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A Report on Small Spacecraft Development Work at the University of North Dakota

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Abstract
An update on current activities related to small spacecraft development at the University of North Dakota is presented. These activities include mission design, spacecraft design efforts and two active design and development efforts. This presentation covers the ongoing activities at UND and the educational and technical value that has been produced. In particular, it focuses on the OpenOrbiter program from an educational perspective.

Through OpenOrbiter, students from a multitude of STEM (computer science, electrical engineering, mechanical engineering, etc.) and non-STEM (education, business, public policy, fine arts, etc.) have had the opportunity to work together. OpenOrbiter is a student-lead, student-driven program. In addition to achieving technical objectives, the involved students have had the opportunity to learn to work with their peers across numerous disciplines. They have learned the specialized vernacular of these other disciplines and the divergent interests, focuses and needs of the disciplines’ practitioners. Current work in documenting the approach for use as a template for implementation at other institutions is presented. In addition to this area of focus, a concise overview of each project is presented and its current status and short and long-term goals are discussed.

OpenOrbiter Mission
The OpenOrbiter Mission will demonstrate the framework and materials developed for the Open Prototype for Educational NanoSats. In addition to this, OpenOrbiter provides participants with an opportunity to experience all aspects of a space program. These include typical elements such as mechanical and electrical design and development, software design and development, assembly, integration and testing, and mission operations. Also included are elements included in most real-world programs but neglected in many university ones. This includes consideration of the policy implications of the mission (and its operation within the university political microcosm and national space policy), education and public outreach and communications. This group has involved numerous non-STEM majors from English, management, policy, arts and others.

Software Development
The operating software for OpenOrbiter / OPEN is nearing completion. With generous support from North Dakota EPSCoR, a student will be funded to complete this during this upcoming summer and test and refine it in the fall. The Payload Software Team has utilized the SURF algorithm for feature detection and is working on implementation. Ground station interface design is complete.

Electrical & Mechanical Design
Mechanical design work on the basic form-factor of the structure is complete. Work on stress testing is ongoing. Electrical design teams have finished the power subsystem and selected the optical payload components. Thermal vacuum testing (Fig. 4) has been conducted and more is planned. Work on Communications, attitude determination and control and the overall bus is ongoing.

Mission Design
Work is ongoing on the development of missions that will utilize the technologies being developed by the spacecraft development programs at UND. Current mission concepts being pursued include: near-Earth object rendezvous, a ‘hitchhiker’-style mission to Uranus and its moons, Earth persistent surveillance and Earth imaging for weather forecasting purposes.

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Roofsat Construction
The Realistic Operational Object for Facilitating Software Assessment and Testing (ROOFSAT) is being developed as a low-cost, highly-accessible platform for the development of software for small spacecraft. It will contain analogs for most of the equipment that can be software-controlled on a CubeSat (or larger spacecraft); however, this consumer-grade electronics is more durable and easily replaceable.

Open Prototype for Educational NanoSats
The Open Prototype for Educational NanoSats (OPEN) will be made available to institutions worldwide to facilitate low-cost CubeSat development. Complete plans, operating software, fabrication and testing instructions will be provided. This should allow the creation of a CubeSat-class spacecraft with a parts budget of approximately $5,000.

3D-Printed Modeling
Models have been created of some parts and the overall framework using 3D-printing to facilitate the testing of parts with ‘black box’ parts for not-yet-implemented subsystems and to test integration with the OPEN design. The use of 3D-printed structures for a high altitude balloon ‘BalloonSat’ is also being investigated, concurrently.