Concurrent Design of High-Altitude Platform mission.

High altitude platforms are widely used worldwide in missions for atmospheric analysis and space system testing among other applications. Since they are relatively inexpensive compared with other means of testing these systems. In order to make these missions the most cost, time and resources efficient their planification phase must be properly designed by means of method like concurrent engineering.

These methods require members of each department related with the mission to work together in a concurrent engineering facility. Within these facilities different mission aspects are being defined in an interactive process in which each expert takes part.

The main fields involving a high-altitude platform mission can be divided into payload installed, platform structure, attitude control and mission analysis. Depending on the requirements of the mission each of these three parts would have a different weight on the final design of the platform.

The first element that is needed to be known is the type of payload that is going to be installed along with its requirement since it is going to determine the main characteristics of the structure (box size and balloon volume).

The second element that is going to determine the characteristics of the structure is the degree of attitude control required. This is determined by the payload (may it require attitude control for pointing cameras or antennas or may not require any at all) and the different torques that can affect the platform during the mission. These torques are produced by the wind acting on the structure at different parts of the mission.

Another relevant consequence of the action of the wind is the resultant horizontal motion of the platform. This deviates the balloon from its original vertical trajectory causing it to land far from the original launch site. Because of this mission analysis is a fundamental part of the design of the mission to size properly the attitude control needed and estimate the site where the platform is expected to land.

In order to perform a concurrent design of a mission different components are required. Firstly, a concurrent design facility is required for the members of the fields involved can work together and make decisions regarding the characteristics of the mission and platform.

For the attitude control (if required) a simulator of the rotational dynamics of the platform is required. This simulator should include the kind of attitude control employed as well as the set of dynamic equations that govern the rotational motion of the structure. Within this simulator the properties of the platform such as the mass and the moments of inertia should be included as well as a model of the controller and the input torques obtained from the atmospheric predictions. Then, a reaction wheel that fulfills the torque requirements is sized.

For the mission analysis another simulator is needed. Within this simulator the equations that govern the motion of the structure in a three-dimensional space must be included. Within these equations the force generated by the action of wind shall be included since it will determine the simulated trajectory of the platform. In addition, the equations that govern the vertical motion of the balloon due to buoyancy shall be included. This would determine the moment at which the balloon will tear apart and the free fall of the box containing the payload will begin.

Another possibility is to blend both the attitude and trajectory simulators into one simulator. Nonetheless, this would require an interface that allow both engineers to work simultaneously in both modules of the simulator.

As was mentioned before, this is an iterative process. The atmospheric properties expected are introduced into the simulator and the resultant forces and torques exerted on the platform are obtained. Then, with the attitude control requirements the reaction wheel is sized and the trajectory of the balloon as well as the landing point are estimated. The mass of the platform is needed to be iterated for the proper sizing of the reaction wheel.

Once the attitude control is sized and the trajectory and the mass of the platform are determined the rest of the systems such as the parachute and communications are selected.