Space Balloons by European Astrotech

Phase A – Conceptual Study

Aims

- **Brainstorm experiment ideas**
- **Develop Mission Goals**
- **Research practicalities**

What is a high altitude balloon?

1. The general theory is:
    a. A payload (an insulated box containing some electronics such as a GPS and a radio to allow you to follow progress) is attached to a balloon which is filled with helium (He).
    b. The balloon is released and, as He is lighter than air, the balloon rises and pulls the payload with it.
    c. As the balloon rises the outside pressure decreases which leads to the helium inside the balloon expanding. This causes the balloon to stretch.
    d. The balloon is made of a form of latex and is incredibly stretchy however it gets to a point where it can't stretch anymore and bursts.
    e. Now that there isn't any upward pull from the balloon the payload begins to fall to earth pulled by gravity, as it falls the parachute opens up slowing its descent and it gently glides down to earth.
2. Throughout the flight the GPS module in the payload box is providing information on its position, this information is passed through a microcontroller which reads the info and converts it into another protocol and in most payloads transmits the data over a radio link to the ground station. As a backup sometimes there is also a mobile phone which sends the data as a SMS as well (however this will only work near to the ground as mobile phones don't get signal at high altitudes).
3. Therefore you need to construct a payload box with a tracking device (e.g. GPS module, microcontoller and then a radio/mobile phone). Additional components include for example cameras and temperature sensor. You also will need a parachute, a balloon and some helium and permission to launch.
4. Getting a system that works is harder than it sounds, HAB payloads are difficult to test in advance so there is a failure rate that unfortunately affects us all. The better planned a payload/flight the less chance of something going wrong.

Your experiment

You will be provided with the HAB essentials to ensure a successful flight (see appendix). To make your mission unique, you will design an experiment to fly onboard the payload. The payload mass cannot exceed 1.5kg without compromising altitude so think carefully about how much your experiment weighs. The lighter your payload is, the higher your burst altitude.

Inspiration...

- The balloons reach an average altitude of 30km. What is our atmosphere like at that altitude? Is it comparable to the atmosphere of other planets? How is the atomic composition different to that on the surface of the Earth?

- Where is the ozone layer? What kind of reactions/phenomena causes the ozone layer to be there? How would you detect atmospheric particles?
- What are the levels of radiation at that altitude? How does this radiation affect living things?
- An interesting thing to do is investigate how the change in environment affects a particular thing. For example: what happens to an insect, a plant, food, drink, electronics at 30km above the earth? You can direct the camera at your experiment so you can see what is happening at different altitudes.
- What time of day will you launch? Use the GoPro provided to take pictures of Earth at sunrise/sunset?
- How will you steady your balloon – wind anchors, gyroscopes? Think about the configuration of your balloon/parachute/payload.

Will it work?

Over the next 10 weeks you will be taught the essentials required for a successful launch and recovery. Beyond the essentials it is up to you what you can investigate. However you must make sure it doesn't interfere with the tracking equipment. For example, mobile phones (unless they are in flight mode) can interfere with the radio transmission. Importantly, does your experiment fit within payload weight and size restrictions?

You want your payload interior to remain relatively ambient to keep the electronics happy. Therefore taking any sensor readings inside the payload will not give you any idea of the conditions of the outside atmosphere. You can attach things to the outside of your payload box – think about how you would do this. You may want to make your own sensors, if so you will have to investigate the components needed and the electronic circuit that will allow you to read the data. Additional sensors also require a program to collect the data for analysis so some thought will need to go into how you will do this, examples will be shown during the tracking and telemetry sessions.

What can you investigate without buying lots of extra equipment? If you do need to buy extra equipment, consider who might sponsor you. Many of the launches by European Astrotech have been sponsored by big companies such as Fuller's Brewery and London Wasps. In return they receive photos of their logos at the edge of space.

Suggested resources and topics to investigate

Topics:

- Atmospheric chemistry
- Solar radiation
- Magnetosphere
- Astrobiology
- Balloon dynamics
- Effects of atmospheric temperature and pressure variations on living things
- Meteorology
- Ground to Satellite(HAB) Communication

Resources

- www.seeedstudio.com – Sensors
- http://habitat.habhub.org/mobile-tracker/
- http://www.space.com/
- http://www.google.com/loon/
- http://www.daveakerman.com/
- https://twitter.com/HABbyEAL
- https://www.facebook.com/highaltitudeballooning
- https://github.com/HABduino/HABduino - Code for those interested (more about this in session 4 - tracking and telemetry)
- https://learn.adafruit.com/category/sensors

Project organisation

An important part of this project is intelligent management of time and people. You will have different interests and strengths so assign your responsibilities accordingly. Although you will all be taking part in the HAB sessions, it is useful to have an initial idea of which sub team you would like to be in on the launch day. Your unique experiment may need experimental approaches to the payload, balloon or telemetry sub-systems to obtain the best results. Due to the importance of these sub-systems, the project management will need proof an experiment on any of these systems are tested well and if it does fail it is shown it doesn't affect the safety of the flight. Each team will require creativity and problem solving for a successful flight.

Suggested sub teams:

- Project manager
- Payload team
- Balloon team
- Telemetry Team
- Experiment team

Outline of the project:

11/09 - Introductory Lecture*
18/09 -Research and Development
25/09 - Telemetry and Tracking 1*
9/10 - Design and Development
16/10 - Telemetry and Tracking 2
6/11 - Telemetry and Tracking 3*
13/11 - Payload design and build*
20/11 - Balloon and Parachute dynamics*
27/11 - Balloon and Parachute testing
4/12 - Payload Build
11/12 - Testing and planning 1
LAUNCH DAY (TBC)
Data analysis and presentation preparation (TBC)
Data presentation assembly and Certificate presentation* (TBC)

Most of the classes are focused on understanding and HAB concepts. There will undoubtedly be work to do outside the sessions especially on design of your experiment, which you are primarily responsible for. You will also need to include a brief report of what you did in each class and send it to Samantha or Jonathan at least 24 hours before the next HAB session. The reports don't have to be long. They are just a good way of communicating what you've been doing and somewhere you can ask us questions. We normally suggest setting up a goggle docs page so you can add your own notes to the document and we can see your ideas and progress.

Written report 1

When European Astrotech embarks on a study or project for the European Space Agency we must present a proposal to them. This will define the concept of the mission, scientific opportunities, goals and requirements. You must prepare a similar written report of your conceptual phase.

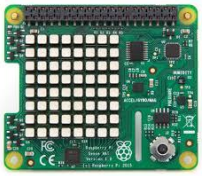
It should include:

- Your experiment ideas
- Motivation behind these ideas
- Related scientific concepts
- Ideas about how you will execute the experiment
- What equipment you will use/ any extra equipment needed
- Any questions you have

Please update your report 24 hours before the next class and if you want to email a specific question you can email either (s.graham@europeanastrotech.com) or (jonathan@europeanastrotech.com)

Appendix

Payload Inventory

		Mass/g
Payload box – 30x11x17cm Other polystyrene		82.5
Nylon tether cord (15m)		~120
Parachute (various sizes)		65
GoPro Hero 3 + waterproof Case + Extra Battery Pac		160
Sense Hat – measures temperature, pressure and humidity		50
Balloon		800
Pi In The Sky Tracker		60

Raspberry Pi		40
Tools and materials	Duck tape, miniature hacksaw, gluegun, superglue, plastic, wood, card, cable ties, soldering iron, spanners etc	
Handwarmers		25g per handwarmer

A 50L cylinder of compressed helium, filling hose and tarpaulin rug are brought to you on your launch day.