people with visual difficulties to discern if the system is sealed properly. If the system is not sealed there will be insulating issues that would cause problems for our control system implementation.