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The First One Hundred CubeSats: A Statistical Look

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Abstract

The concept of CubeSats was publicly proposed in 2000, with the first CubeSats launched in 2003. By the end of 2012, more than one hundred CubeSats have been launched, and 80 more are manifested for launches in 2013, with at least that many expected in 2014. Ten years ago, CubeSats were routinely dismissed by industry professionals as being too small to be worth flying; now, NASA is the majority launch broker, and a significant share of the manifests are filled by U.S. DoD-sponsored, industry-built CubeSat missions. How did initial perceptions of CubeSats evolve to this state? Are CubeSats toys, tools, or merely another source of orbital debris?

With so many CubeSats now in orbit, it is now possible to make a data-based assessment of these missions. Using data collected from a variety of sources, this study evaluates the on-orbit performance of CubeSats. The history of CubeSat missions is reviewed, with the missions classified according to size, origin, mission life, and on-orbit performance. It is shown that several correctable design/implementation errors plague the university side of CubeSat missions, and that the P-POD launch container, not the CubeSat specification, is the true enabling technology for this class of mission.

1. Introduction

As has been extensively documented elsewhere, the CubeSat standard was developed by Bob Twiggs and Jordi Puig-Suari in 1999 (Puig-Suari, Turner, and Ahlgren, 2001), (Nason, Puig-Suari, and Twiggs, 2002), (Heidt, Puig-Suari, Moore, Nakasuka, and Twiggs, 2000), (Wenschel, et al., 2006). By the original definition, CubeSat-class spacecraft are compatible with the

Poly-Picosatellite Orbital Deployer (P-POD), a standardized launch interface on the order of 13 cm x 16 cm x 40 cm that carries between one and three small spacecraft totaling less than 5 kg and 10 cm x 10 cm x 33 cm in size. The unit size for a CubeSat – called 1U – is 10 cm x 10 cm x 11 cm; thus, a standard P-POD carries a total of 3U. While much attention has been devoted to the miniaturization and standardization afforded by CubeSat spacecraft, the true innovation of CubeSats is the P-POD launch interface. To the great-

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