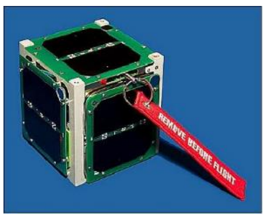
"Let's Go to Space": The Weiss CubeSat Development Team

By Kevin L. Simmons, Principal Investigator for WeissSat-1

Many born in the sixties and seventies daydreamed of becoming astronauts, ballerinas, soldiers, or actresses. The imagination and creativity of a child encourages curiosity and excitement – all potent fuels for learning. As adults, thrilling highs and crushing lows occur less and less frequently. The euphoria so easily experienced as children is replaced by the minor blips and dips of the daily grind. So when an educator is afforded the opportunity to bring a vision to reality, one must wholeheartedly accept the challenge. This is the story of the Weiss CubeSat Development Team (WCDT).

The mission of the WCDT – with the tagline "Let's Go To Space" is very simple: to design, build, test, and fly a CubeSat into space, and to do so within three years.

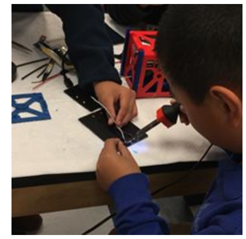


What exactly is a CubeSat? It is a small nanosatellite form factor measuring 10 cm on a side with a mass of approximately 1.33 kg. A CubeSat with dimensions of 10 cm x 10cm x 10 cm is referred to as a 1U. Multiples of this satellite (2U, 3U, 6U, etc.) are also commonly flown into space. CubeSats were intended originally for education and created by Stanford's Bob Twiggs and Cal-Poly's Jordi Suari-Puig (History, 2017). They developed both the CubeSat and its accompanying deployment mechanism, the P-POD. Where a large communication satellite may span twenty plus years from design to end of its life, these small spacecraft allow STEM university students to build, test, and fly them within four years. In the past fifteen years CubeSats have emerged as a disruptive technology, and once where only nations could place satellites into orbit, now a motivated middle school, The Weiss School, will do so (NASA, 2017).

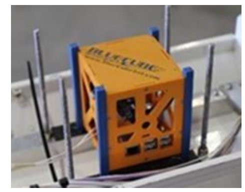
The original plan was multipronged and depended on early third party validation, measureable early student successes, and building a strong sense of team and loyalty. The experiential elements would consist of both hands-on work at the school and traveling to the University of Florida (UF) to attend workshops. At UF the WCDT met with the undergraduate and graduate engineering students from the Small Satellite Design Club. Optimal attitudes and behaviors in the younger students are more easily developed by working closely with those already in the field.

In a well-received elective class, 6th-8th grade students would be introduced to the basics of Aerospace science to include elements of mission design, the properties of space, principles of rocket propulsion, rocketry ascent, orbital mechanics including Hohmann Transfers, spacecraft descent, and environmental and life support systems (ECLSS). Aerospace students and competition teams are trained using the *Understanding Space – An Introduction to Astronautics* textbook (Sellers, 2000).

During an after-school voluntary activity, 6th-8th grade students would form the team, with the first meeting occurring in August 2015. After two weeks nine of the brightest 6th and 7th grade students had committed to the team, which was renamed the Weiss CubeSat Development Team. The team would be asked to do the very difficult, with no penalty for failing, provided they continued to stretch. The path forward would be similar to the Army's 'crawl, walk, run' model: first the basics and bench work, then progressively more realistic and difficult tasks with captive carry flights, tethered and high altitude balloons, and finally orbital spacecraft development.



Students began by working with the BLUECUBE Aerospace (BCA) 1U CubeSat emulator describe. BCA is a small company formed by Albert Einstein Distinguished Educator Fellows with the intention of helping students learn through using a unique CubeSat emulator. Students 3D printed 1U chasses, and assemble the Raspberry Pi-based BCA emulators. Student-created Python-based code allows remote access to emulator data, consisting of multiple sensor data and camera images via a Wi-Fi network to student laptop graphic user interface (Simmons, 2015).



Early third party validation and a nod of success came from the interaction with Generation Orbit (GO), an Atlanta-based, NewSpace company (Olds, 2017). GO personnel conducted a weekend workshop at the school and later WCDT students traveled to Cartersville, Georgia where they completed their first final flight review (FFR) prior to an emulator captive-carry flight. Inside an electronics jammer pod under the wing of a modified Leer jet, a WCDT emulator collected sensor data while the jet flew numerous high 'g' flight profiles.

Then students turned their attention towards conducting their first tethered balloon and CubeSat emulator flights in the spring of 2016. Numerous tethered 'balloonsat' missions occurred over the next months as the students gained knowledge in several areas. A memorable photograph taken from an airborne emulator shows several of the Weiss students forming the Weiss 'W'.

During summer 2016 the author traveled to the SmallSat conference at Utah State University. It is the world's largest meeting for the CubeSat community (SmallSat, 2017). The purpose of attending was to prepare for the upcoming NASA CubeSat Launch Initiative application period. The author also met with key NASA personnel and companies which would later become the WCDT primary spacecraft bus and payload contractors.

Applying for the CSLI would also provide external validation for not only the program but build confidence in the students. Having a due date in November, it was mid-February 2017 that NASA announced their selections for the third round of the CSLI (Berzinski, 2016). The satellite to be built by the WCDT would be called the WeissSat-1, with the understanding that this would be the first of many spacecraft. This educational CubeSat is primarily intended to train students, its secondary purpose is to collect data as to the viability of extremophile bacteria in melting ice while in LEO (NYRAD, 2017). With great anticipation NASA

announced selections for the 8th round of the CSLI in February 2017 (Jackson, 2016). Of 34 proposals selected, 31 were from universities, but only one middle school. The WCDT was further honored by a visit from one-time shuttle astronaut and current Senator Bill Nelson, who held a press briefing at The Weiss School in March (WPTV, 2017). Selection by NASA not only provided additional validation but also greatly enhanced team espirit de corps. Many new students joined.

In April 2017 the WCDT demonstrated growth in its capabilities by successfully launching it first high altitude balloonsat (HAB) mission. With support from the WeissSat-1's primary bus partner, NearSpace Launch Inc. (NSL), students gained valuable experience with a transmitter similar to the flight hardware and in using the data downlink provided by the GlobalStar network of satellites. Launched from the school, live video transmission and over 250 data points were collected during the 4 hour mission, which ended in the Atlantic north of the Bahama Islands.

Last summer eleven WCDT students attended the 31st annual SmallSat Workshop and Conference in Logan, Utah. This was the first year a middle school student team attended. It was incredibly beneficial to the team in that they spent a week with like-minded professionals and university students, and they were well received. Utah Public Radio interviewed members of the team which aired on August 29, 2017 (Teichert, 2017).

At The Weiss School spinoff benefits of the WCDT are numerous. Through the school's Distinguished Speaker Series, astronauts Story Musgrave and Apollo 16 moonwalker Charlie Duke have visited and presented (Berzinski, 2016; Peters, 2017). Students are frequently invited to exhibit and present at Aerospace conferences and banquets, including the American Institute of Aeronautics and Astronautics, the Missileers and Space Range Pioneers, and the Humans2Mars Summit. (Humans, 2017). Weiss annually conducts highly successful aerospace summer camps, and leads a NASA-sponsored Space Settlement Contest working with students from several nations to form a single team. WCDT members call on Congress with the Space Exploration Alliance (Space, 2017; Congressional, 2017).

Weiss has sharply increased participation in regional and state-level science and engineering fairs, and high school only competitions. In the recent Regional Science/Engineering Fair Weiss won best overall project, won five of eleven categories entered, and 18 of 23 students placed. Many of these projects were Aerospace-themed.

This author believes the ultimate teaching frontier is at the intersection of aerospace, biotechnology, and entrepreneurship. Having an opportunity to unleash a 'blue-sky' vision that encompasses all three in the form of a satellite carrying a biotechnology payload represents the ultimate real-world student challenge. During the WeissSat-1 mission students at times will fail, and learn from it.

Students will gain academic confidence through this experience. Getting to space requires them to 'work hard, work smart.'

At the time of this writing the WCDT had recently met again with its payload partner, NYRAD, and will soon receive its full WeissSat-1 engineering unit from NSL. Once received, students will test hardware to prepare for NASA's stringent certification testing. NASA personnel have indicated that WeissSat-1 will most likely be manifested soon for a 2018-Q4 launch. Candidly the team hopes for a Florida launch, but will gladly accept any ride NASA provides. In the meantime they prepare for another HAB mission with the goal of reaching at least 30,500m (>100,000 ft). Why do something so risky and so difficult? Why not? Let's Go To Space.

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