

SSC07-XI-10

Beyond the Beep:
Student-Built Satellites
with Educational and “Real” Missions

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21st Annual AIAA/USU Conference on Small Satellites
Logan, UT

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Sneak Preview

- Read my paper (and send me updates)
- An updated look at the numbers
 - Reliability
 - Flagship vs. Independent
 - New: mission utility
- Examples of sustained programs
- Does the mission matter?

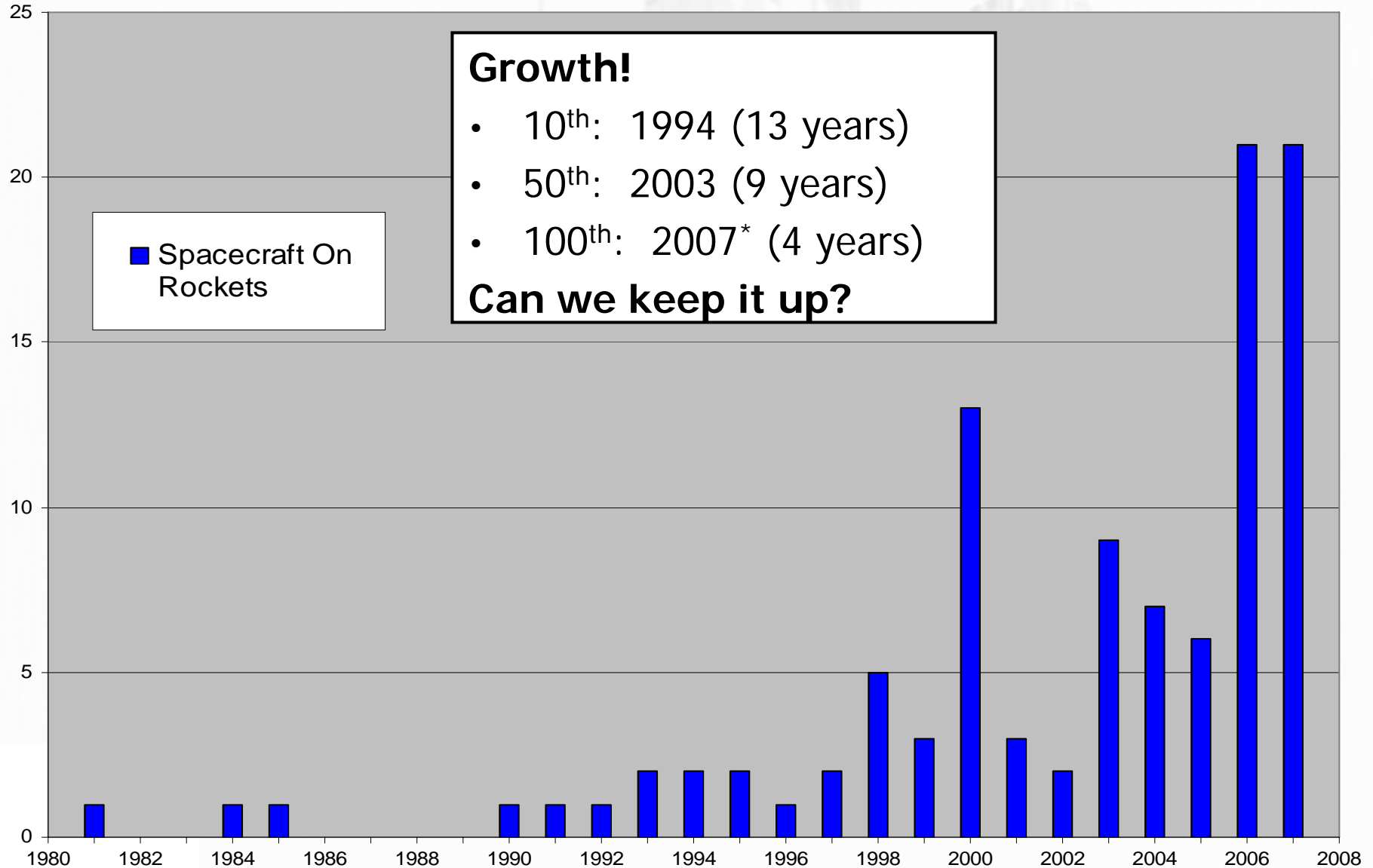
“University-Class Satellite”

- 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!

Admitting my Biases

- Sustained programs = good
 - Better education
 - Reduced concept-to-operations time
 - More useful missions
- Useful missions = good *[I think]*
 - Educational value of answering to an outside customer
 - Increased return from launch investment
 - Make meaningful contribution beyond the university

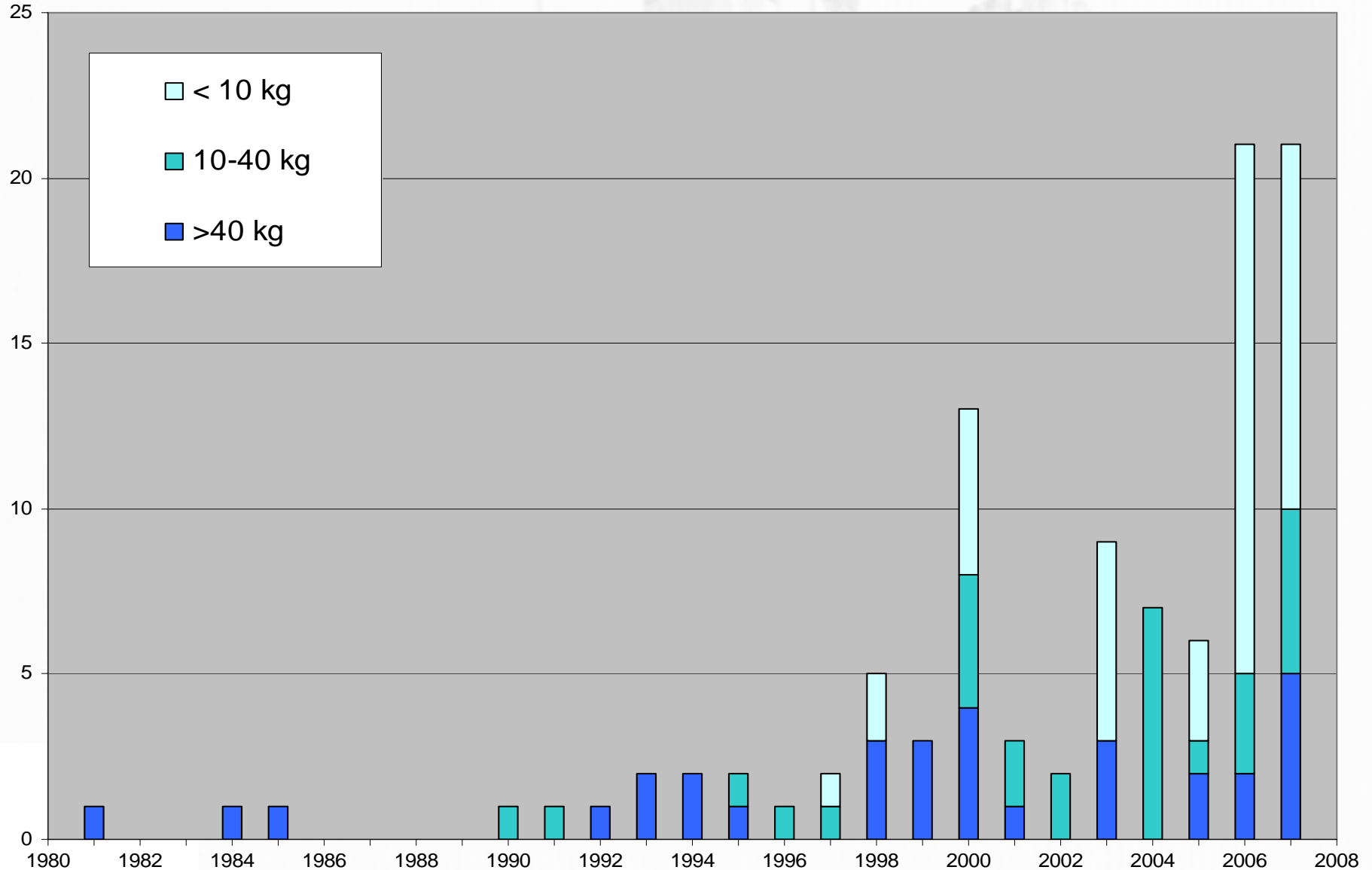
The Numbers



It's Not Just CubeSats!

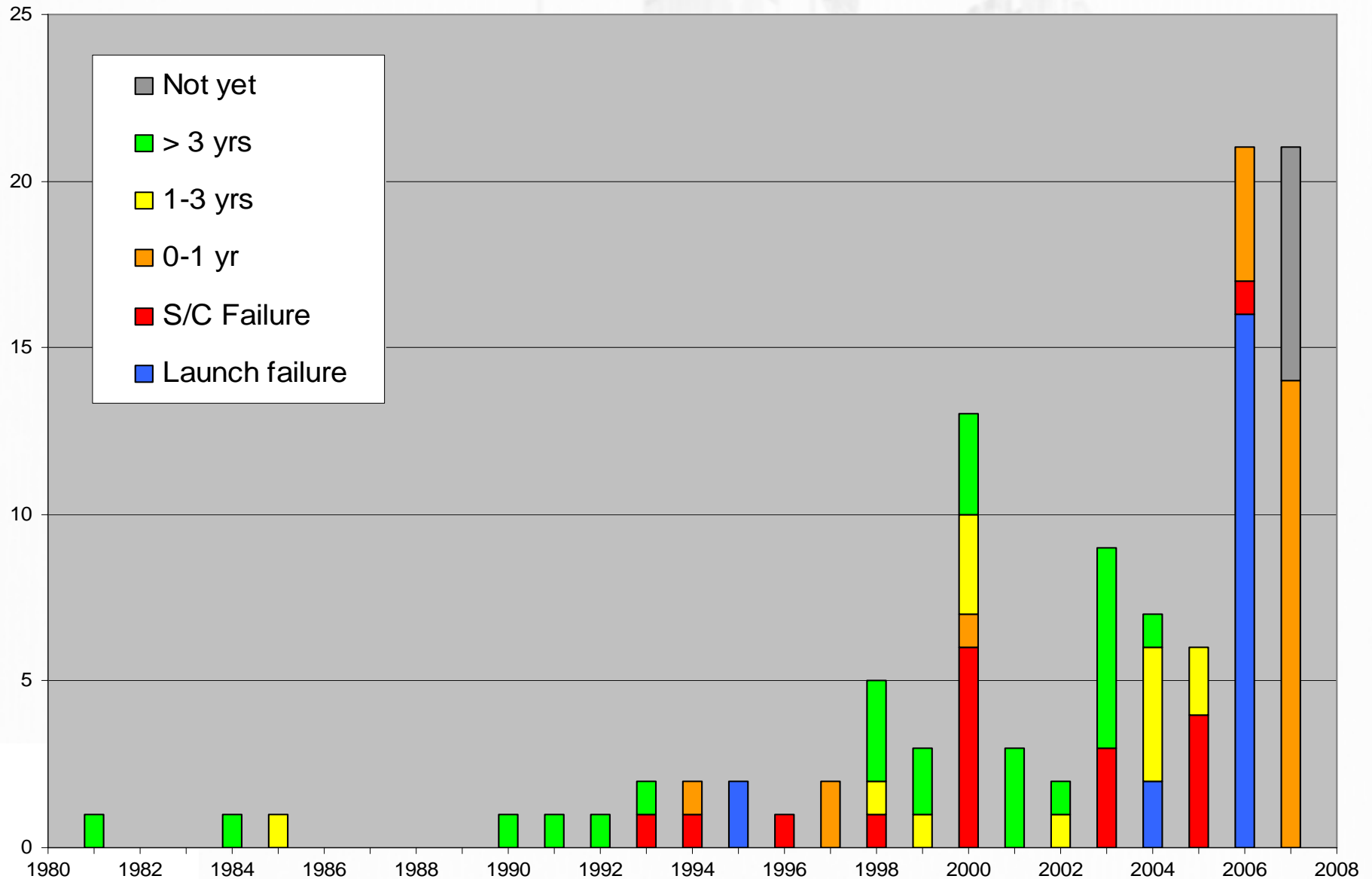
[Okay, it's mostly CubeSats]

*Beyond
the
Beep*



A Better Year for Mission Success

*Beyond
the
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What Breaks?

18 of 78 orbited spacecraft "failed"

What Breaks?

TUBSAT-B
at 1250 km

- Radiation: 1*
- Launch interface: 1
- Launch thermal: 1
- **Communications: 4½**
- **Power: 4½**
- **DOA: 6***

JAK, Thelma, Louise
~200 gram, battery-powered
proto-CubeSats

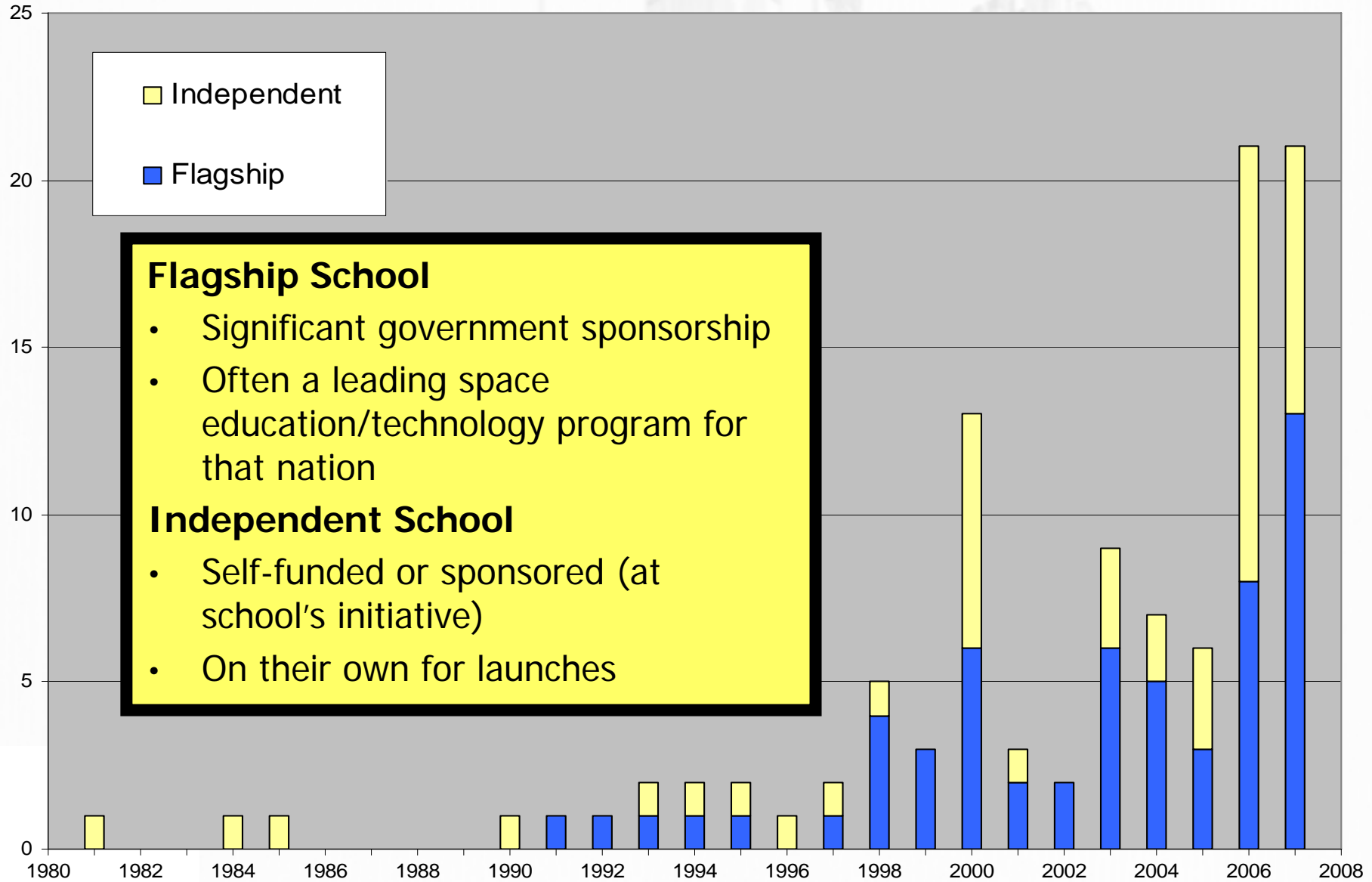
What Doesn't Break?

Lifetime
reduction

- Structures
- Thermal*
- Commercial Electronics in
Radiation Environment*

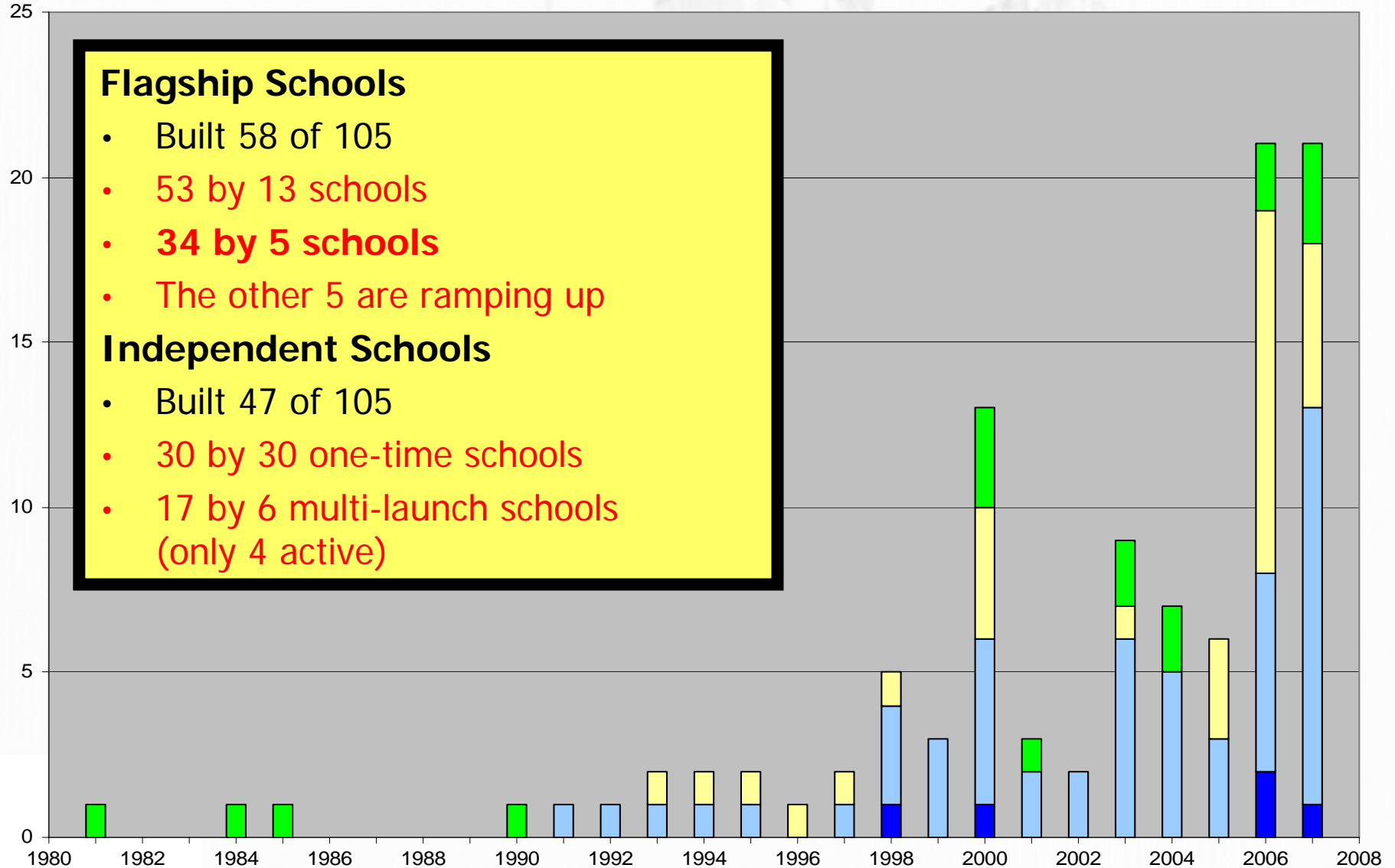
Perhaps we need to worry more about system-level functional testing and less (?) about the space environment

2007: Return of the Flagships



Repeat Business: You Gotta Be Somebody

Beyond
the
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Flagship Schools

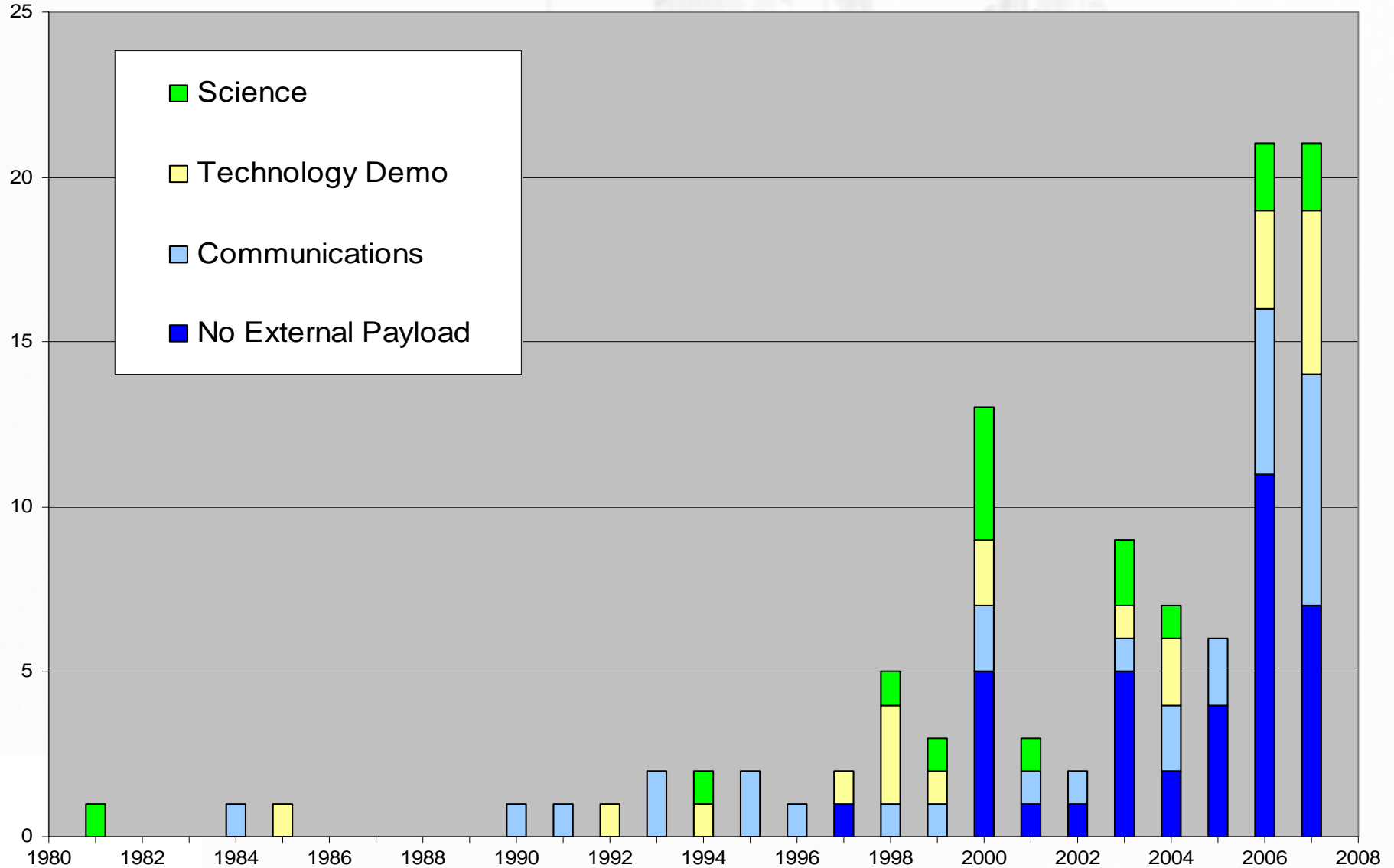
- Built 58 of 105
- 53 by 13 schools
- 34 by 5 schools
- The other 5 are ramping up

Independent Schools

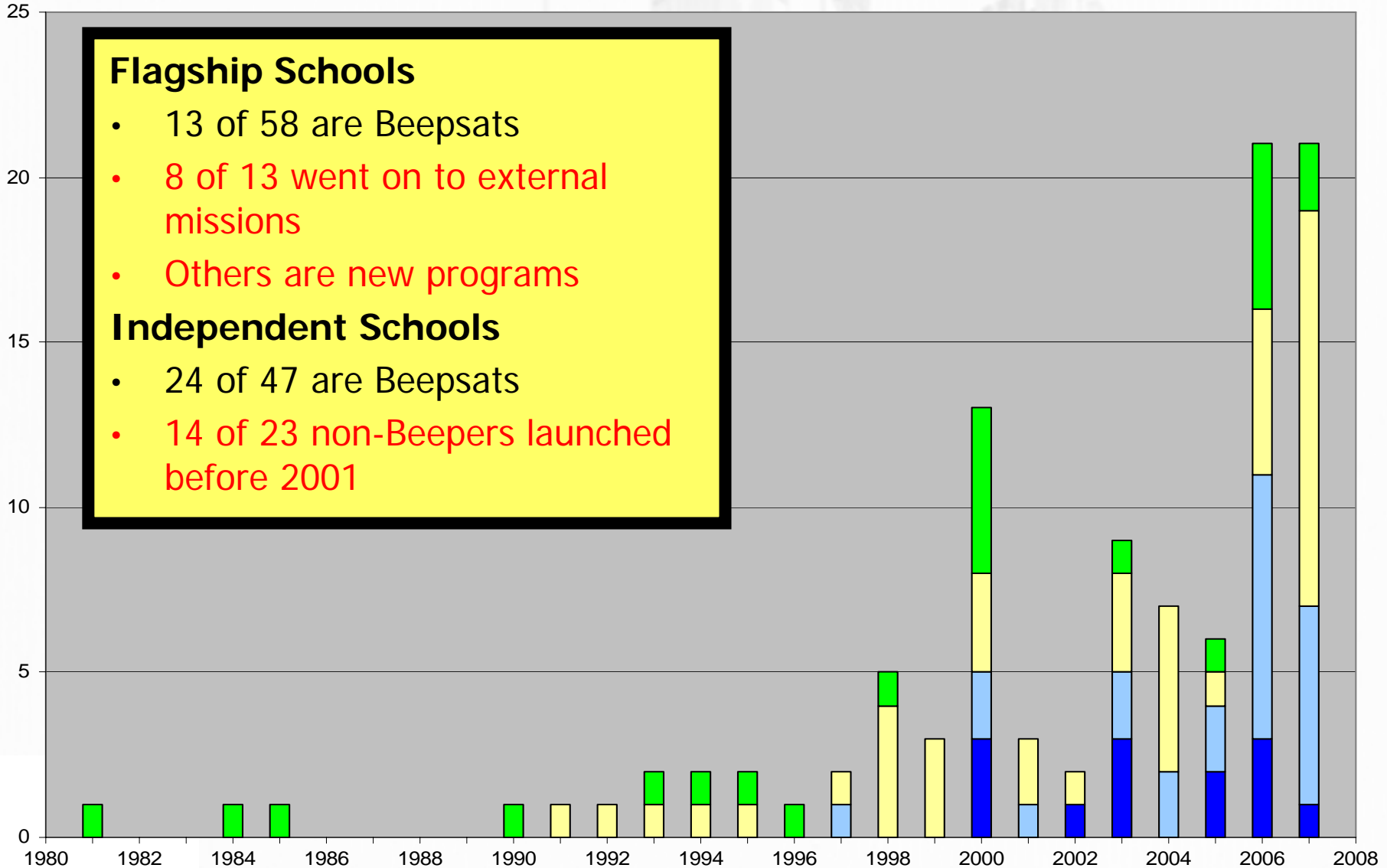
- Built 47 of 105
- 30 by 30 one-time schools
- 17 by 6 multi-launch schools (only 4 active)

Beyond the Beep?

*Beyond
the
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Beyond the Beep?



Flagship Schools

- 13 of 58 are Beepsats
- 8 of 13 went on to external missions
- Others are new programs

Independent Schools

- 24 of 47 are Beepsats
- 14 of 23 non-Beepers launched before 2001

To Grossly Oversimplify

- Flagship schools
 - Build “real” missions (duh)
 - Use CubeSats as stepping-stones
 - Sustain programs around a larger (20-100 kg) bus
 - Move up the “value chain” and out of the university class
- Independent schools
 - Build one satellite, then fade away
 - Build mostly CubeSats (but not all)
 - If program is sustained, it’s a series of E-class CubeSats

Three Recipes for Sustained Programs

1. Build a standard bus for national space program development, and “graduate”
 - SSTL
 - Technical University of Berlin, KACST (?)
2. Build a standard bus to support research/operations in the national interest
 - KACST (Saudi Arabia)
 - US Naval Academy - MidSTAR
3. Provide an important space-related service
 - Cal Poly (P-POD launcher for CubeSats)
 - Santa Clara (mission operations)

Launch Access is Still a Problem

- Largest set of spacecraft: the unlaunched
 - More than 100 university-class spacecraft in development
 - Dozens of projects that have fizzled
- Launch options
 - More than 3 kg: Space Test Program (low priority payloads)
 - Less than 3 kg: Pay ~\$40k/kg
- Time is not on our side
 - Mean time to build is approaching the “student time constant” (3 yrs)
 - Mean time to launch usually exceeds that period
- Growing capacity for CubeSats, but are there enough CubeSats to meet the capacity?

Does the Mission Matter? Maybe.

- 37 E-Class Missions Can't Be Wrong!
 - E-Class are faster to build (but slower to launch?)
 - E-Class is better than Null-Class
- But can you sustain it?
 - Sustained programs tend to have external missions
 - Sustained independent programs are an anomaly ... is that intrinsic?
- What's an independent program to do?
 - Amateur communications
 - Multi-spacecraft missions
 - Biology
 - Crazy ideas

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