Mission Assurance for Small Satellites – Balancing Cost, Risk and Uncertainty (i.e., More Risk)

Instructor: Dr. Michael Swartwout, Saint Louis University, mswartwo@slu.edu

Course Summary

The already-challenging task of mission assurance for spacecraft is made more challenging by the peculiar nature of small spacecraft. "Small" spacecraft are not simply miniaturized versions of traditional spacecraft; they represent a different approach towards balancing the challenges of cost, performance, schedule and risk. Developers of small spacecraft are more willing to accept elevated levels of risk and reduced performance, in order to meet restrictions in schedule and cost. The use of terrestrial, "off-the-shelf" electronics is one consequence of this mindset; though these non-hardened devices increase mission risk, there are other aspects to the small satellite mindset that may pose more immediate consequences. One of the outcomes of this short course is to know why the standard approaches to assurance are infeasible, impossible, or at least extremely difficult to implement for this category of space systems

However, not all small satellites are created equal; among the developers of small spacecraft, there are four distinct types: traditionalists, crafters, hobbyists and constellations. Each type has its own approach to mission assurance, and each type has vastly different levels of mission success. A second outcome is to be able to identify the four types of small satellite developers and understand their different approaches, the reason for their approach, and the likely results of their missions.

Much of this short course will involve defining terminology, starting with an explanation of the regions of Earth orbit where most of these spacecraft operate. We will then briefly touch on the effect that budgets and production rates have on space systems and identify five useful heuristics for understanding the constraints that affect space missions. We will then devote our attention to a suggested taxonomy for space missions, where we will define and defend the use of the term "small spacecraft" as being the most apt description of the missions under consideration in this short course. Unlike larger spacecraft, where categorizing missions based on mass is useful, secondary spacecraft are best categorized by their launch interface and developer type. With that background, we will review the history and "census" data for secondary spacecraft, to get a better sense of the numbers of missions flown, the types of missions, and the nations of origin.

Finally, with the data available, we will examine the mission success rates of the various classes of small spacecraft. Particular attention will be paid to the common pitfalls in both systems engineering and in performance issues with certain classes of components.

Instructor Bio

Michael Swartwout is an Associate Professor of Aerospace & Mechanical Engineering at Parks College of Engineering, Aviation and Technology, Saint Louis University. His primary research interest is in the design and operation of autonomous space vehicles, with particular attention on the ways that the design / validation process can enable or impair mission success. As a faculty member, he has led student teams in the launch of two CubeSat missions; as a graduate student, he led a student team that launched the Sapphire spacecraft in 2001. Dr. Swartwout earned his PhD from Stanford University, and his MS and BS degrees from the University of Illinois (Urbana-Champaign).