Summer 2013 research report

Jan Kolmas

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For me as a rising senior in Mechanical Engineering, the last summer before graduation was an important opportunity to acquire more experience and figure out whad do I want to do after college. Thanks to the Tetelman Fellowship, I was able to spend 10 weeks at the Technical University Delft in Netherlands doing satellite research. Since Yale does not have an aerospace curriculum, it was important to me to see, how does such curriculum look like and whether I would be interested in continuing this way for my Master's studies. At TU Delft, I could get experience that I would not be able to get at Yale.

My original research topic was structures and configuration of the DelFFI satellite mission, but the topic was changed to a more general one, satellite reliability. I have studied past missions similar to the DelFFi mission and looked into detail why small satellites fail and what can be done about it. The abstract of a paper that was a final deliverable of my research reads:

> Small satellites, especially CubeSats offer a new innovative and cost-efficient approach to space applications. However, more than half of small satellites experienced a failure in orbit, and more than half of those failures was fatal. This high failure rate of nanosatellites and picosatellites raises the question of what causes the failures and how can satellite developers use that knowledge to build more reliable systems. In this paper, data from more than 150 anomalies in satellites under 50 kg is analyzed in order to produce recommendations for satellite engineers concerning specific subsystems and components. The two components that are responsible for most failures and deserve more attention are batteries and transceivers. This paper also shows on specific examples, that extensive ground testing is the best way of finding potential failures and should not be underestimated.

I have built on a master thesis of another student and extended her work. I have made a database of more than 280 potential satellite anomalies and performed a statistical study of this data set. I have analyzed, which satellite components and subsystems are most often responsible for failures, paying attention to the severity of the failure and whether it happens rather sooner or later in the satellite's life. Based on the statistical findings, I have selected six

satellite missions for a case study, where I have proven the points made by the statistics and extended the study to involve origin and ground testing on the component.

I have learned about all subsystems and components of a small spacecraft and about statistical methods of reliability modelling. I have also discovered, how studying and research is done in Europe. It is likely, that this summer experience will influence my career decisions, and in fact, change my life.