The Long-Threatened Flood of University-Class Spacecraft (and CubeSats) Has Come: Analyzing the Numbers

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Same Song, Sixth Verse?


- Why? (Besides an excuse to come to Logan, of course)

- The third watershed is happening
  - Second event: JAWSAT (2000)
  - Third event: ORS-3 (2013) [or OUTSAT (2012) or ...]

- Agenda
  - Listen to my talk
  - Read my paper (please?)
  - Check out my database
  - Argue!
"University-Class Satellite"

• Working definition
  – Self-contained device with independent communications, command & control
  – Untrained personnel (*i.e.* students) have key roles in design, fabrication, integration and operations
  – Training is at least as important as the rest of the mission

• Excluded (by definition)
  – Many, many satellites with strong university participation (especially as science PI)
  – Most Amateur satellites

• Exclusion does not imply lack of educational value!
Missions Manifested Per Year

Growth!

- 10\textsuperscript{th}: 1994 (24 years)
- 50\textsuperscript{th}: 2003 (9 years)
- 100\textsuperscript{th}: 2008 (5 years)
- 150\textsuperscript{th}: 2012 (3 years)
- 197\textsuperscript{th}: 2013 (1.9 years)

2011 - \textit{Is "steady state" 8 or 15 (or 25?)}
It’s Not Just CubeSats!  *(Okay, it’s mostly CubeSats)*
No Flag? No Problem!

It's Raining CubeSats!

Flagship
Independent

Year
No Flag? No Problem!

Flagship School
- Significant government sponsorship
- Often a leading space education/technology program for that nation

Independent School
- Self-funded or sponsored (at school’s initiative)
- On their own for launches

It’s Raining CubeSats!
Thank you for putting this on the exam
Thank you for putting this on the exam

1970-2011
- 29 flags built 73 spacecraft (47%)
- 54 independents built 84 (53%)
- Only 5 repeat independents, ever!

2011-2013
- 31 new schools (7 flags)
- 66 spacecraft, 16 by flags (24%)
- 6 active (repeat) flags
- **18 active (repeat) independents** (up from 10 in 2001 and only 4 in 2009)
Is this good? You tell me! *(Please?)*
What The CubeSat Hath Wrought

- Leveled the playing field
- Hit (close to) the sweet spot
  - Enough capability to fly real-ish missions
  - Not so much capacity that students’ reach exceeds their grasp
- Created two standards
  - The containerized spacecraft carrier
  - COTS spacecraft parts
- Raised expectations (thanks to NSF, NRO, NASA and ESA)
Speaking of CubeSats...

- 193 CubeSats in 14 years
- 116 since 2011
- 2014: 30, 50 or 100?
Who’s Building Them?

It’s Raining CubeSats!

Swartwout
Toy, Tool, or Debris Cloud?

It's Raining CubeSats!

Swartwout
Are We Ready?

Number of CubeSats on the same launch

ORS-3: A record number of secondaries
... until next year
... until whenever QB50 flies
Are We Ready? (Probably Not.)

• It’s hard enough to build, integrate & launch 27 CubeSats...
  – Tracking / deconfliction
  – Recontact
  – Uplink / downlink management
  – Unexpected behaviors from common subsystems on different platforms
  – The unwanted attention if 40% don’t meet their mission

• The snowball effect

• What happens if/when we have another JAWSAT event?
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• Sources
  – Smallsat Conference Proceedings / Conversations
  – Gunter’s Space Page
  – Encyclopedia Astronautica
  – Mike Rupprecht (DK3WN Satblog)
  – FlightGlobal SpaceTrak

• My database:

  http://astrolab.slu.edu/AstroLab/Research.html
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