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A Methodology for CubeSat Mission Selection

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Abstract

Over 400 CubeSats have been launched during the first 13 years of existence of this 10 cm cube-per unit standard. The CubeSat's flexibility to use commercial-off-the-shelf (COTS) parts and its standardization of interfaces have reduced the cost of developing and operating space systems. This is evident by satellite design projects where at least 95 universities and 18 developing countries have been involved. Although most of these initial projects had the sole mission of demonstrating that a space system could be developed and operated in-house, several others had scientific missions on their own. The selection of said mission is not a trivial process, however, as the cost and benefits of different options need to be carefully assessed. To conduct this analysis in a systematic and scholarly fashion, a methodology based on maximizing the benefits while considering programmatic risk and technical feasibility was developed for the current study. Several potential mission categories, which include remote sensing and space-based research, were analyzed for their technical requirements and feasibility to be implemented on CubeSats. The methodology helps compare potential missions based on their relevance, risk, required resources, and benefits. The use of this flexible methodology—as well as its inputs and outputs—is demonstrated through a case study. This tool may come in handy in deciding the most convenient mission for any organization, based on their strategic objectives.

1. Introduction

CubeSats are small satellites that are based on the CalPoly standard of 10 cubic centimeter units (1U) (CalPoly, 2014). The number of CubeSats launched to orbit has grown exponentially from one in 2002, to eight in 2008 to over 120 in 2015 (a complete list of CubeSats launched from 2002 and their respective missions can be found as Appendix A in this paper). By the time of publishing of this manuscript, the design and development of over 150 CubeSats have involved universities across the world; from those, less than half have reportedly carried a payload other than a commercial off-the-shelf (COTS) camera, radiometer, or beacon. The CubeSats that have limited their mission to these three options are sometimes referred to as being education-class or "beepsats" because their function is mainly to send back telemetry (Swartwout, 2013). However, non-"beepsapts" have demonstrated that university- or education-class CubeSats can also carry functional payloads that produce data of value to the home organization and country. In other words, universities can train their students and young engineers in satellite develop-

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