Cubes That Help Industry Out of the Box

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Universities Complement Industry

- **Decentralized**
  - Professors/students given independence
  - Youthful, dynamic environment
  - Sharing – theses, papers, reports

- **Education Focus**
  - Technology exploration is valued
  - Sufficient $$$ for capital investment (facilities, equipment)
  - “Science projects” flourish
  - Some emphasis on problems with large economic impact

- **Embrace Risk**
  - Explore “home run” ideas/concepts
  - No fear of failure – “lessons learned”
  - Paradigm shifts

- **Centralized**
  - Rigorous processes & procedures
  - Experienced, wise, risk-averse engineers
  - Territorial – patents, trade secrets, etc

- **Performance Focus**
  - Near-term technologies and designs
  - Must make $$$, each and every quarter
  - Few “science projects” allowed
  - Access to capital (equipment, factories, money)

- **Risk averse**
  - Simple, low-risk designs
  - Small, incremental adjustments to designs and processes
Universities are an Idea Breeding Ground

- Hotbed of idea cross-pollination
- Churning flood of ideas and information
- Supercharging for the space industry

- New designs
- New products
- Efficient batteries
- Lighter mechanisms
- New GNC ideas
- Faster algorithms
CubeSats Provide Focus

- CubeSats help harness idea churning to meet space industry needs
- Small enough to be manageable by a university
  - Allow significant individual contribution
  - Students get to see results fast
- Large enough to provide valuable technical insight
  - Enough system complexity to require SE and architecture thinking
  - Enough diverse subsystems to provide something for everyone
    - Students get to work on their pet projects
    - Professors get to insert their favorite experiments
CubeSats vs. IndustrySats

- 1-2 yr to build
- 0.1-1 yr design life
- 1-3 kg
- 1-3 L
- 1-3 W
- $40-80K per kg to build
- $40-80K per kg to launch

- 4-8 yr to build
- 2-20 yr design life
- 500-5,000 kg
- 1,000-10,000 L
- 1000-15,000 W
- $40-80K per kg to build
- $40-80K per kg to launch
SE Look at CubeSats

- **Short life and low reliability enables**
  - High mass efficiency

- **Power efficiency**
  - Large surface area gives more room for surface-mount solar panels and antennas
  - Lack of gimbals degrades solar and RF efficiency by 90%
  - CubeSat size is just about at the cross-over where surface-mounted apertures can compete with gimbaled systems

![Areal Efficiency Graph](chart.png)
Example CubeSat Project Results

- Northrop Grumman CubeSat project with CalPoly and Stanford
- Produced sophisticated system trade tools
- Valuable, deep survey data, plus new component ideas

**Linked Excel Database**

- *Subsystem Architecture Trades.xls*
- *Point Design Architectures.xls*
- *Subsystem Trades*
- *Point Designs*
- *Subsystem Component Data*
- *Point Design Trade*

*Subsystem Architecture Trades.xls*  
*Point Design Architecture Trade.xls*
Example CubeSat Technology Spinoff

- Discovered library of public domain software for image processing…
  … from the medical industry!

- Innovative technique for efficient scene matching
What can you do?

- Apply CubeSats to real world needs
  - Communication
  - Surveillance
  - Astronaut Assistance
  - Exploration
  - Science

- Try something new
  - Show us a new way to do …
    - Propulsion, navigation, communication, attitude control

- Leverage your other resources
  - Nanotech, biotech, microelectronics