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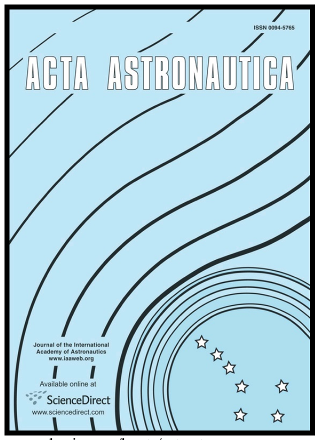

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When will On-Orbit Servicing be part of the space enterprise?

Daniel E. Hastings[1], Benjamin L. Putbrese & Paul A. La Tour
Engineering Systems Division, MIT, Cambridge, MA 02139

ABSTRACT

The space industry is currently at a significant inflection point. Over the past decades, many spacecraft at geosynchronous orbit have continued a trend towards increasingly massive and longer-lasting satellites, and while they do represent some of the most exquisite, highest-performing satellites ever launched, some experts now feel that such trends are unsustainable and are beginning to place increasing strain on the underlying industry. To support current and future spacecraft, on-orbit servicing (OOS) infrastructures have been proposed, which would provide services such as repair, rescue, refueling, and upgrading of customer spacecraft in order to alleviate the identified space industry trends. In this paper, system dynamics modeling is used to assess various scenarios for OOS incorporation into the overall space industry, by evaluating its long-term effects on the design, cost, and underlying experience of a reference geosynchronous constellation. This system dynamics model is based heavily in behavioral economics' Prospect Theory, with such concepts as anchoring and loss aversion factoring heavily into the overall simulation of the space industry. The primary conclusion of this analysis was that relatively low costs and substantial incorporation of servicing capabilities into customer architectures are likely to be necessary to ensure long-term sustainability of such a project. Finally, several policy implications for an OOS infrastructure are outlined.

1. Introduction

The ability to repair, refuel, and reposition spacecraft in orbit has often been proposed as a means of radically restructuring the conduct and planning of space missions. As the predominant spacecraft design paradigm stands today, once a satellite has been placed into its predetermined orbit, there is absolutely no way for engineers to in any way modify or fix that satellite, beyond changes in software or self-repositioning (which is likely impossible, or at least very undesirable given the large amount of precious on-board fuel which is required for significant orbital maneuvers). Naturally, this paradigm places significant constraints on satellite design parameters and mission flexibility. Also, should an anomaly strike, mechanical or otherwise, before the end of a satellite's operational lifetime, then options for repair and recovery of prior levels of service are very limited. While engineers have certainly devised ingenious methods for salvaging value from damaged or malfunctioning spacecraft in the past (for instance, by shifting a mission's concept of operations to accommodate the spacecraft as is), few would dismiss a means of fixing (or upgrading) the spacecraft and continuing its mission as originally planned, if such a service was available.

This paper explores in the overall space industry response to the implementation of OOS. More specifically, if it is believed that increasingly massive, powerful, expensive spacecraft represent an unsustainable path for the overall industry, and that this trend in spacecraft design will continue largely

[1] Corresponding Author: hastings@mit.edu , tel:+1 617 253 0906