Feasibility of Cubesat Frames for Heat Dissipation Multi-view Onboard Computational Imager (MOCI)

Michael Ely[#1] , David L. Cotten[^1,2], Deepak Mishra[1,2]
[#]mje80254@uga.edu, [^]dcotte1@uga.edu,
[1]Small Satellite Research Laboratory, University of Georgia,
[2]Center for Geospatial Research, University of Georgia

Overview

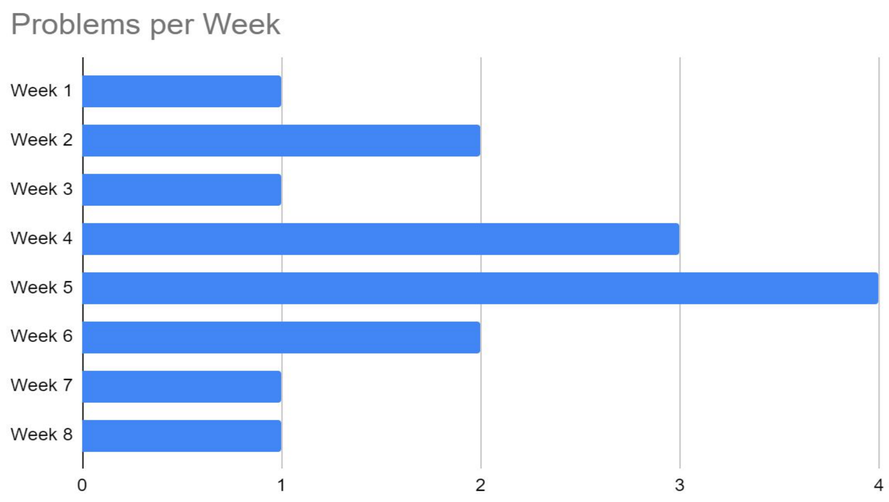
Production in the field of aerospace faces the adversary of development errors and expenditure limitations. During manufacturing, flaws can arise that lead to time and monetary costs. These costs can lead to mission and production delays with some cases leading to complete failure. To avoid unnecessary expenditures while maintaining mission and safety requirements, aerospace organizations employ a material review board (MRB) to handle analysis and solution development. Material review board's responsibilities also include concluding acceptable error during production. The research presented shows material review board requirements of the Small Satellite Research Lab (SSRL). Using industry knowledge and manufacturing information from the development of the SPectral Ocean Color (SPOC) satellite, a set of guidelines have been created for construction of the Multiview Onboard Computational Imager (MOCI) satellite and future missions by the Small Satellite Research Lab. The following information will give background into the integration of SPOC along with the error and difficulties that arose, as well as solutions.

Background

The SPOC satellite mission was started in mid year of 2016. Integration of the SPOC satellite began in May of 2019. With this being the first satellite being manufactured by the SSRL it was expected that a series of errors would occur. Throughout the development process, errors were discovered, rectified, and record. This has allowed for a detailed account of the issues encountered along with the solutions implemented.

The graph below indicates the amount of problems that occurred per week over the course of this past summer. These were problems that stalled progress until they were fixed. This information provided a decent understanding of the timeline for future expected errors. Mid integration is when the most issues arose. This can be expected as large portions of the work were completed towards the center of the timeline.

Some issues are not listed in the graph below as they were on going issues that did not directly halt satellite integration, such as the development of wire harnesses.



Harnessing

Harnessing had a series of issues including running out of materials necessary for assembling harnesses. This included, but was not limited to crimps and headers. Extras were ordered, but the amounts disposed were higher than what was initially expected. This issue will be fixed for MOCI integration by increasing the expected components ordered. For SPOC, estimation of needed components ranged between 1.25 and 1.5 times the needed amount. For MOCI 2.5 times the needed amount will be ordered to avoid shipping based delays.

Assembly of the harnesses also had issues. Due to a lack of experience with the development work, a large amount of training was required to for an individual to successfully assemble harnesses. This lack of experience led to faulty harnesses that had to be reconstructed. Additional harness creation slowed down the completion of this part of integration. To avoid this problem in the future, harnessing assembly training will be held 6 months prior to the beginning of MOCI integration. In addition, many test harnesses will be created to learn common mistakes during assembly. That learned information will be added to the guidelines.

A smaller issue that occured with harnessing was related to the epoxy used. As the epoxy cured it put tension on the connectors and wires which would lead to cracking and joint failure. Different epoxies are being investigated.

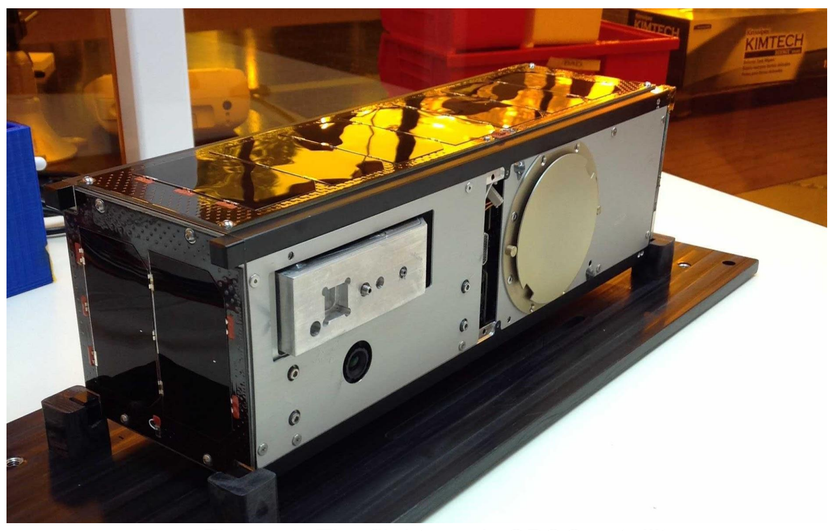


Figure 1: The flight ready SPOC satellite

Inspection

Inspection is already a large part of preparation testing and integration. Due to some issues, more thorough inspection methods are being implemented. Major problems were caused by faults in components and systems received from suppliers. This included oversized holes and incorrect board header lengths.

These issues will be avoided for MOCI by having inspections complete 2 months prior to integration. This will allow enough time for the problem to be solved with the supplier. Currently, all previously received hardware for MOCI is being re-inspected to ensure that the part exactly matches what was ordered with no defects.

Nut Plate

Towards the end of integration an issue arose with one of the holes on the frame. An oversized hole prevented mating between the fastener and threads. This fasteners secures a 3U solar panel to the frame. It was determined through structural analysis that the fastener was critical for maintaining the integrity of the solar panel.

To solve this problem a nut plate was designed to act as an extension on the hole. The plate has three threaded holes. The nut plate was first secured to ancillary holes adjacent to the oversized hole which effectively created addition threads of the proper diameter for the solar panel fastener to connect. The design was created from research into standard practices already produced in the aerospace industry.

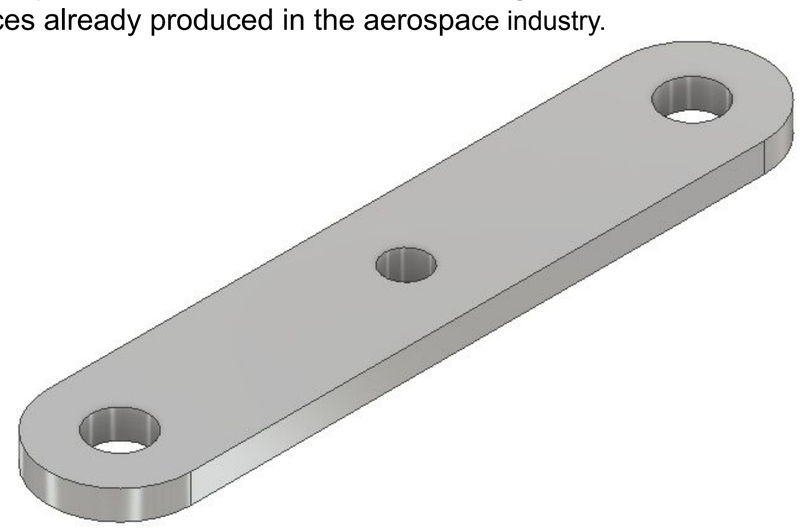


Figure 2: Nut plate solution for SPOC frame modification.

Heat Strap

Heat strap issues were discovered late into integration. Original tolerancing was too tight on the system and made heat strap integration difficult. Tolerance stack ups throughout the satellite prevented the holes between the frame and heat strap to align. This led to additional stress on the heatstrap and the attached electronic board.

For MOCI, this problem will be solved by changing from holes to vertical slots on the heat strap. By doing so, tolerancing problems can be avoided and allows the system to be less rigid. This will also be helpful with allowing flexing during deformation from launch conditions.

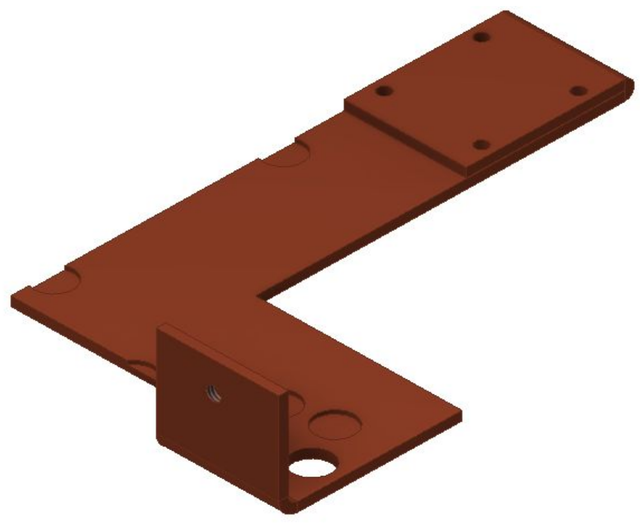


Figure 3: SPOC UHF heat strap

Moving Forward

Many issues were discovered with the integration of SPOC. These are to be expected as a new venture leads to unknown consequences. The Small Satellite Research Lab is taking thorough notes of all problems and solutions discovered to help prevent the problems from occurring again.

The set of guidelines named GASPI (Guide and Alternative Solution Procedure for Integration) will continue to be developed through MOCI integration. Problems, solutions, and developments that occur during MOCI integration will be added to GASPI to further expanded the document. The end goal is that this document can be used as a reference for avoid disasters during integration on future missions by the Small Satellite Research Lab.

References

[Interviews conducted with members of the SPOC Integration Team]

The User's Guide: University Nanosatellite Program NS-9 Revision B.Kirtland AFB: University Nanosatellite Program Office, November 2016. Print

For more information about our research/missions, visit www.smallsat.uga.edu

Small Satellite Research Laboratory
Franklin College of Arts and Sciences
UNIVERSITY OF GEORGIA