FEASIBILITY STUDY FOR STRATOSPHERIC GIS AIRCRAFT MISSION

Assoc. Prof. Dr. Roumiana Ilieva
Faculty of Management, Technical University of Sofia, Bulgaria,

Abstract: *A stratospheric helium balloon flight is planned to be performed by team ARTweSphere, members of the Space Challenges 2012 program. Mission aims to launch a stratospheric balloon 30 kilometers in the atmosphere where certain experiments to be conducted in order to benefit humanity and future sub-orbit biological missions. A set of different experiments are planned: biological experiment (Yeast - Saccharomyces Cerevisiae); measurement of cosmic rays via photo film; safely return a legonaut on the surface of the Earth and take a photo of the Earth surface from 30 km altitude. Out of Space Object (O.S.O.) project specifications are defined. The architecture and aerodynamics of the O.S.O. are outlined. Internal construction is described. Technical specifications are outlined: communication, components and navigation including telemetry downlink (TX), ground station (R, antenna, payload tracking and visualization, balloon predictions (path / burst / landzone), chase car, setup for SDR, RTTY implementation, Styrofoam and heating; detaching mechanism; power supply including battery pack, smart charger, fluid bearing; structure material. Budget, marketing and sponsorship strategies are discussed as well.*
***KEYWORDS**: STRATOSPHERIC, GIS, AIRCRAFT MISSION*

1. Introduction

The *mission aim* is to launch a stratospheric balloon 30 kilometres in the atmosphere (fig.1) where certain experiments to be conducted in order to benefit humanity and future sub-orbit GIS and biological missions. To perform this aim the following mission objectives are set: to take a photo of Bulgaria from 30km altitude, safely return a legonaut on the surface of the Earth and perform scientific experiments. Analysing all the factors influencing the strato-flight, the following procedures are being established:

- Altitude reached with payload, measuring facilities
- Minimum streamline aerodynamic resistance
- Unit's Fluidal Stability
- Hull toughness and effective components distribution
- Radio communications test, GPS transmission
- Biological species experiment related to the atmospheric radiation intensity and field as well as UV influence on bacteria
- Properties and durability test to the housing materials
- Meteorological survey that concerns future air flights and its safety
- Gentle and safe descending /landing after detaching
- ECC ozone density measurement
- NDVI measurements

Fig.1 Simulation of O.S.O.'s Stratospheric Flight

2. Prearranged GIS Experiments

Exploring the influences over the strato-flight, some GIS tests are being scheduled step by step.

2.1. Atmospheric Experiments and Tests

2.1.1. ECC Ozone Density Measurement

The first experiment that is planned to be performed on-board the High Altitude Balloon (HAB) contains Electrochemical Concentration Cell (ECC) ozonesonde (fig.2).

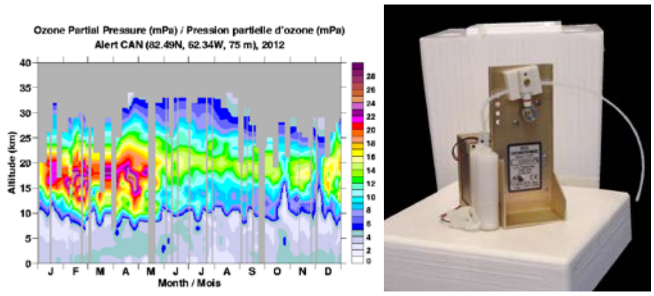


Fig.2 ECC ozonesonde [22]

It is a lightweight, compact, and inexpensive balloonborne instrument for measuring atmospheric ozone. ECC sondes do not require an external electrical potential. The ECC gets its driving electromotive force from the difference in the concentration of the potassium iodide solutions in the instrument's cathode and anode chambers [20]. When ozone enters the sensor, iodine is formed in the cathode half-cell. The cell then converts the iodine to iodide, a process during which electrons flow in the cell's external circuit. By measuring the electron flow (i.e., the cell current) and the rate at which ozone enters the cell per unit time, ozone concentrations can be calculated [21].

2.1.1. NDVI Measurements

Second experiment planned to be performed is a measurement of the NDVI - Normalized Difference Vegetation Index. This can be achieved by measuring Photosynthetic Active Radiation (PAR) spectral region (solar radiation in the near-infrared spectral wavelengths longer than about 700 nanometres), which leaf cells evolved to scatter (i.e. reflect and transmit). An infrared camera, pointed towards the ground was planned to take several pictures of the forests of Bulgaria, while another is taking several high resolution shots of the same area. In general, if there is much more reflected radiation in near-infrared wavelengths than in visible wavelengths, then the vegetation in that pixel is likely to be dense and may contain some type of forest, since NDVI is directly related to the photosynthetic capacity and hence energy absorption of plant canopies [23].

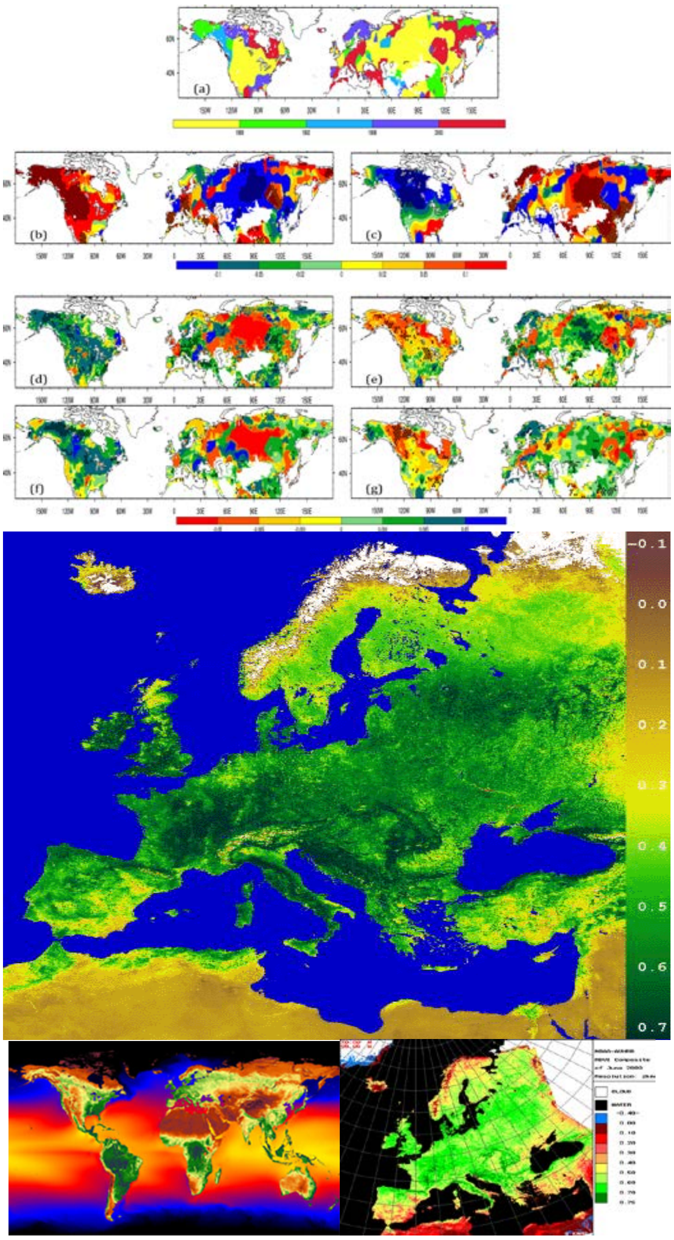


Fig.3 Exemplar NDVI over Europe, derived by German Remote Sensing Data Center

2.1.2. Measurement of Cosmic Rays via Photo Film

The cosmic rays are a flux of particles that enter the atmosphere. The aim of this experiment is to measure the secondary cosmic rays that are a result of the reaction of the primary cosmic rays with the gases in the atmosphere. There will be two samples of X-ray photo film to measure the cosmic rays in the stratosphere. The setup requires one sample on the balloon apparatus and one control sample on the ground. The samples will be wrapped in a light and moisture isolated bags that will be vacuumed. After landing the balloon sample will be gathered and both samples will be revealed simultaneously to compare the results. The sample on the balloon will have traces of cosmic radiation embedded on its surface, which will be visible under a microscope. The photo film will be taken from an X-ray laboratory and developed there after the experiment.

2.2. Biological Experiment

The next - Biological experiment (Yeast - Saccharomyces Cerevisiae) aims to measure the bacteria's survivability at stratospheric pressures and temperatures, as well as the impact of X-rays, UV light and the high levels of radiation on the sample's biomass, growth and metabolism. It is planned to use two samples of photo film to measure the cosmic rays in the stratosphere. The basic idea is to have one sample on the balloon apparatus and one control sample on the ground.

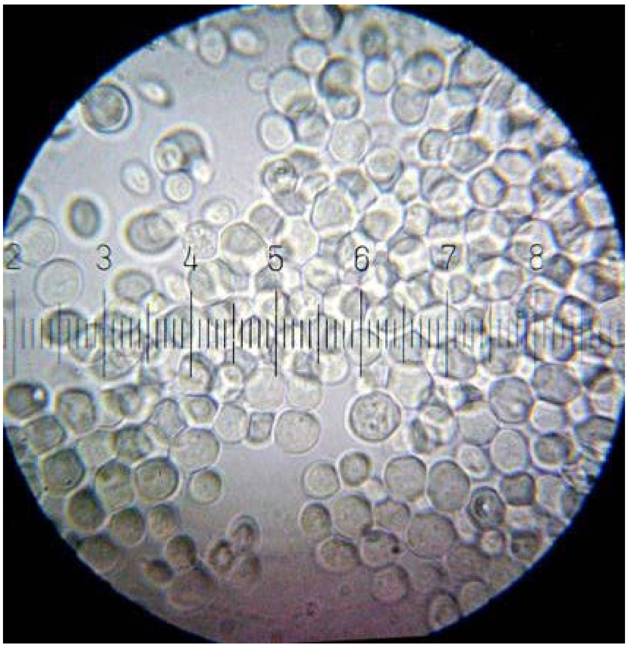


Fig.4 Yeast - Saccharomyces Cerevisiae

The species were selected due to the fact that it is considered a model organism, and its size, generation time, accessibility, manipulation, genetics, conservation of mechanisms, and potential economic benefit area easily manipulated.

This experiment would be valuable to man’s effort to understand the impact of suborbital flight, and the impact of various factors upon carbon-based life forms. It aims to measure the bacteria’s survivability at stratospheric pressures and temperatures, as well as the impact of X-rays, UV light and the high levels of radiation on the sample’s biomass, growth and metabolism. More specifically, the radiation will impact the pyridine dimer and the DNA. The expected result is the reparation to cause a fault in the synthesized protein inside the cell. Shorter life duration of the fungi may be observed. Life duration, biomass, metabolism change and productions are the factors by which the samples will be compared with the control sample on the ground. The monitored sample will be placed onboard in a glass container, so that it is both protected from the extreme-low temperatures and pressure, but still allows some external factors to influence the sample. A control group will remain on the ground, and upon the apparatus’s successful return the two samples will be quarantined in an isolated environment and having in mind Saccharomyces Seraphs quick multiplication and short generation times, differences will be derived and recorded. In order the experiment to be completed, a class I or II biologic laboratory is required, which the team is negotiating for with laboratories situated in the building of the Faculty of Biology at the Sofia University. The group is still doing a research for more information regarding the material and isolation of the container. The container will weight a maximum of 50g, including the Yeast sample and the required isolation. The team is consulted by leading specialists in space radiation, biotechnology and biosciences. However, the exact specifications of the container, experiment outcome and the monitoring of the sample during the flight will take more time to develop and clarify.

2.3. Additional Tasks of the Mission

2.3.1. Photo of the Earth surface from 30km altitude

The last main objective of the flight is to take a picture of the surface from approximately 30km altitude. This will be performed by the HTC Wildfire S smartphone, mentioned later. The picture will be taken in high definition, in visible light spectrum. A popular consumer camera - 5 megapixel Contour HD (fig. 5) have been chosen. This camera has proven itself in similar missions and suits the team needs, considering factors like price, size, weight, quality of footage, battery life and robustness. The dimensions of the camera are 34x53x95mm.

Fig.5 5 megapixel Contour HD camera

It is very lightweight (123g with battery) and shoots in a wide variety of resolutions, including 1080p. The largest memory card available for the camera (SanDisk Micro SD 32GB) can store up to 480 minutes of video footage on the highest available resolution at 30 fps. In that mode, the included battery lasts up to 4 hours of filming in the severe conditions of the stratosphere. The Contour HD enables 110 and 135 degrees of shooting, both of photos and video. The camera focuses by using two laser pointers, located on both sides of the lens. Since there is a requirement for a second camera, the HTC Wildfire S smart phone also will be used as a backup on the main GPS system in the aircraft. The smart phone also records video and takes photos in 5 megapixels, uses the same type of memory card as the Contour HD, utilizes standard autofocus functionality and the Geo-tagging feature.

2.3.2. Providing "Comfortable" flight and successful landing of the Legonaut

One of the main objectives of the mission is to have Lego figure on board of the apparatus. The Legonaut will be placed in the uppermost module of the O.S.O., which will ensure his safe landing and retrieval. His dimensions have been considered and plenty of space will be available on board. Research is still doing on the actual sizes of the Legonaut. A "seat-belt" and a chair have also been prepared for "him".

3. Architecture and aerodynamics of O.S.O.

This is the most innovative part of the launch. The team is not satisfied by the way current launches are done and more specifically the parachute component. The parachute increases the horizontal declination of the payload after the release from the balloon, causing less predictability of the landing zone and ultimately less certainty in the retrieval of the payload. The team looked for an alternative and found it in the nature. The aerodynamic form of the O.S.O. allows for a more vertical decent which dramatically increases the chance of retrieval. Also, the team believes that being produced on a larger scale, the apparatus will be more cost-effective considering the greater success rate of the missions.

3.1. Bionics Concept of the Device

The idea of establishing the aircraft was derived from bionics. The natural form has the exact proportions. The aircraft was designed taking into account the golden section and the correct geometry. The parachute will remain irrelevant to the unit due to its uncontrolled conditions during descending. Landing site cannot be precisely predicted and calculated due to the meteorological conditions in the upper atmosphere.

According to the physics of a wing (fig.6) lift force is created by the movement of a vehicle flying in the air and is perpendicular to the direction of flight. It keeps the unit in the air when is higher or equal to the weight force. The amount of lift force depends on several factors: profile, size and speed. The biggest percentage of lift force is being created by the feather-like wings. The lift force manifestation occurs in the so called center of pressure location.

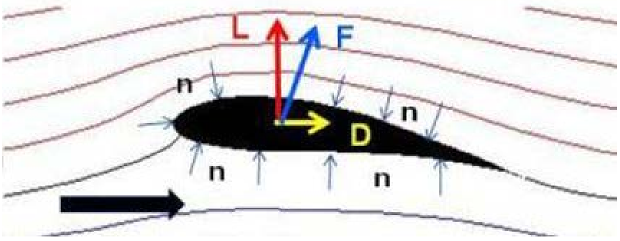
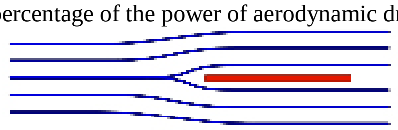
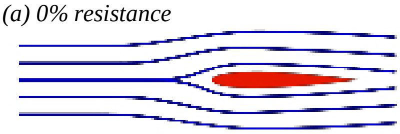


Fig.6 Physics of a Wing

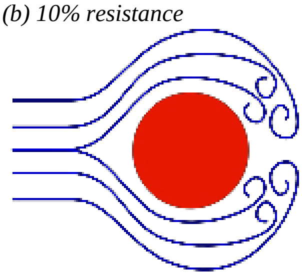
When two solid bodies interact with each-other, the forces being transmitted occur in the physical point of contact. However, when a rigid body interacts with fluid, processes become more difficult to describe because the fluid can change its shape. To this relation the physical point of contact between the fluid and the rigid body becomes every single point on its surface. Generally the fluid streamlines the rigid body, thus sustaining constant surface contact with it. An idea of the form and set up by the resistance movement in the fluid can be graphically displayed with images and assessing the percentage of the power of aerodynamic drag in fig. 7.



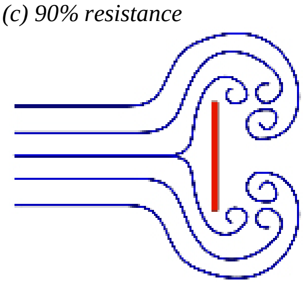
(a) 0% resistance



(b) 10% resistance



(c) 90% resistance



(d) 100% resistance

Fig.7 Streamlined shapes

3.2. Shape and Dimensions Design

During the research phase it has been concluded that the best suited concept to team's purposes would be the architectural and bionic forms of "acer" trees and especially their leaves. The form and shape of the leaves allows its gentle and straight vertical line of landing. The advantage of this form is that the air resistance will be increased, thus the descending will prolong in time, decreasing damage possibilities. Additionally a breaking system will be necessary in order to control the rotation of the wings and the camera oscillations that will occur due to the rotation. This will add some extra weight and mechanism to the unit. A slight disadvantage related to this kind of models is the geometric and mathematical relation between the main body and the wings. Depending on their proportions the unit may accelerate fast, rotate faster thus affecting the corpus stability etc.

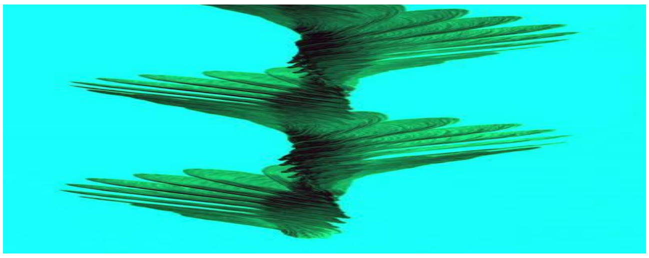


Fig.8 Simulation of "acer" leaves landing trajectory

Precise scientific measurements are done in order to achieve best suited aero-bionic form that will certainly satisfy the requirements and the mission objectives. Choosing bright and reflective color will enhance the unit's visibility and constant observation (red, purple, yellow etc.). Based on the researches and considerations that have taken place during the development of the model, it has been concluded that the image shown in fig. would be the final concept of the O.S.O.

Fig.9 Final conceptual model

3.3. Internal Construction

Important and ultimately vital part of the mission is the safety of the payload and its components. The density of the separate devices inside the unit underlines their easy assembling/disassembling. With other words they must keep certain minimum distance between each other for several reasons: heating; electromagnetism and electric currents; lesser damaging risks. For this purpose it has been concluded that an aluminium cubic or pyramidic-like frame may be implemented to tight up the whole internal structure. In order the apparatus to be mechanically fortified, it has been chosen to implement an internal frame structure made of aluminium that will support and tight up the whole structure and shape (fig.). It will benefit the landing shock and eventual internal disorder. Aluminium is remarkable for the metal's low density and therefore its implications in aerospace and aero-industry. It is relatively soft, lightweight, ductile and malleable metal. It is nonmagnetic and does not easily ignite.

Fig.10 Conceptual Body Frame

The limitation on the available power in the wind means that the more blades there are the less power each can extract. A consequence of this is that each blade must also be narrower to maintain aerodynamic efficiency. The total blade area as a fraction of the total swept disc area is called the solidity, and aerodynamically there is an optimum solidity for a given tip speed; the higher the number of blades, the narrower each one must be. In practice the optimum solidity is low (only a few percent) which means that even with only four blades, each one must be very narrow. To slip through the air easily the blades must be thin relative to their width, so the limited solidity also limits the thickness of the blades. Furthermore, it becomes difficult to build the blades strong enough if they are too thin or the cost per blade increases significantly as more expensive materials are required. That's why four blades will be used, based on perfect symmetry. In fig. a pattern of fixing the blades to the hub is proposed. Similar approach to attach the blades will be used.

Fig.11 Blade Attachment

Fig.12 gives an exemplary internal configuration of the components disposition. Since there is no parachute, the main idea is to place the most robust components at the bottom and the more fragile ones at the top of the capsule. The team is still developing the exact configuration and placement of the components, thermal and shock isolation.

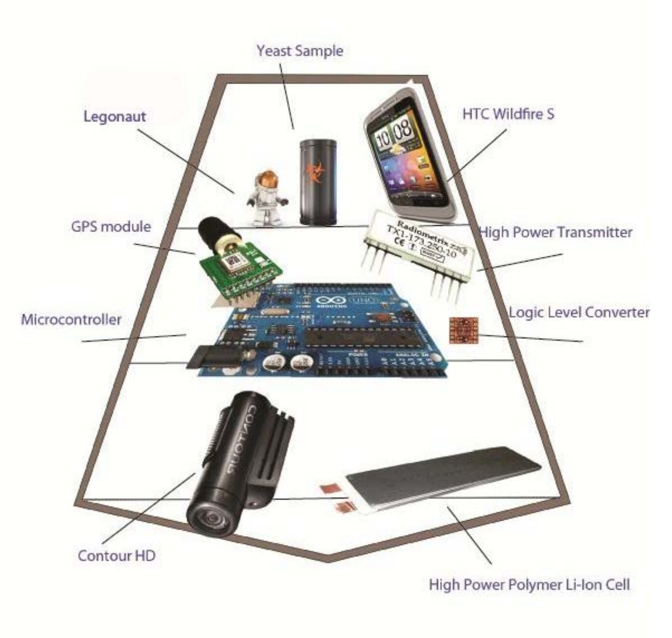


Fig.12 Components Disposition

The final shape and dimensions of the flying machine are shown in table 1 and fig.13 respectively. They may slightly vary after the physical tests.

Table 1 Parts Ratio:

Height: 300mm
Cone diameter: 250mm
Wing/Feather spread: 600mm
Maximum Mass: 1,4 kg

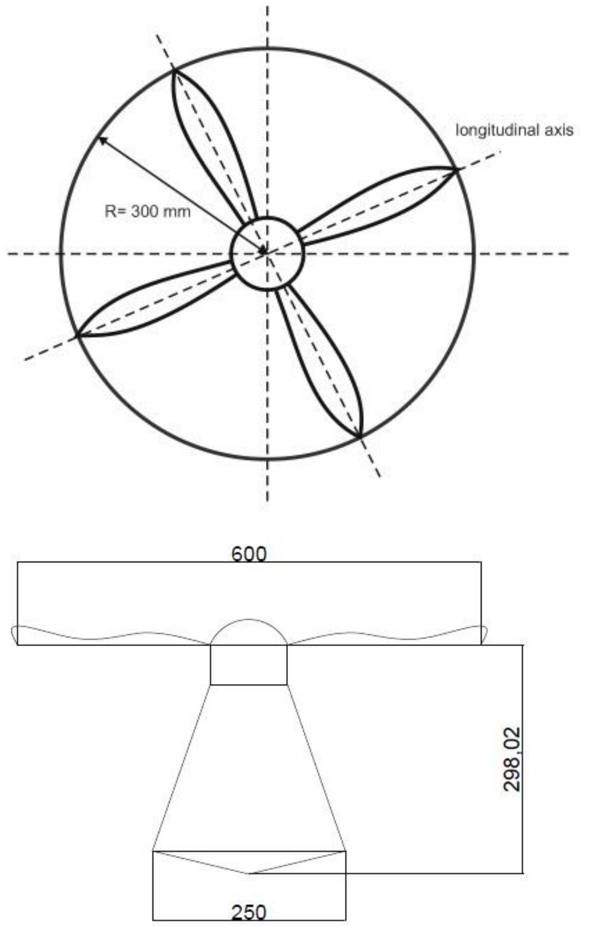


Fig.13 Model Dimensions

4. Technical Specifications: Communication, Components and Navigation

The main components are:

- Arduino Uno Board ATmega328 AVR: microcontroller which will put the all the communication components in symbiosis.
- Assembled uBlox Max-6 Breakout with Sarantel Antenna: GPS module
- VHF Narrow Band Fm High Power Transmitter: Radio Module
- Logic Level (Voltage) Convertor: A device that will allow the voltage current to be altered to a needed grade.
- Android 2.1 HTC Wildfire S: It will serve as a backup tracking and GPS device.
- Avast mobile security: software that will provide the function of SMS commands tobe sent on board the stratosphere apparatus in order to complete certain procedures and sequences.

4.1. Telemetry downlink (TX)

A radio module will be used to transmit position and other telemetry down the team's base station. This data will be used for tracking the payload and mapping additional telemetry over the duration of the flight. Controller unit will need to prepare all data in a specific sentence format and transmit using RTTY (Fig.14). It has low power requirements and it is ideal for long range reliable transmission at 50 baud. Amateur radio license not required. Best choice. APRS is an alternative that could be used as there is already infrastructure available in Bulgaria. APRS is not covered in this document.

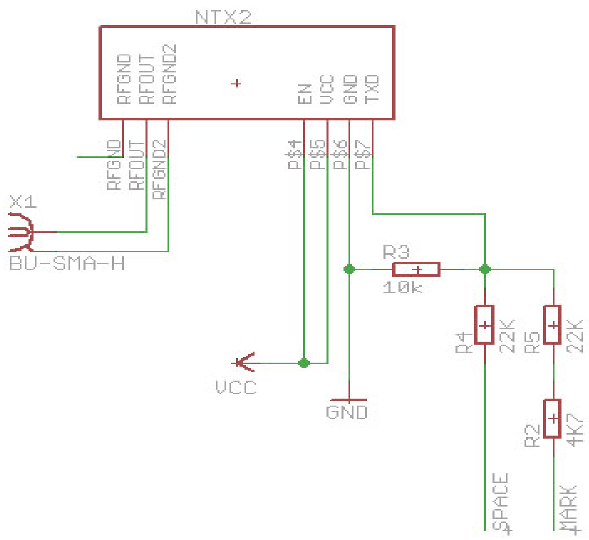


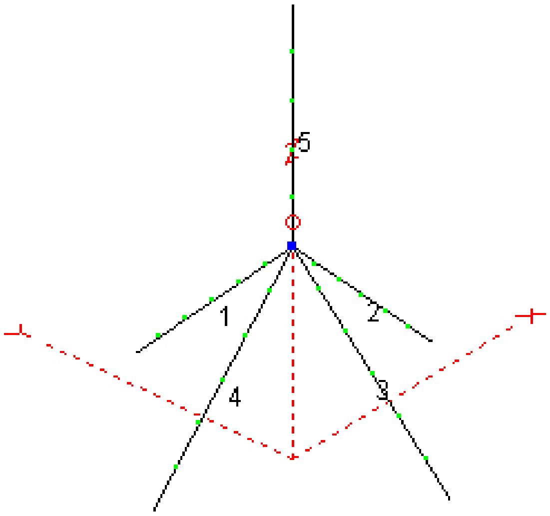
Fig.14 Radiometrix NTX2 circuit for RTTY [4]

4.2. Ground Station (RX)

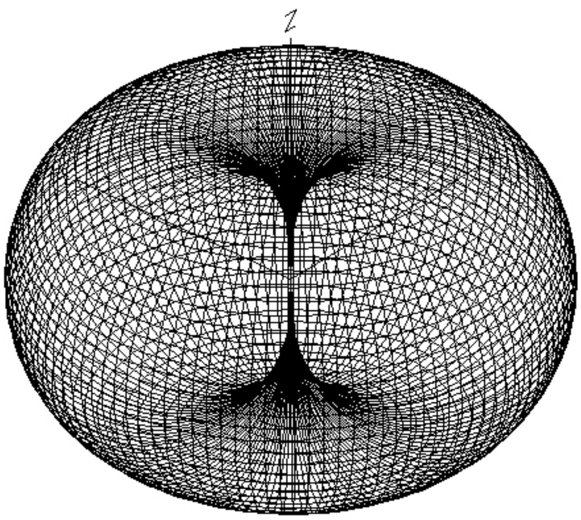
Ground station refers to any static or mobile RX unit that will listen to the payload signal. Mobile RX will most likely be a chase car following the package during the flight in an attempt to increase the chance of recovery. SDR is best suited for the mobile RX as it will require minimal setup. The purpose of those stations is to record telemetry transmitted by the payload and if possible upload it to the internet. This is a good opportunity to work with Bulgarian Radio Amateurs as they can listen to payload telemetry. A guide for tracking the payload and required software is available in Tracking and visualization section. Software Defined Radio ezcap EzTV668 USB Dongle that can be used for SDR. Software does all the heavy lifting. Cheap solution and software is free. Anyone with a computer can setup a RX station. Ideally a preamp kit [18] or other preamp should be used with this. Price: 20-25 USD [7][8].

4.3. Antenna

1⁄4 Wave Ground plane antenna will best fit for this project as it provides the best coverage and can be easily built (Fig.15).



(a) Antenna model



(b) Radiation pattern
Fig.15 Ground plane antenna

4.4. Tracking and visualization

This section will describe the method which will be used to track the payload and visualize the data.

4.4.1. Payload Tracking

Tracking is done using distributed [13] version of fldigi software. The software is specifically tailored for habitat and is very easy to use. Support quick auto configuration for switching between different flights at the same time. Automated decoding and upload of sentences to habitat.

4.4.2. Balloon predictions (Path / Burst / Landzone)

The predictor [9] is available in two modes. First mode is to give an idea of which direction the balloon is likely to fly and land. Second mode is actively running during the flight within the tracker.

4.4.3. Chase Car

Tracking Recovery team can download the Habhub Chase Car app [10] for Android. App will record GPS position and upload data to habitat which will then be visualized on the map.

4.5. Setup for SDR

Here are steps and software to get SDR up and running with a USB dongle. Guide assumes running Windows OS. Software needed:

- HDSDR
- Virtual Audio Cable
- DL-fldigi

4.6. RTTY implementation

The C code for the implementation of RTTY can be found in the references [3]. The guide includes everything that is needed. RTTY is over FM. To implement a RRTY over FM it is necessary to generate two tones. One - for MARK and one - for SPACE. The following C code can be used to generate tones.

4.7. Styrofoam and Heating

The styrofoam insulation will prolong the heating perseverance inside the O.S.O. during the flight. However an internal heating element will be needed in order to keep the average temperature above zero degrees Celsius. Otherwise the styrofoam itself is irrelevant.

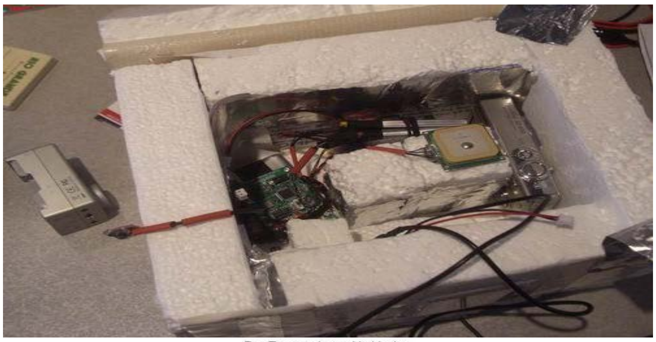


Fig.16 Styrofoam Insulation

Hand warmers will play the heating role and thus increase the duration of positive temperature inside the apparatus, which will increase the efficiency and survival probability of the craft.

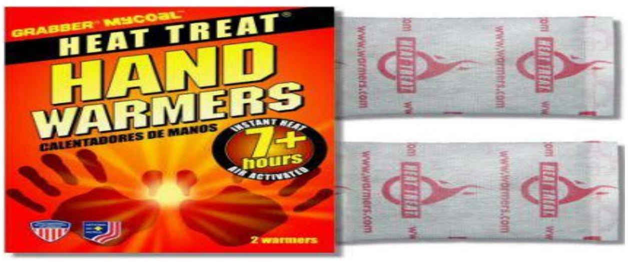


Fig.16 Hand Warmers

Warmer Dimensions:
6.5”H x 5”W x 0.25”

Average price and broadly commercial - 1.15 $ per unit.

No online link will be provided purposely. The item will be bought from a local store in Sofia.

Nonetheless thermal parameters will be as close as possible to the "box-like" crafts, thus the team judges as accurately as possible through analog systems at this point of development.

4.8. Detaching Mechanism

A wire of non-magnetic high-resistance alloy of nickel and chromium (Nichrome) will provide the heat and temperature needed to the mechanism that will separate the balloon from the payload. Attached to the motherboard, at a certain point the nichrome wire will experience low amount of voltage current which will allow it to heat up to the point where the nylon rope will be literally melted. Thus the payload will separate /release without having any difficulties regarding post cut-down issues.

For 75 mm 22AWG Nichrome 0.5 amperes, will be needed for heating up to 20 degrees.

$U = I \times R$

$U = 0.5 \times 0.25 = 0.125 Volts$

$P = U \times I$

$P = 0.5 \times 0.125 = 0.0625 Watts$

Of course it will be used a little bit over the given nichrome length. A 15mm long wire will take its place from the motherboard station all the way to the outer side of O.S.O.'s carbon-oleoresin corpus, thus tying up with the nylon rope which itself will be physically connected to the propeller unit (balloon). Two holes R=0.25 mm will symmetrically drilled on the bottom side, where the nichrome wire will leave the inner space of O.S.O.

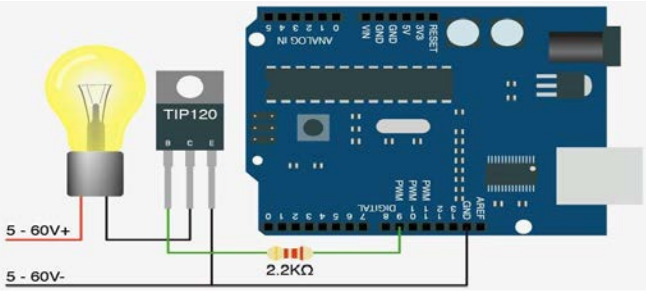


Fig.17 Detaching Circuit

Where the light ball stands, will actually be the nichrome wire itself. A transistor will also be added in the set of electrical grid in order to amplify the incoming resistance, thus increasing heat potential, which will lead to a rapid temperature increase in the nichrome wire. This detaching mechanism will successfully be triggered from the mother board, with a specific time given by a preset code. Then for not more than 10 seconds the nichrome electrical grid will experience 2000mA and 0.600 volts, that will heat up the nichrome wire to 70-80 degrees. That temperature will be enough to melt the nylon rope like a knife does to butter.

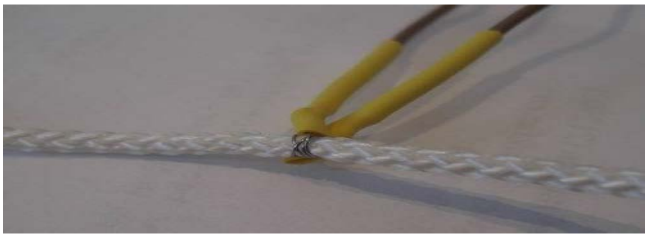


Fig.18 Detaching Mechanism

The picture above averagely describes how the chrome wire will be tangeled/tied to the nylon rope. Several spiral circles (as shown) taking place will secure and reinforce the nylon-nichrome connection [24]. This item will be bought from a local store in Sofia.

4.9. Power Supply

4.9.1. Battery Pack

High Power Polymer Li-Ion Cell: 3.7V 4000 mAh (6745135-10C) 14.8Wh, 40A rate - UN Approved (NDGR)

Table 2

Capacity:	***• iNominal: 4100mAh • Min. 4000 mAh • Average: 14,8 Wh(Capacity will reduce with cycle life , Battery labeled with Min. capacity at 300 cycles) • Energy Density: 174 wh/kg***
Life Cycle:	*> 500 times*
Charging Rate:	*2 A Max. (0.5C rate)*
Discharging Rate:	*40 A Max. (10 C rate)*
Size with tolerance +/- 0.5 mm:	*7.0 (thick) x 45 (width) x 136 (length) mm*
Weight:	*3.0 oz (90 grams)*
Full Data Sheet	*http://www.batteryspace.com/prod-specs/4108.pdf*

The battery has been chosen due to its high potential. It has strong temperature resistance and is capable of powering up the whole system giving reliable and safe electricity to all the components, without experiencing current limitations.

4.9.2. Smart Charger

(1.8A) for 3.7V Li-ion/Polymer Rechargeable Battery Pack

http://www.batteryspace.com/

Product ID # 4862

Part Number: CH-L3718 Price: 16.95 $

The charging device as an additional external component will serve to recharge the battery after the test and experiments are performed.

4.10.Fluid Bearing

Due to its low friction, high viscosity and light weight properties an aerodynamic bearing will take place between the propeller and the body itself. It will easily take in consideration the rotation speed and low temperatures that are experienced up to 30 km in the stratosphere.

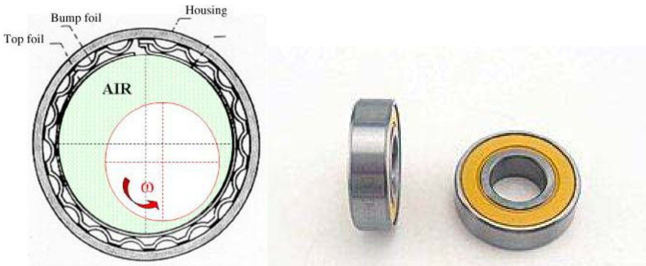


Fig.19 Fluid Bearing

4.11.Structure Material

The body of the box containing all the electronics and experiments will be made from composite materials such as carbon fiber-reinforced polymer, glass, or aluminium.

Carbon fiber reinforced polymer (CFRP) or just carbon fiber is a very strong and light fiber-reinforced polymer which contains carbon fibers, and the polymer is often epoxy (Epoxy, also known as polyepoxide, is a thermosetting polymer formed from reaction of an epoxide "resin" with polyamine "hardener").

Many carbon-fiber-reinforced polymer parts are created with a single layer of carbon fabric that is backed with fiberglass, its light and with high stiffness. Material is suitable for boxes or pipes affected by big pressure or forces

Carbon fiber, carbon graphite or CF, is a material consisting of fibers about 5- 10 m in diameter and composed mostly of carbon atoms. The carbon atoms are bonded together in crystals that are more or less aligned parallel to the long axis of the fiber. The crystal alignment gives the fiber high strength-tovolume ratio (makes it strong for its size).

The properties of carbon fibers, such as high stiffness, high tensile strength, low weight, high chemical resistance, high temperature tolerance and low thermal expansion make it appropriate basic material for making the box (carbon body). Turbostratic carbon fibers tend to have high tensile strength, whereas heat-treated mesophasepitch-derived carbon fibers have high Young’s modulus (i.e., high stiffness or resistance to extension under load) and high thermal conductivity. The material is often used in aerodynamics for elements or plane parts, helicopter propellers or for more stifness of car parts.

Fig.20 Structure Material

The modulus /measure for stiffness/ of carbon fiber is typically 20 msi (138 Gpa) and its ultimate tensile strength is typically 500 ksi (3.5 Gpa). High stiffness and strength carbon fiber materials are also available through specialized heat treatment processes with much higher values. Compare this with 2024-T3 Aluminium, which has a modulus of only 10 msi and ultimate tensile strength of 65 ksi, and 4130 Steel, which has a modulus of 30 msi and ultimate tensile strength of 125 ksi.

Carbon Fiber - Standard grade

Standard grade carbon fibers have a good combination of strength with stiffness.

With a specific modulus of 92, over 3 times than of metal (Steel and aluminium are both the same) carbon fiber / epoxy laminates are finding increasing application.

Typically UTS 1.5 Gpa Modulus (Ex) 130 GPa Density 1.6 g/cc Carbon Fiber – Special grade Standard grade carbon fiber (T300, HTA, etc) have mechanical properties without resin of approx. 3 - 3.5 GPa tensile strength and 230 - 240 GPa Tensile modulus.

Materials for insulation - styrofoam or Expandable Polystyrene (EPS). EPS is manufactured from expandable polystyrene beads containing a blowing agent and flame retardant additive. The ability of extruded polystyrene insulation to resist moisture makes it very good material for isolating parts, doesn’t absorb water and is does notloss strength in damp conditions. Thanks to its closed cell, unique, air-filled cellular structure, its resiliency and light weight and its ease of convertibility from raw material to finished product.

The bolts will be lag bolts/ with screws/ or cap screws made of aluminium - light with enough strength and stiffness characteristics to take shear resistance.

Steel - higher levels of carbon within the steel create harder steel; however, harder steels tend to be more brittle. Therefore, sudden shocks to a bolt might cause a shearing effect, which essentially snaps it in half, so higher levels of carbon are likely.

7 *Budget*

The following table covers an incomplete and preliminary budget.

Table 3

Components	***Price/Value, €***	***Quantity /Pieces***
Video camera Contour HD GPS	*150*	*1*
Arduino Uno Board	*24*	*1*
Polymer Li - Ion battery	*22*	*1*
GPS module - uBLOX MAX - 6 with Sarantel passive antenna	*37*	*1*
HTC Wildfire S smartphone	*140*	*1*
Radio module - RFM22B	*15*	*1*
Logic Level converters	*4*	*2*
Battery	*45*	*2*
Handwarmers	*5*	*3*
Composite materials	*760*	*680 g*
Isolation		
- Plastic Foam	*4*	*1m2*
- Styrofoam	*7*	*1m2*
Bubble wrap	*11*	*6osm2*

4.12.Marketing

The team’s website is almost ready where are posted pictures, videos, and a visual description of the project with pictures and text. A Facebook page also have been created at the following address (https://www.facebook.com/ARTweSphere), which is used to post pictures, videos, and results from group meetings, changes in direction the project has taken, funny stories, and interesting links. The Facebook page is used for gathering followers. Depending on sponsors, it is possible to use Facebook ads. Hype will be build before the launch and on the day of the launch the Facebook page we will be update (we can also use Twitter). It is also considered live footage from the lift-off point. As a result, people will be able to see in almost real time what is happening. Depending on sponsorship it can be organized an event in the day of the launch with BBQ and drinks. The team will invite people from rocket and aero clubs in Bulgaria and the general public to join the event. After a successful launch it will be created an overall video about all the stages of the product and all our results and future plans. The team plans to advertise the project on internet (specialized forums and websites) and contact television and radio to ask them if they want to mark the event or its successful completion.

4.13.Sponsorship

The members of the team plan to contact different parties who might be interested to be sponsors:

1. Mobile operators - contacts are established with representatives of Globul, Mtel and Honda

2. Retail product vendors – negotiating for different options for their advertisment: posting the logos of the sponsors on the website and on Facebook. Moreover, it is possible to put stickers on our probe and on the balloon. The team can also put their products on in front of one of the cameras. They will be able to use the HD footage in ads or put it on their websites.

4.14.Legislative Framework /Permissions

Flights with engineless aircrafts /gliders/ are referred to at Section 7, Paragraph 7 of Regulation 22 for flights in the airspace and to/from airports in Republic of Bulgaria.

Moreover, helium balloons must have documents such as specifications, certificates, insurance, etc., that have to be provided in advance for consideration for specified parameters.

The area of the air flight is decided by DP "ATM" where the aircraft operator should submit an application after receiving a permit from DG "Civil Aviation Administration"

Section 7, Paragraph 7

Flights performed with engineless aircraft /with or without crew or for sport, for transportation of dangerous loads or for other purposes/.

After receiving a permission to fly at paragraph 1, the aircraft operator or the authorized person provides a flight plan form, prescribed in Annex № 2, submitted not later than an hour before flight time to the address of IFPS and DG "Air Traffic"

5. Conclusions and Future Work

During the research phase it has been concluded that the best suited concept to the team's purposes would be the architectural and bionic forms of acer trees and especially their leaves. A slight disadvantage related to this kind of models is the geometric and mathematical relation between the main body and the wings. Depending on their proportions the unit may accelerate fast, rotate faster thus affecting the corpus stability, etc. Precise scientific measurements are to be done in order to achieve best suited aero-bionic form that will certainly satisfy the requirements and the mission objectives.

Solid planning is required to finish the project on time – entire research of the experiments and their realization is necessary. The team has to build models and run extensive physical tests and software simulations of the apparatus and its behaviour during the flight. There is a suspect that further permissions to be able to use the desired aerodynamic form might be need. Also, it is necessary to find the most suitable composite material and manufacturer for the apparatus. The Yeast experiment requires class I and II biological laboratories, which are yet to find and contact. That is why negotiations are planned with acad. Prof. Dr. Sci. A. Atanassov, Manager of the Joint Genome Center (JGC), founder and 24 years director of the AgroBioInstitute (ABI), announced by the EU as a Centre of Competence /Excellence in Plant Biotechnology and the main initiator of the Genetically Modified Organisms (GMOs) Low. He was recommended by Prof. Dr. M. Baltadjieva, Corr.mem. of BAS and head of the Laboratory for testing of milk and milk products in Plovdiv, which is also discussed to be involved in any future experiment.

The launch of the aircraft is expected to be in August 2012.

6. Team Structure and Project Management

The author – Team Mentor / Project Management /System Analysis, Design & Simulation Modeling /PM /Legal Issues /Publication of results

Nikola Efremov - Project Management / Optics / PR / Budget Network Technologies, New Bulgarian University

Rossen Popov - GPS / Radio / Budget Radio Communication / Web Development Information Technologies, University of Manchester

Elena Dimitrova - Aerodynamics / Capsule Production / Graphic Design & Simulation /Assistant Manager / Engineering Design, Technical University of Sofia

Ionel Silverova - Legal Aspects, Marketing /PR, Sponsors and Budget Analysis

Desislav Georgiev - Power / Insulation / Trigger

Dmitry Chendev - Communication /Programming Components /Creating website /Blog

George Simeonov - Programming / Locating components

Iva Gilianova - Biological experiments / Plate / Optical Measurement Equipment (index)

Maria Koseva - Research on Materials and Workmanship / Logo and Design

Hassan Ibish - Finding Components / Legal Issues

Ecatherina – Meteorology Analysis

Hristian Ignev, Vilian - Support

Acknowledgements:

The author expresses deep gratitude to the organizers of Space Challenges mission - K. Kozarev and R. Raychev; ArtWeSpere team members; Assoc. Prof. M. Evtimova, Dr. G. Chervendinev, Assoc. Prof. D. Geshev, Assist. Prof. B. Martynov, TU-Sofia; Dr. H. Panayotov, TU-Plovdiv; V. Marinov, Bulgarian Federation of Radio Amateurs, for their invaluable assistance in the development of the concept, its approbation and provision of materials to various aspects of the study. Also technical development is largely due to the commitment of the students of the project team.

Bibliography

1. Sentence format, http://habitat.habhub.org/docs/ukhas_parser.html
2. RTTY in Background section, http://www.ukhas.org.uk/guides:tracking_guide
3. RTTY with NTX2 + code, http://www.ukhas.org.uk/guides:linkingarduinotontx2
4. NTX2 Datasheet, http://www.radiometrix.com/content/ntx2
5. http://store.comet.bg/bg/CatalogueFarnell/Search/?keywords=radiometrix
6. http://www.sparkfun.com/products/10153
7. http://www.ebay.co.uk/sch/i.html?_nkw=EzTV66
8. http://www.amazon.co.uk/s/?field-keywords=EzTV66
9. http://spacenear.us/tracker/
10. https://play.google.com/store/apps/details?id=com.pexat.habhub.chasecartracker
11. http://www.hdsdr.de/
12. http://software.muzychenko.net/eng/vac.htm
13. http://ukhas.org.uk/projects:dl-fldigi
14. http://www.ysarc.org/Techie_Stuff_files/typical%20antenna%20radiation%20patterns.pdf
15. http://www.funcubedongle.com/?page_id=74
16. http://www.funcubedongle.com/?page_id=286
17. 70cmpreampkit, http://www.minikits.com.au/kits2.html
18. http://www.gsmarena.com/htc_wildfire_s-3777.php
19. Space Challenges 2012 Project, http://tsiolkovsky.net/program_sc/
20. Stübi R., Levrat G., Hoegger B., Viatte P., Staehelin J., Schmidlin F. J.: 2008, "In-flight Comparison of Brewer-Mast and Electrochemical Concentration Cell Ozonesondes," J. Geophys. Res., 113, D13302, doi:10.1029/2007JD009091.
21. Terao, Y., and J. A. Logan (2007), "Consistency of Time Series and Trends of Stratospheric Ozone as seen by Ozonesonde, SAGE II, HALOE, and SBUV(/2)," J. Geophys. Res., 112, doi:10.1029/2006JD007667.
22. Electrochemical Concentration Cell (ECC) ozonesonde, http://www.dropletmeasurement.com/brochures/ECC%20Sonde.pdf, available at June, 2012
23. Mao, J. F., Shi, X. Y., Thornton, P. E., Piao, S. L., and Wang, X. H.: Causes of spring vegetation growth trends in the northern mid–high latitudes from 1982 to 2004, Environ. Res. Lett., 7, 014010, doi:10.1088/1748-9326/7/1/014010, 2012.
24. http://www.fishersci.com/ecomm/servlet/itemdetail?catalogId=1&productId=3227731&storeId=10652&langId=1&distype=0&accessories=false&fromSearch=
25. Nikolova, I, W.Jahn, Die Einführung und Konkurenzvorteile des TQM, Wissenschaftliche konferenz Innovationen und wettbewerbsfähigkeit, Karlsruher Institut für Technologie, TU Sofia,TU Braunschweig, FOM Essen, ISSN-1310-3946, 2011
26. Shoikova, E., M.Krumova, A.Peshev (2012) Knowledge management, learning and professional development enchanced by cloud computing, ESI2012, June 9-10, European Polytechnical University, Pernik, Bulgaria (Plenary paper)
27. http://www.sycamorefan.com/fan/feature/features.html, Nature + technology, accessed on 05.2012
28. Ангелов К. Ръководство по управление на проекти, 2009.
29. Дамянов, Д., Демирова, С. Използване на експертните системи като иновативен подход при проектиране на технологично преструктуриращи се процеси, XVII ННТК с международно участие „АДП-2008"
30. Димитров, Ив. Анализ на риска на инвестиционните проекти, Практическо ръководство, Авангард Прима, София, 2012
31. Гешев, Д. Аеродинамика на летателните апарати. Основен курс. София, Кинг-2001, 2006