Document:	Alternatives Evaluation
Project:	Weather Balloon Altitude Control System
Submitted to:	Hongwei Gao
Submitted by:	Tim Basta, Trevor Clark, Scott Miller
Date:	9/22/2014

Introduction

This section of the report will cover the design alternatives proposed by the Capstone group. These design alternatives are a group of ideas that could possibly be used to accomplish the functional requirements. This report will discuss the design alternatives in detail, then rank them based on operational criteria proposed by the Capstone group. This report will also discuss the user operation requirements for the project. These can include ergonomics, setup, maintenance, and correct operation of the product.

Design Alternatives

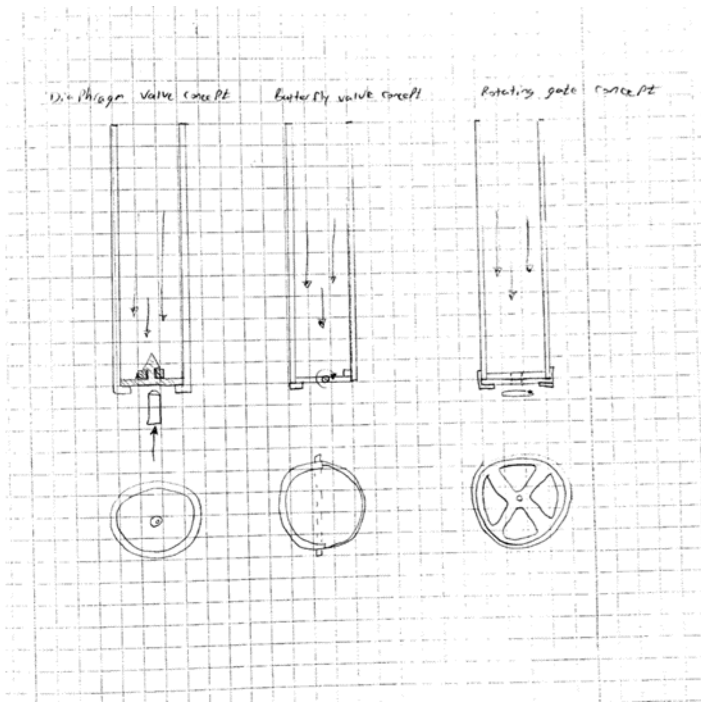
The design alternatives area is where you will be explaining the top design selections that you have come up with. Here, about a 1 – 1 ½ pages for each design idea along with sketches needs to be produced so the reader can get a good understanding of what the concept is. The sketches don't have to be perfect. You can make copies of the ones in your journal and scan them in.

Mechanical design alternatives:

Diaphragm valve: This design alternative will obstruct the flow of Helium through the vent tube with a flexible rubber disk trapped against a ridge internal to the flow tube. Venting will be accomplished by an armature pushing on the diaphragm from the outside, temporarily compromising the seal and allowing the Helium to vent.

Butterfly Valve: This design alternative will use a disk of rigid material connected through the center axis by a rotating connection point. The inside of the flow tube will have a sealing ridge on half of the circumference, and have an identical sealing ridge on the outer opposite side. The flow would be obstructed by having the disk rotated about the pin until it contacts the stops. Helium flow will be allowed by rotating the disk in the opposite way.

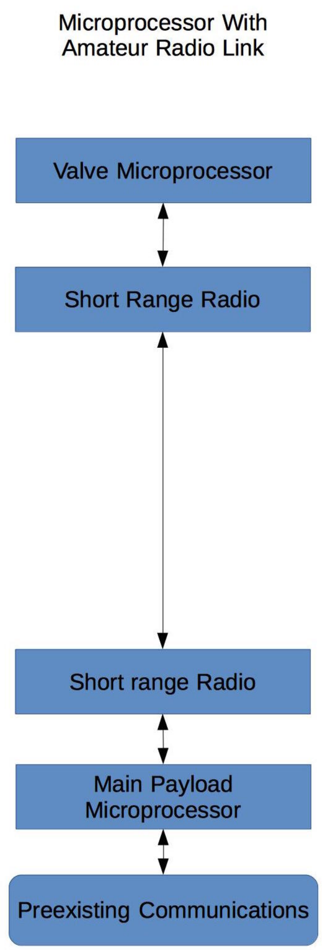
Circular gate Valve: This design will use two circular disks of rigid material that lay flat against one another and cap off the end of the flow tube. Each disk has as identical and symmetrical hole pattern such that when the openings are lined up, gas is allowed to flow through the openings. By rotating the top disk, the openings are misaligned, and the flow opening is closed. The two disks will use a high viscosity lubricant at their interface. This will help make the seal gas tight, as well as prevent the two surfaces from wearing on one another.



Electrical Design Alternatives

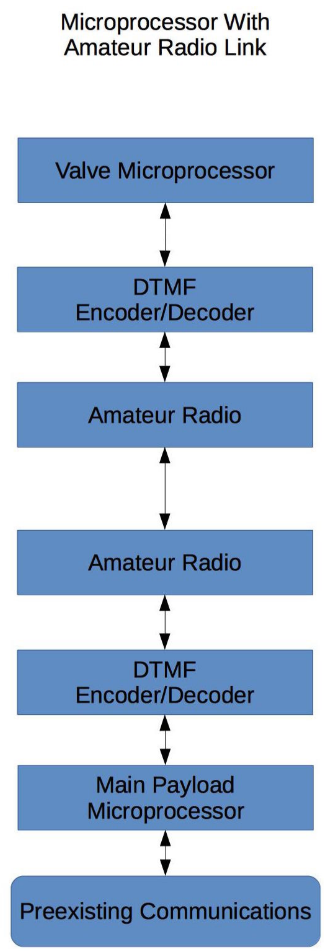
Design Alternative 1: Microprocessor with external short range radio.

This alternative is using a microprocessor with an external short range radio module such as a ZigBee module.



Design Alternative 2: Microprocessor with amateur radio link.

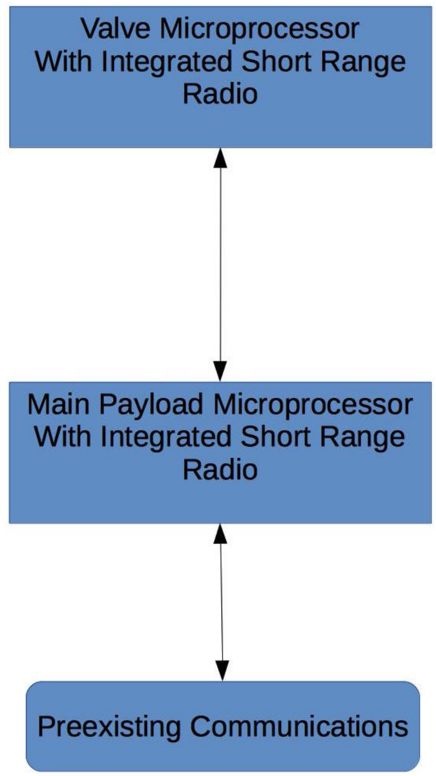
This is probably the most commonly used solution to this design challenge however there are a lot of things to interface together and it is somewhat complicated.



Design Alternative 1: Microprocessor with integrated short range radio.

There are some microprocessors that have integrated radios similar to ZigBee modules. This system wil have the least amount of components

Microprocessor With Integrated Short Range Radio



Client/User Operation

The client and user operation of the valve has both mechanical and electrical considerations and will be explained in detail individually.

Proper operation of the physical valve and related components is vital to the end user successfully deploying the system. There are complexities associated with integrating the system with the end user's tracking and communication system as well as with connecting and filling the necessary weather balloon. Easy to follow instructions and methods to reduce incorrect usage will be vital for preventing errors and avoiding unnecessary confusion and frustration.

The valve system will require an interface on the outside of the flow tube that will allow the user to easily and quickly connect the specified balloon type to it. This will be either a surface that provides enough friction to retain the balloon nozzle, or a latching system that will capture it.

The valve system will also need an in-line fill system that will allow the user to fill the balloon with Helium through the valve system after it has been connected. A unique fill nozzle that can interface on one end with the Helium tank regulator, and on the other end with the valve, will need to be created.

This will allow the user the most efficient launch procedure, instead of having to fill the balloon then attack to the valve.

The electrical and computer user interfaces are also important components of the valve project. The electrical operation considerations will be detailed separately from the computer user interface. Electrical operation includes the specification for interfacing the end user's communications equipment with the valve microprocessor. The computer user interface is used to select the valve's operating mode as well as for downloading sensor and operation data.

The user interface for the electrical system describes how the end user will interface their communications system with the microprocessor within the valve system. Because the valve system must interface with a wide range of tracking and communication systems, a protocol standard must be developed and documented. This document will specify how to physically interface with the valve microprocessor, electrical specifications for logic levels, and how data is expected to be sent and received. The specifications for the physical connection with the device must include port pin-out diagrams, special handling requirements (such as static electricity precautions), and where to find the ports on the printed circuit board. The electrical specification must include maximum and minimum electrical ratings, supported logic levels, and timing requirements. Finally the protocol which is used to communicate data to and from the valve microprocessor must be detailed (such as how and when to acknowledge a data byte).

The computer user interface will be used to both upload operating information to the valve microprocessor and for downloading data stored in its onboard storage. A graphical user interface should be used to easily perform these actions which can be run from either a software application or a specially crafted webpage. If any features are not self-explanatory a user manual or electronic help document should be present to guide the end user through the operation. The interface will allow the end user to select modes of operation such as fully autonomous mode, a desired altitude ceiling, what sensors to record data from, and/or if the valve should expect commands from the end user's own communication equipment mid-flight. The interface must also allow for downloading flight information after the flight has concluded. The user interface must present this data in an easy to work with file format such as comma separated values within a text file.

Decision Matrix:

Using a design matrix the best solution for the design challenge can be selected via quantifiably criteria. In a design matrix on the left the different design alternatives are listed and then along the top of the matrix the different design criteria are listed. Then the design alternatives are systematically scored on a scale, in this case we are using a scale from 1 to 5 with 5 being the best, against the selected criteria. For this design the selected criteria are power usage, cost effective, ease of integration, durability, ease of use, and overall effectiveness. Power usage is probably the most important criteria for this project. This is because low weight is a critical requirement for the ballooning payload. More power usage means more batteries which translates into more weight. Cost effective was chosen as a criterion because the final design needs to cost less than $100 per unit for 100 units. Ease of integration with the rest of the system and ease of use for the end user are obviously important because if it is too difficult to use no one will want to buy or use the product. Durability of the design also translates to the lifetime of the product. A longer product lifetime increases the value for the end user. The design alternatives were also scored for overall effectiveness in meeting the design requirements for this project. The design matrix generated is shown below with total scores for each design alternative in the far right column.

Criteria Scale: 1-5 With 5 Being the Best	Power Usage	Cost Effective	Ease of Integration	Durability	Ease of Use	Overall Effectiveness	**Total**
Design Alternatives							
Wireless System							
Microprocessor and Short Range Radio Separate	3	3	4	3	3	5	**21**
Microprocessor And Amateur Radio With DTMF	1	1	3	3	5	5	**19**
Microprocessor With Built In Short Range Radio	5	5	2	5	3	5	**25**
Mechanical System							
Diaphragm valve	N/A	5	2	1	3	1	**12**
Butterfly Valve	N/A	3	3	4	4	3	**17**
Rotating Gate Valve	N/A	4	5	5	5	5	**24**

From the above design matrix the winning design alternatives are for the wireless system a microprocessor with a built in short range radio and for the mechanical system the rotating gate valve. These designs are superior to the other alternatives when compared with the selected criteria.