CubeSats for Education, Not Any More

By

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and

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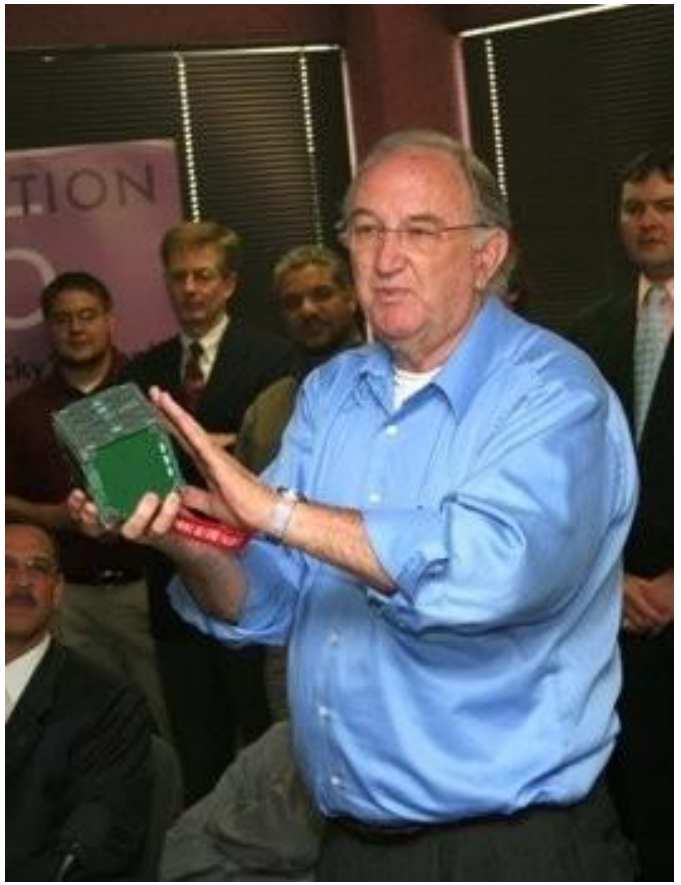
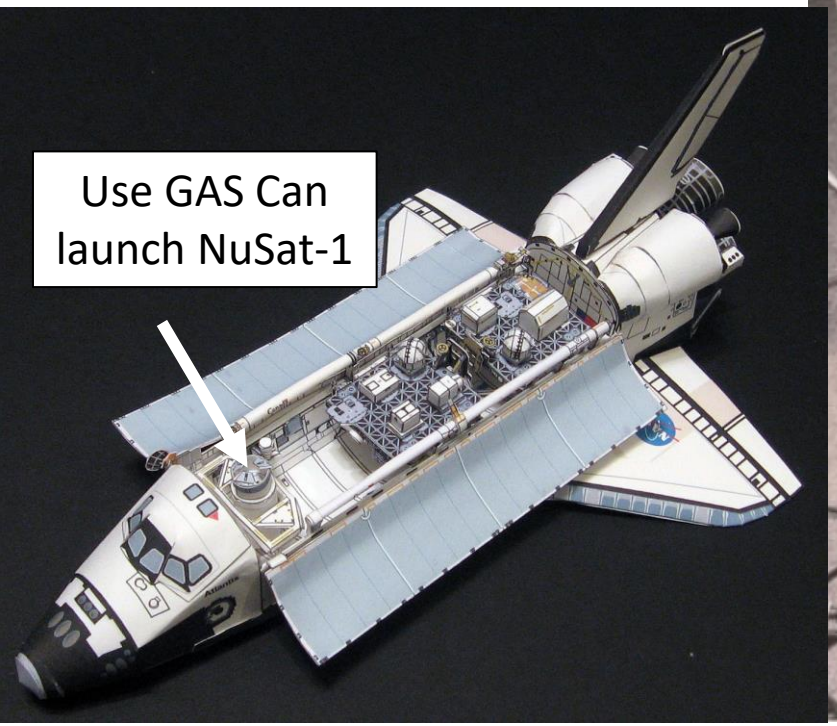
Intro and Biography

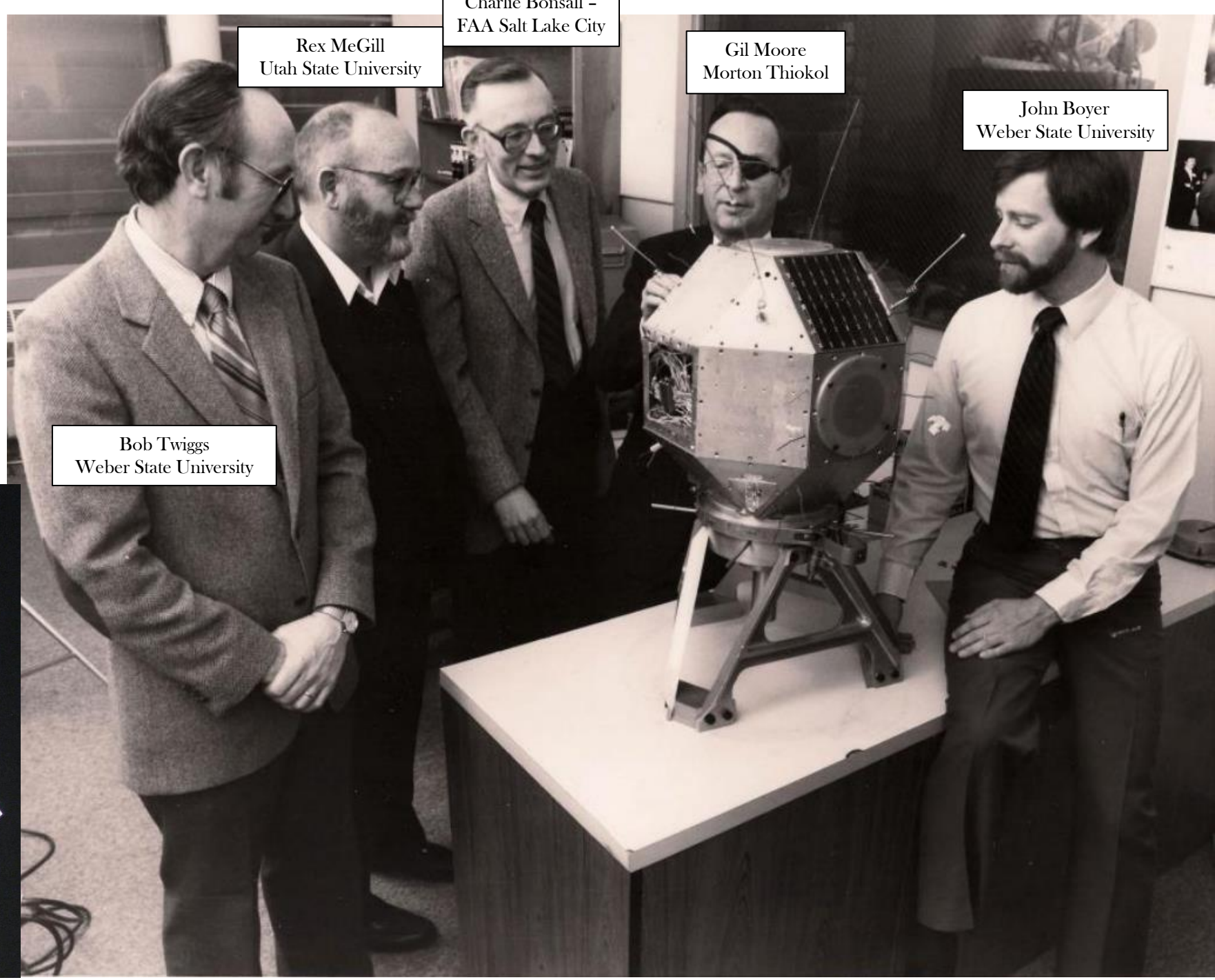
- Introduced the CanSat, CubeSat and the PocketQube for educational applications in space.
- Academic Career
  - 1982-1994: Weber State University, Utah,
    - Started the Center for Aerospace Technology
    - Built the 2 Educational Spacecraft
  - 1994-2008: Stanford University, California
    - Started the Space Systems Development Laboratory
    - Introduced CubeSat
  - 2009-2019: Morehead State University
    - Launched First PocketQube



Launched NuSat-1 in 1985

Never made a spacecraft before!





After four years at Stanford found that we needed a new standard for student-built satellites

Why?

- Took too long to build
- Too much room to add new ideas
- Difficult and expensive to launch

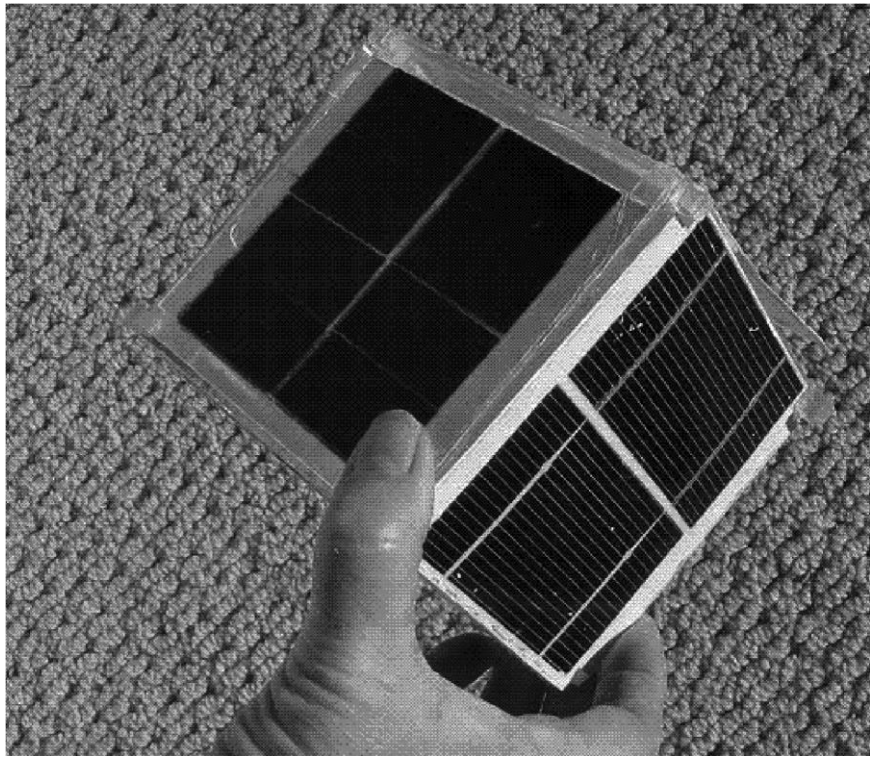
Stanford University's OPAL and SAPPHIRE Spacecraft

The New Standard

- Make a new standard that reduces size and launch costs
- Goals:
  - ✓Small size for limited room
  - ✓Low cost to launch
  - ✓Have multiple sats in one container
  - ✓ Safely enclosed launcher

The New Standard – Called CubeSat

- Concept for picosat.
  - 4-inch cube
  - Jack-in-the-box 3-unit launcher – P-POD
- Co-development alongside Prof. Jordi Puig-Suari at CalPoly



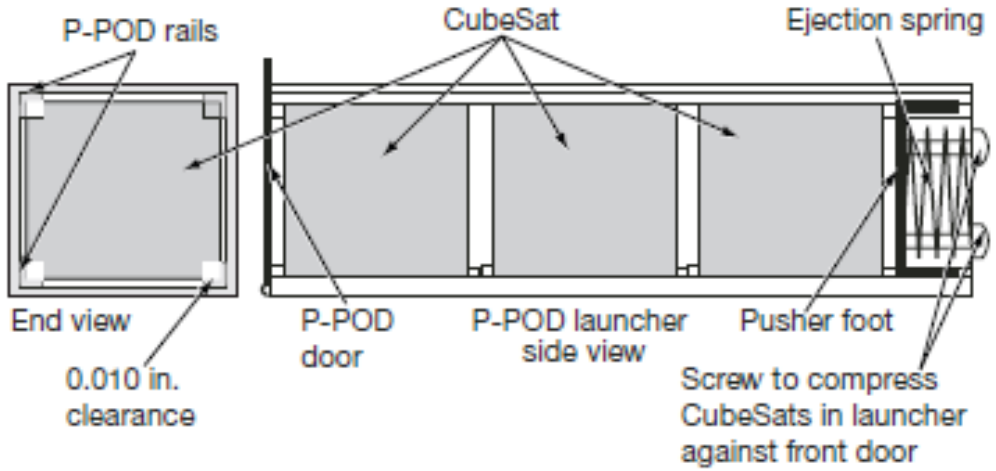
First plastic model of CubeSat Made of a Toy Box!

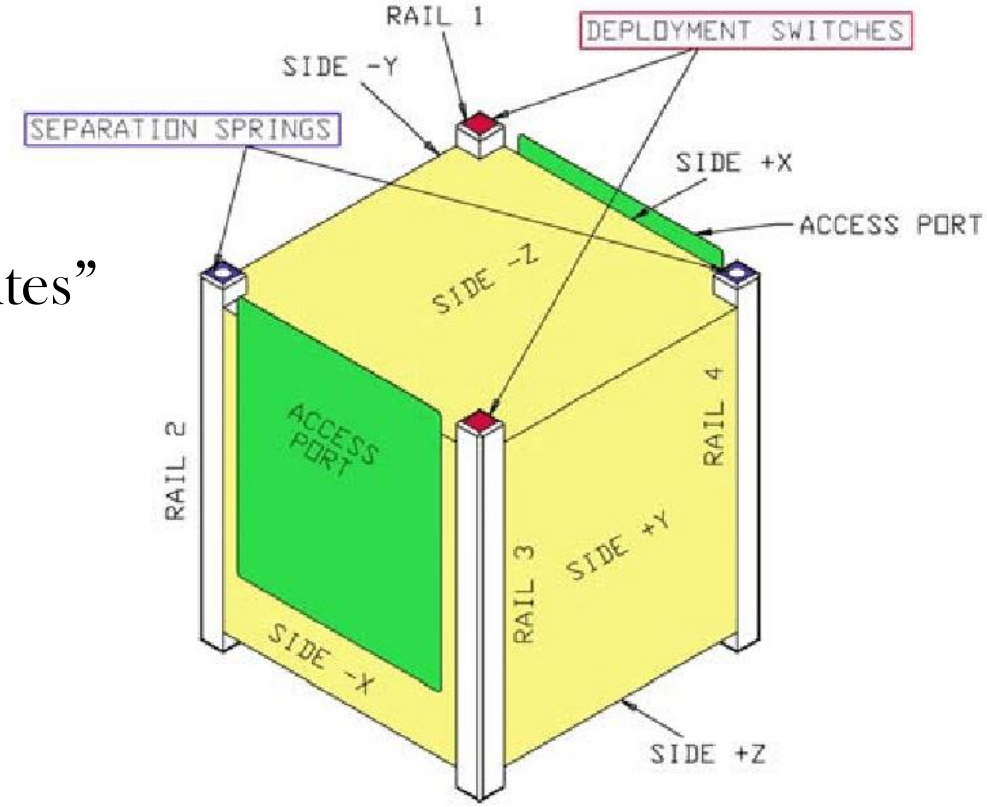
Some People Didn't like the Idea

Comments on concept

- "Dumbest idea I've ever Heard"
- "Too small to do anything useful"
- "You academics are not smart enough to build satellites"

Except in Japan!





The CubeSat TimeLine

Presented first time at JUSTSAP Nov 1999

1st Launch of CubeSats 2003/06/30

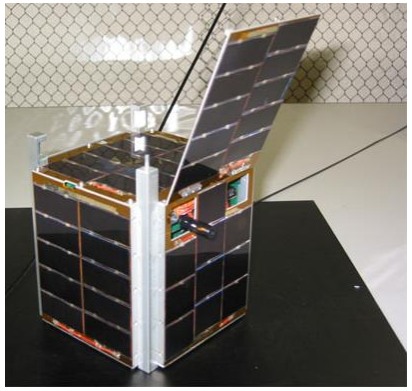
- QuakeSat, Stanford University,
- CanX-1, University of Toronto
- XI-IV, University of Tokyo
- CUTE-1, Tokyo Institute of Technology
- DTUsat-1, Danish Technical University
- AAU Cubesat, Aalborg University

2nd Launch: SSETI Express 2005/10/27

- nCube-2, Norwegian U of Sci and Tech
- XI-V, University of Tokyo
- UWE-1, University of Würzburg

3rd Launch and 1st from Japan 2006/02/21

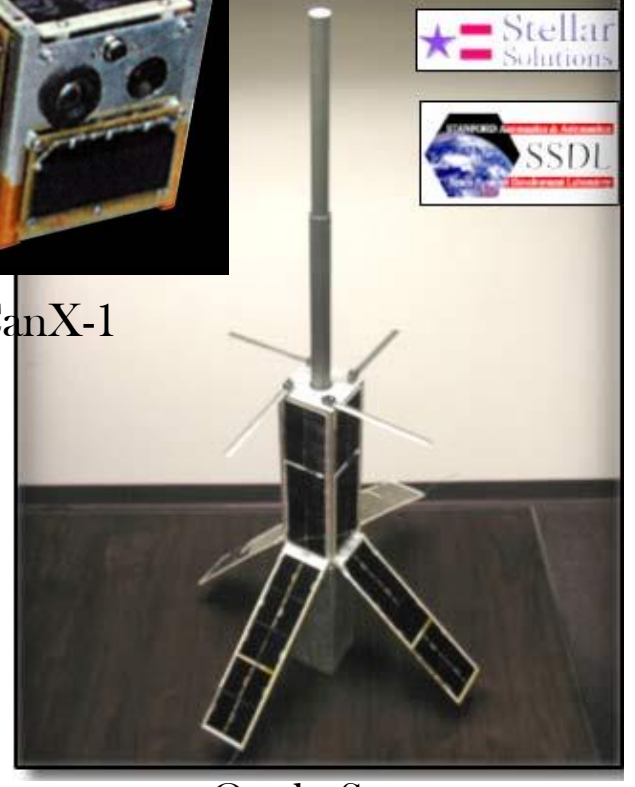
- CUTE-1.7+APD: Tokyo Institute of Technology



CUTE-1

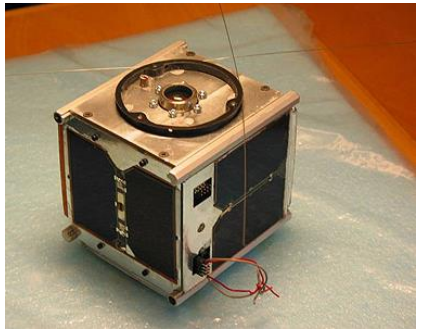
CanX-1

XI-IV



QuakeSat
First 3U CubeSat!

DTUsat-1



AAU Cubesat

The CubeSat TimeLine

4th Launch Exploded!, 2006/07/26

- The Loss of the Dnepr with 14 CubeSats!
- Almost Called it Quits!

Then Even More Exciting Stuff Begins!

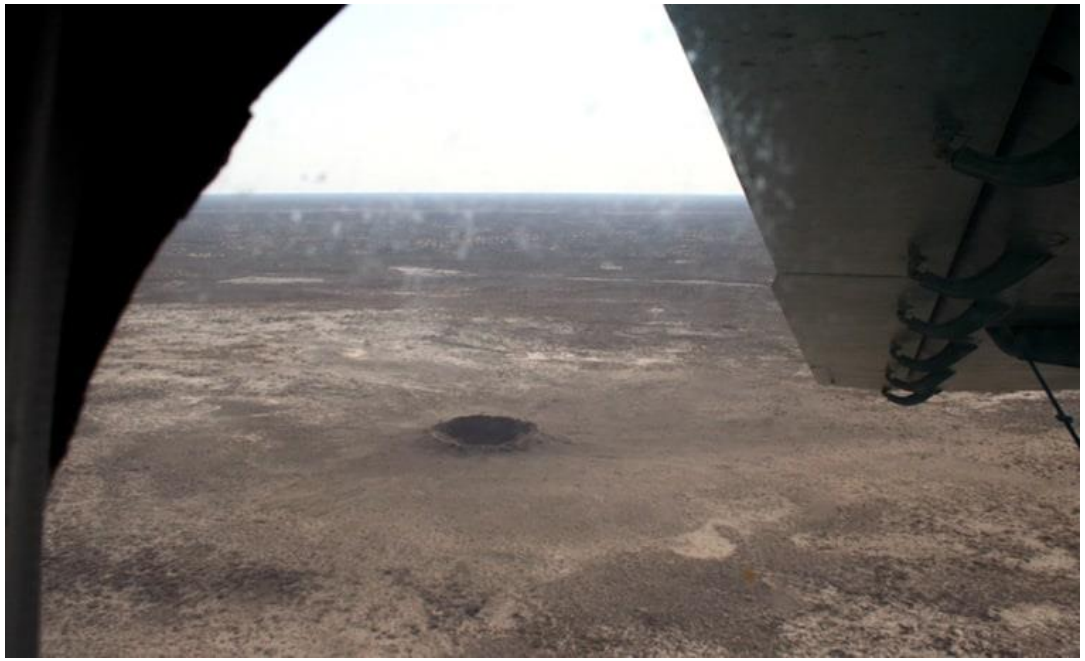
But Eventual Acceptance by the Community

✓First Universities

✓Amateur Radio (AMSAT)

✓Commercial Aerospace

✓Finally, Governments



Hole with our CubeSats!

CubeSat History Project

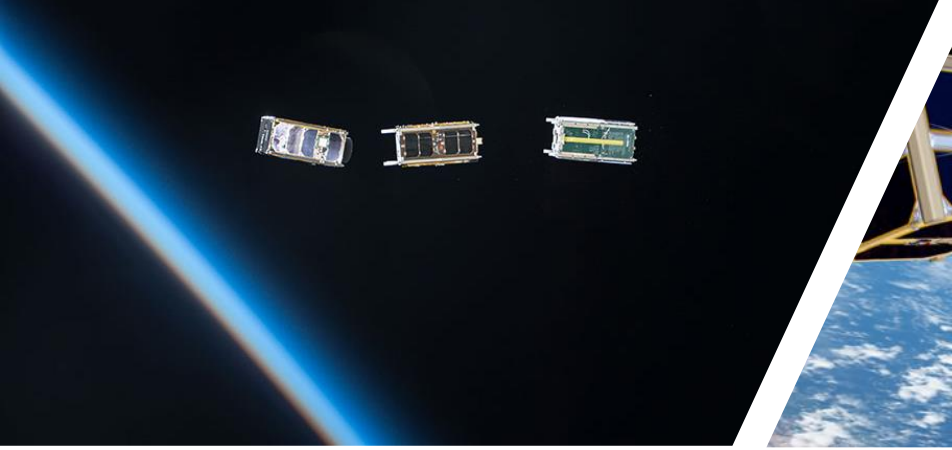
- Writing a history of how the cubesat was made and adopted
- We are looking for more Japanese and International participants to tell their stories of the first CubeSats in their countries!
- To contribute to The CubeSat History Project and schedule an interview:
  - Email Dr. Zucherman at azucherman@gmail.com
  - Or scan the QR code

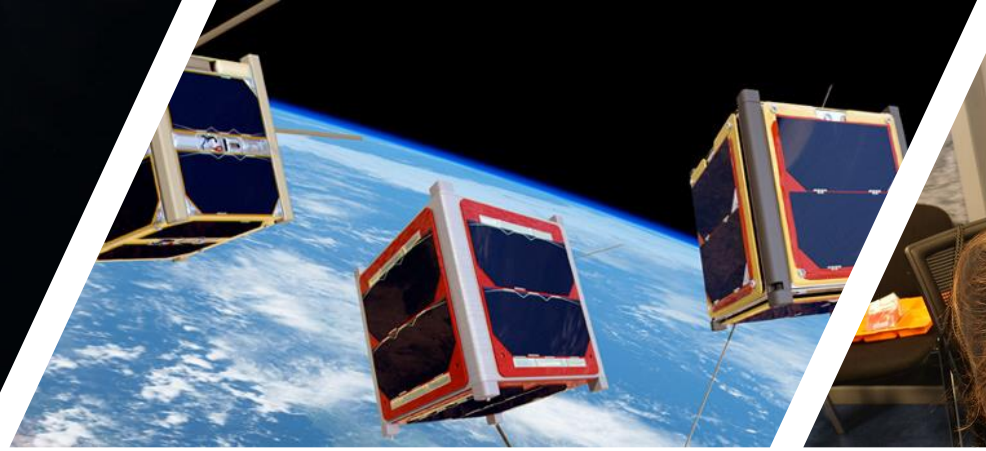
What has been the value of the CubeSat?

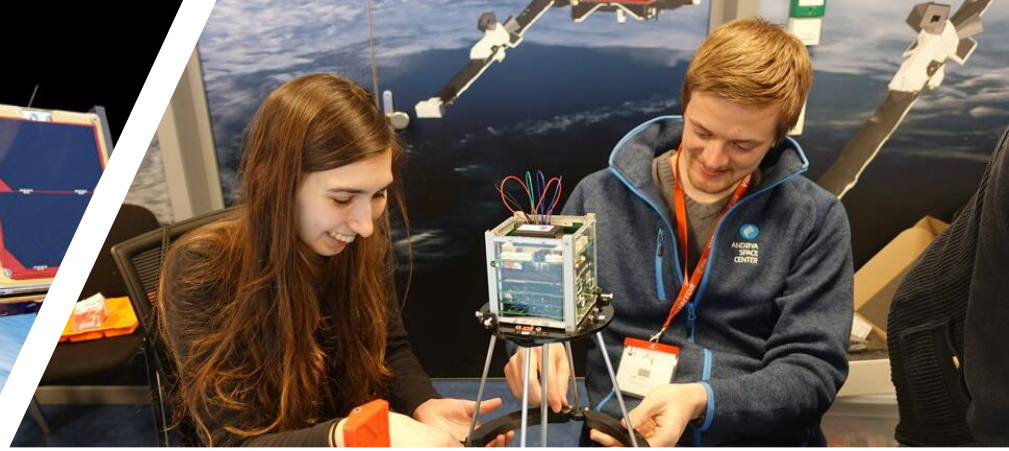
- Wildly Ppular with students
- Produced new space industry leaders
- Changed industry concept in how to build satellites
  - ✓Large to small.
  - ✓Less expensive missions.
  - ✓Reduced development time.
  - ✓Use of ridesharing to reduce launch costs

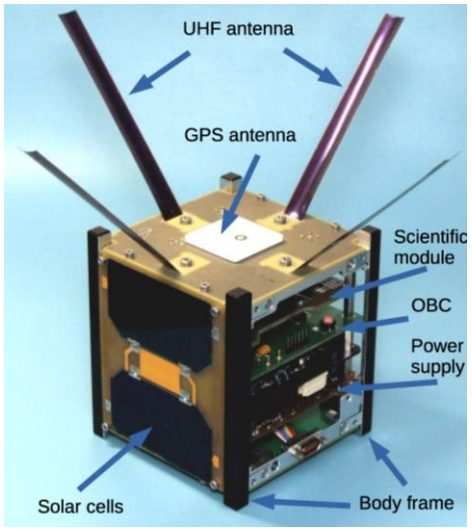
Some bad things about being popular!

- Licensing becomes more difficult.
- Costs of launching tripled
- Expectations and complexity of the missions increase!
- Driven by a Faculty Advisor or Mentors
  - Wants a Nobel Prize!
  - Time to develop leave out initial students --- 3-5 years to never
  - Students are not learning management standards

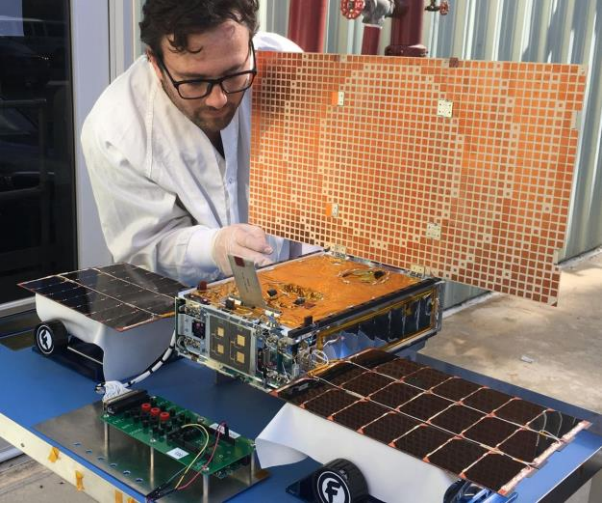


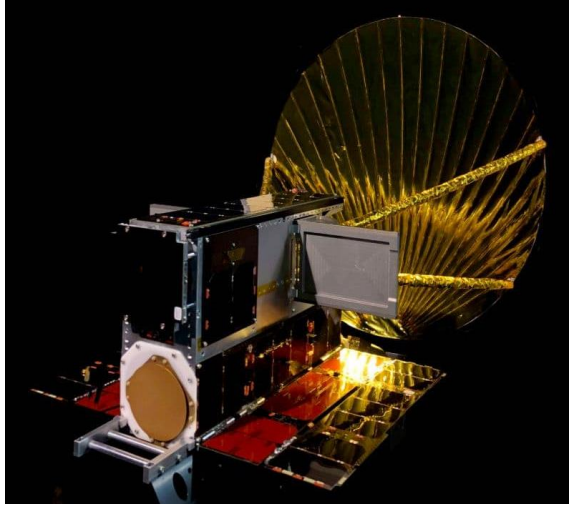


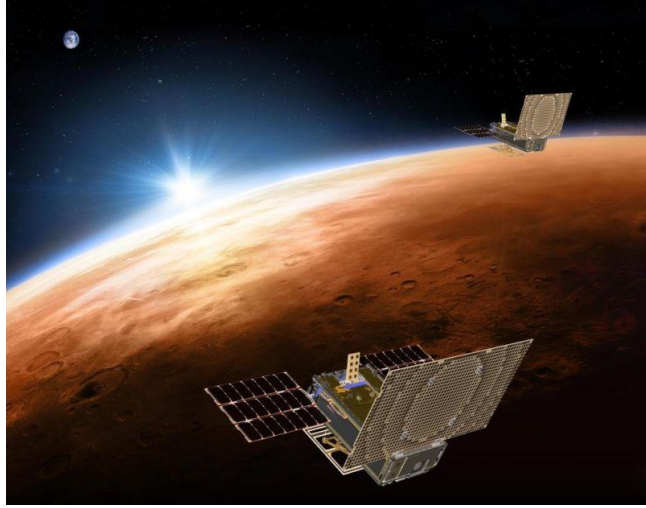


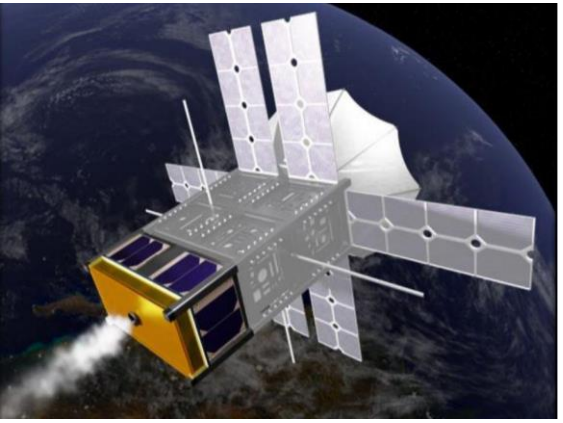


What I Wanted!

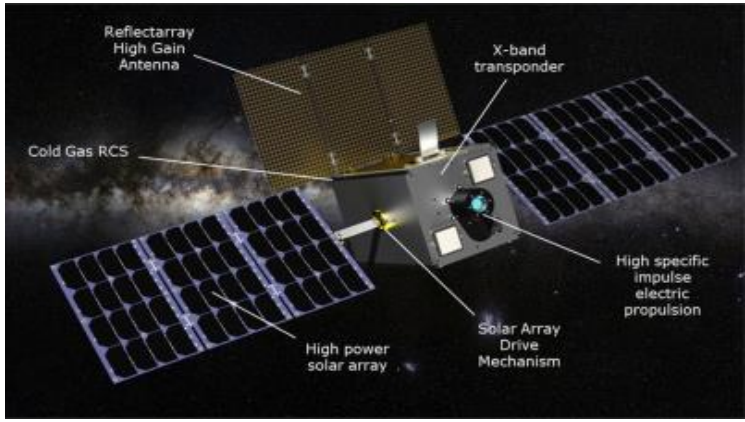


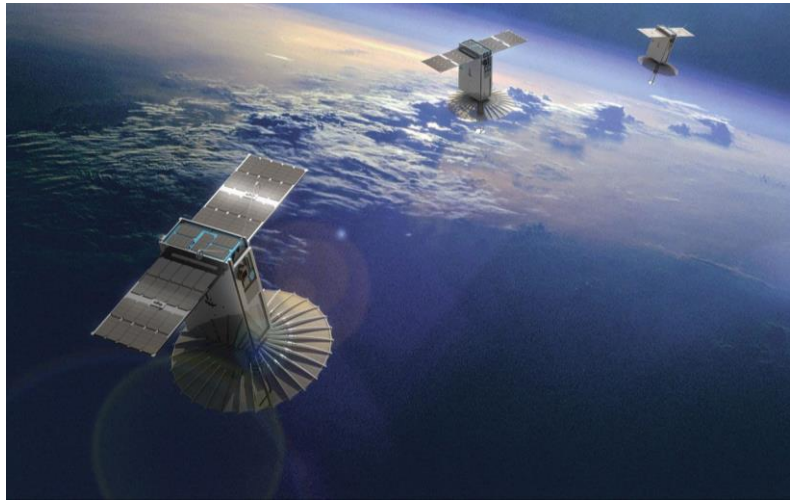


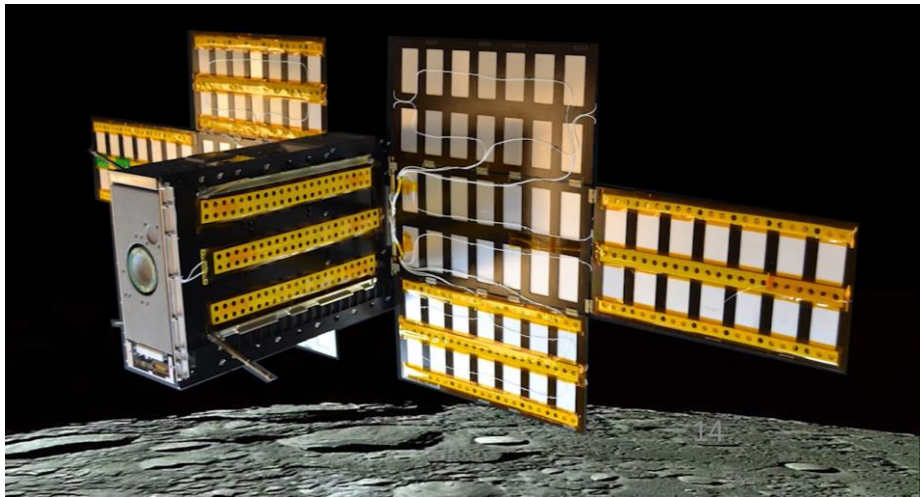




What They Became!

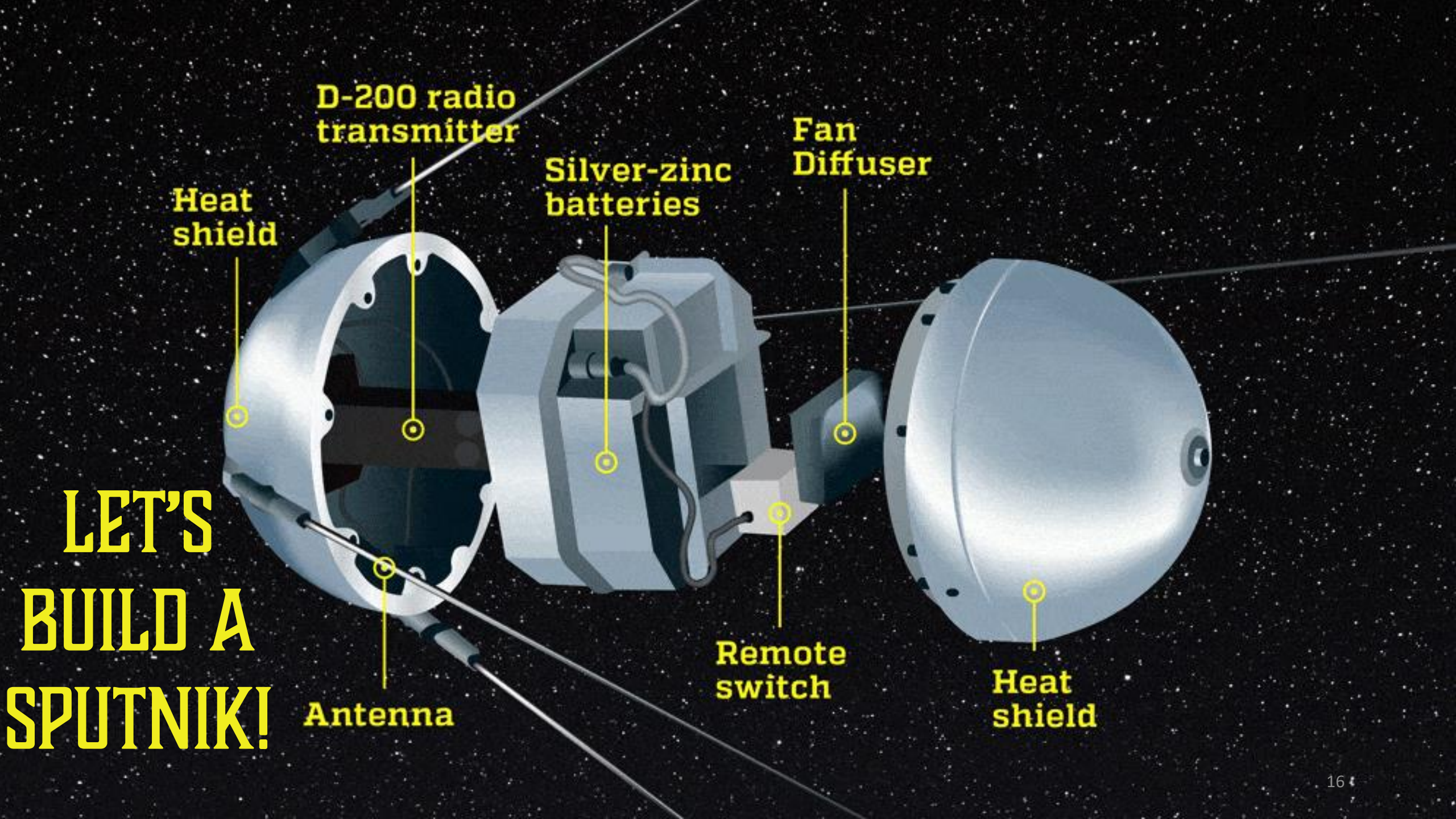






But what about the Future?!?!

- Are CubeSats still meeting the original needs for education?
- Simple to build?
- Inexpensive to build and to launch?
- Minimum paperwork – less government regulation?



LET'S BUILD A SPUTNIK!

OR A VANGUARD!

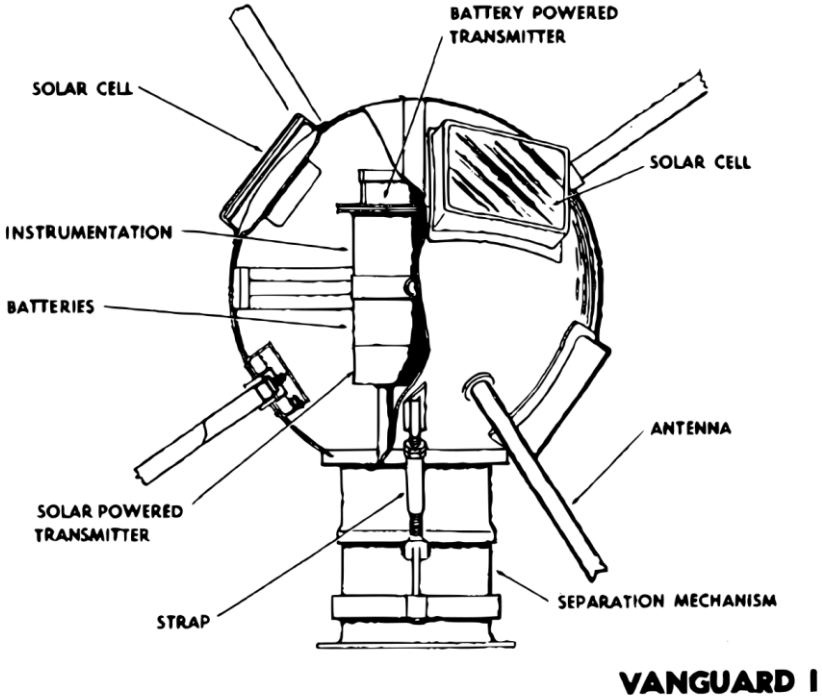
What is needed for first time student missions?

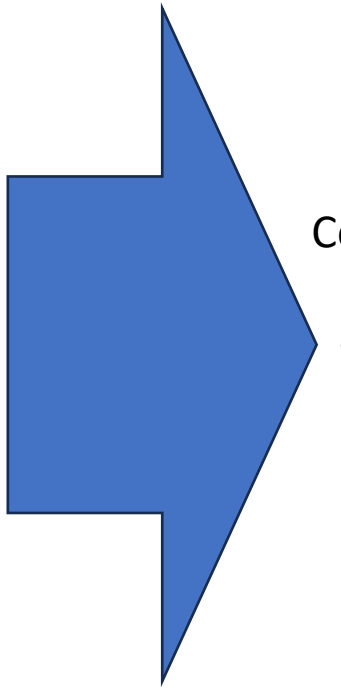
- ✓Mission starting with mission management concepts.
- ✓Completed with firm development goals.
- ✓Must be completed and launched within TWO years.
- ✓Must be no more complex than SPUTNIK.
- ✓Have an orbit life of six months or less.

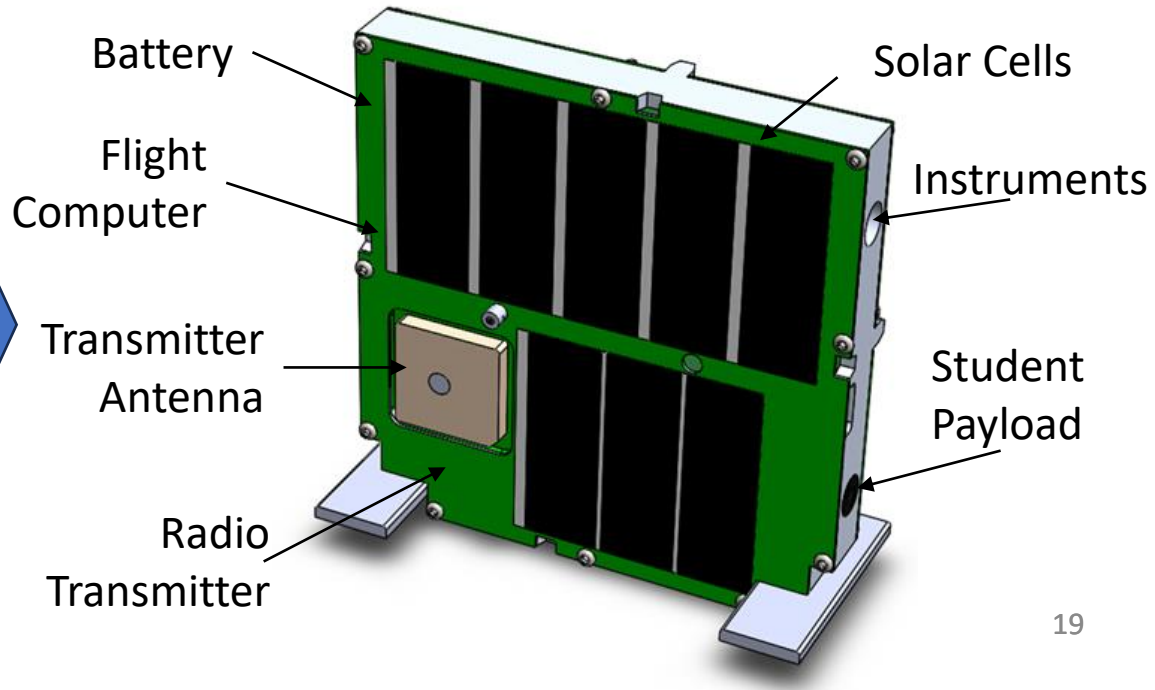
Challenge to you!

How can the academic community get back to the basics for first-time CubeSat students?

1. Work together to maximize opportunity in a single launch
2. Make the design low-cost.
3. Have simple sensors for using low downlink data rate.

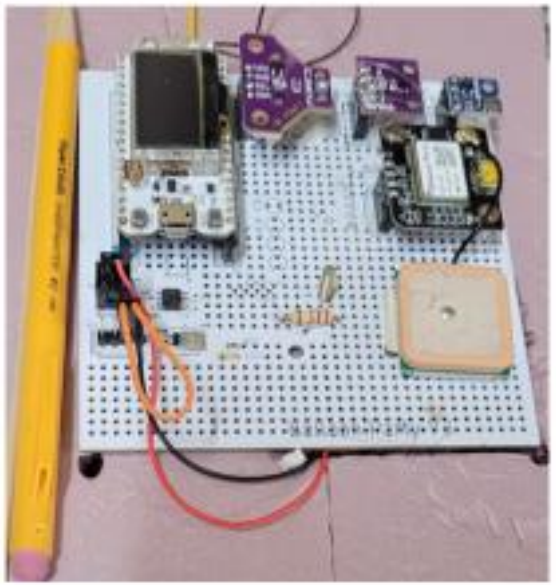




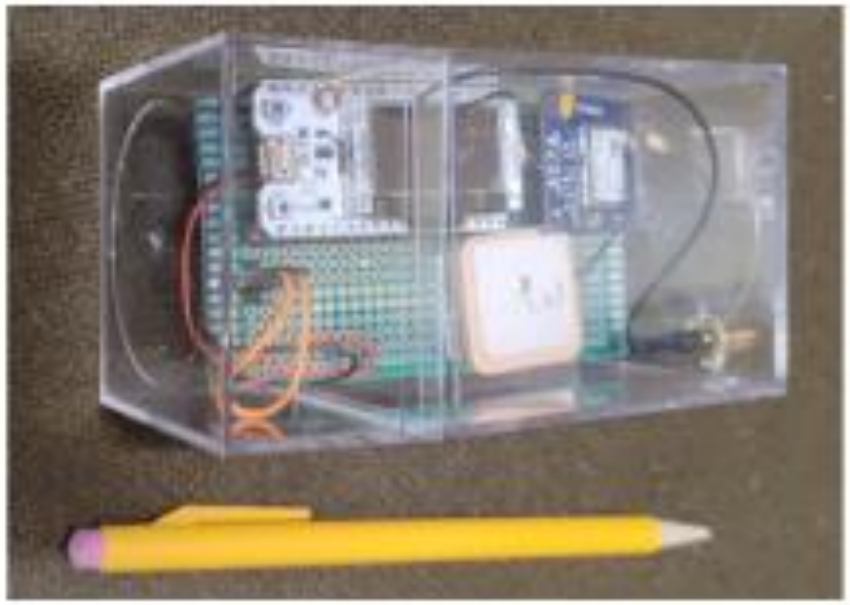


SlimSat Concept!

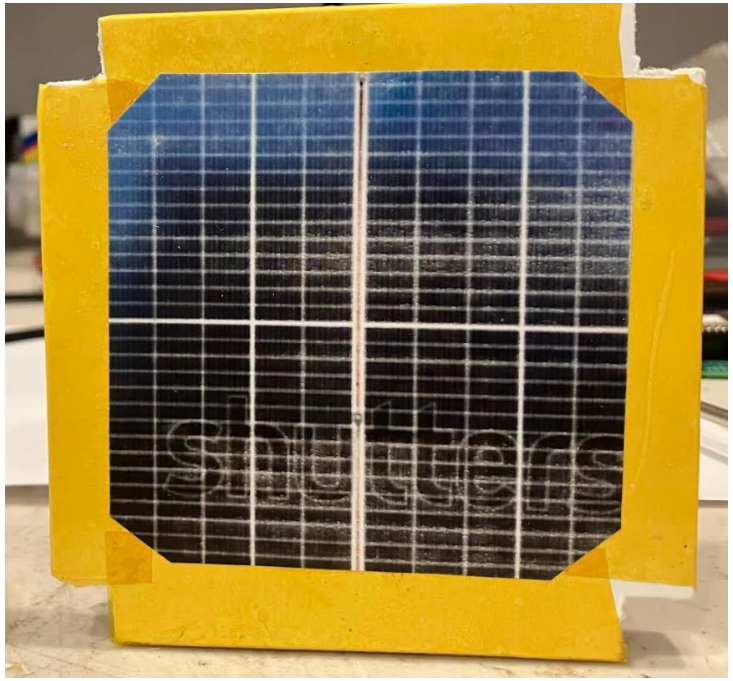
- +20 Missions per deployer!
- 7 per 1U
- Affordable for pre-university students



Engineering Breakout Model



Ground Station Set Up



Questions?

- To Learn More about the SlimSats Reach out to:
  - Bob Twiggs at rjtwiggs@gmail.com
  - 408-230-4728
- Contribute to The CubeSat History Project and schedule an interview by:
  - Emailing Dr. Zucherman at azucherman@gmail.com
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