Outputs and remarks of the first SSETI Workshop

Pisa Team – Risk Analysis Subsystem

List of participants

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Outputs

Besides contributing to the definition of the Mission Objectives presented in the Official SSETI Website (http://www.sseti.net/home/WSW/ - Status - Status Report), even if usually Risk Analysis can be performed only during a more advanced phase of the design process, we managed to produce something that we would call a "level zero" analysis. Clearly at this stage, our Workshop outputs can be taken only as a general guideline. This was done in order to make clear the kind of information our group would need to go ahead with the project and point out common failures on which the other subsystems may trip.

AOCS

We would like just to point out the problems concerning your instruments that we assume more likely to be happening (so that you might choose to take them into account in your design process). Relevant data to be provided to us as soon as possible are estimated lifespan, materials, and angular velocity.

Reaction wheels*:* vibration problems (due to the launcher ejection and a possible irregular spinning), resonance conditions, saturation and cracking due to creeping.

COMMUNICATIONS

Due to the very slim structure of the antenna, some instability and deformation problems may arise (e.g. special attention must be paid during the launcher ejection phase).

The orbit should be crossing van Allen belts, therefore a possible communication blackout can occur (this could be a guideline for a possible design modification of the antenna in order to solve this problem).

INSTRUMENTS

We need you to provide us, as soon as possible, a list of all the instruments you want to board in and it has to be as detailed as possible; by "detailed" we mean that it should contain the following information:

The instrument is subcontracted (you buy it from someone else)?
In this case you should specify the features of the seller (is he government certified? Did you deal with him in the past?) and for each object the safety degree (is it space certified?), and it might help to have any reference regarding it;

The instrument is built within your labs?
In this case detailed functional description, list of all the materials used and a list of all the tests done and foreseen must be provided.

Just a little note about the camera: all the fragile materials (especially glass) must be singularly tested in order to determine their behaviour as far as vibrations are concerned.

MECHANISM

We would suggest to keep the overall mechanic as simple and slim as possible, in order to avoid non mandatory mass wastes and difficult to predict failure modes (of course this suggestion shall be taken just as a general guideline, according to any previous specification). These are our final conclusions:

we agree not to use an orientation system for the camera and also to carry two cameras, helping to achieve one of the most important objectives of this mission (take pictures);

we suggest also to watch out carefully for failures in the mechanisms used to open the solar panels;
Finally we want to point out that the document sent by the Mechanism team is very well done and we hope it will be taken as a good example by the other groups.

Nevertheless to start the FME(C)A we also need the functional tree and, if it's possible, the specific drawings of each component for every subsystem. In the functional tree we would like to find a clear explanation of the functional relations between each component and all the interfaces among subsystems.

MISSION ANALYSIS

The probability to make a mistake in the design phase, without correctly considering the interactions between spacecraft and the external environment, is around 21.4%.
In our project the most important causes of this kind of failure could be Van Allen Belts and Space Debris.

As far as the Van Allen belts are concerned, we suggest to calculate how long the satellite remains inside of them, in order to see if this problem could be neglected or not. If not, additional caring must be taken, and this will end in more weight. We calculated the period of the orbit, in order to see how many times a day the satellite was passing through the Van Allan belts.

About Space Debris, it could be useful to see the website of American Institute of Aeronautics and Astronautics to find specific information.

Orbital calculations

These are the calculations we made.

The speed values we got are:

Perigee velocity: Vp=9.86 Km/s

Apogee velocity: Va=1.63 Km/s e=0.715

The orbital period is:

T=38640.2 sec = 10.73 h

We used the following data and procedures:

DATA

Earth radius: Re=6.370 Km

Earth gravitational parameter: mu=3.986 10^5 Km^3/s^2

Perigee radius: Rp=7020 Km (=Re+650)

Apogee radius: Ra=42370 Km (=Re+36000)

PROCEDURES

Major semi-axis: a=(Ra+Rp)/2

Eccentricity: e=(Ra-Rp)/(Ra+Rp)   Rp=a(1-e)   Ra=a(1+e)

Perigee velocity: Vp=sqrt((mu/Rp)(1+e))

Apogee velocity: Va=sqrt((mu/Ra)(1-e))

Orbital period: T=2*pi*sqrt(a^3/mu)

It was clear that the Apogee and Perigee measures were taken from the Earth surface, because 650 Km<Re, but just in order to be clear, we think that for future (more complex) calculations, we should specify frames, from which point measures are taken, etc.

POWER

Naples estimated the power supply to be 55W. For this range of power output, we have found that the failure rate (FITS) is 2.0 (data took from Mil-Hdbk-217).

Solar panels have the 10% of probability to fail. This can be caused by the detachment of cells or micro meteorites impact. So we recommend that the panels should be over-dimensioned of a 10%.

A preliminary analysis on the batteries showed that Lithium ones are better than Ni-Cd. Lithium batteries seems to be lighter (Lithium Specific weight = 0.53 Kg/dm^3), and more powerful (187 W h/Kg). Even if Lithium batteries are less reliable, for a 14 days mission the risk is not so critical.

You should watch out carefully for harness loosing due to vibrations during the launch (almost 13% failure probability). Usually cells and panels failures tend not to have a critical impact as far as hazards and the overall system survival are concerned, but of course many objectives may result affected by them.

PROPULSION

Before being able to define a detailed analysis of the possible failures of the propulsion system, we would need more precise information about what kind of propulsion your subsystem group is going to choose and about every single part composing the subsystem itself. Actually, we request some technical details, i.e.:

Propellant type?

Mass propellant?

Fuel tank material?

Tank volume?

Type of connections between the subsystem elements?

In order to prevent eventual failures, we would need a block diagram of the subsystem, to identify critical points like valves, pressure conditioners, and safety system. A careful and conscientious design of the propulsion subsystem will contain percentage of failure lower than the statistical one, which is 3.7%.

STRUCTURES

In order to prevent the possible failures of the structural system, our analysis will focus the attention on three different aspects:

valuing the vibrations that could stress the micro-satellite, checking the vibration spectrum of the Ariane V to avoid resonance problem of the structure, paying attention especially on hanged masses;

controlling the stress acting on the system during the ejection phase that could cause structural damage;

watching out carefully the temperature gradient in order to keep deformations and dimensional variations of the structure under control.

A good structural project, which cares about this main technical advice, could keep the failure percentage lower than statistical value of 3.5% . Therefore, in a more advanced phase of the structure designing, we will be able to perform a more complete analysis of the possible failures of this subsystem.

Considering the short time of the mission, we also suggest to use low cost materials, granting in any case the efficiency of the structure.

THERMAL

The failure mode of this subsystem depends on the type of temperature control installed. Due to the satellite dimensions, we think it should be sufficient a passive system.
If you want to use electric heater, be sure that the cable sold is sufficiently strong for the vibrations of Ariane V. A detachment of a sold will cause a temperature fall under minimum allowable levels and the failure of the component.

Remarks

We are definitely enthusiastic for this new way of designing. We loved to work together with other European students and to be part of a student-made project. We believe that the tools used (mIRC, UBB, Team Updates, e-mails and teleconferences) will be efficient once we get used to them. Even if at the beginning they looked chaotic, we are sure they will be very useful in the future if we only find the good way to organize the discussions. A teleconference once every two or three weeks will be important to guarantee the continuity of the design process. About the name of the satellite, we like Mr. Ockels proposal, but we would rather name it NewAge1, in order to underline that this project should be just the first of a series. We are looking forward to cooperating again with all the other subsystems.