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DEFINING THE FUTURE

Cubes That Help Industry Out of the Box

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Universities Complement Industry

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

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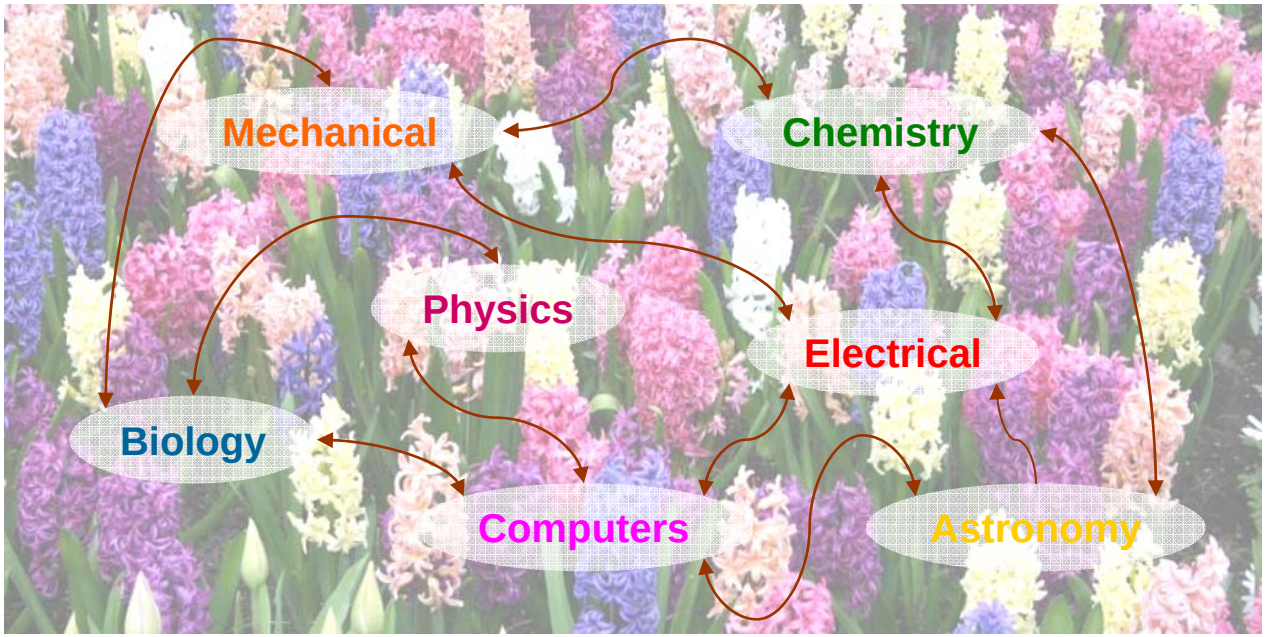
Universities are an Idea Breeding Ground



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

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

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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

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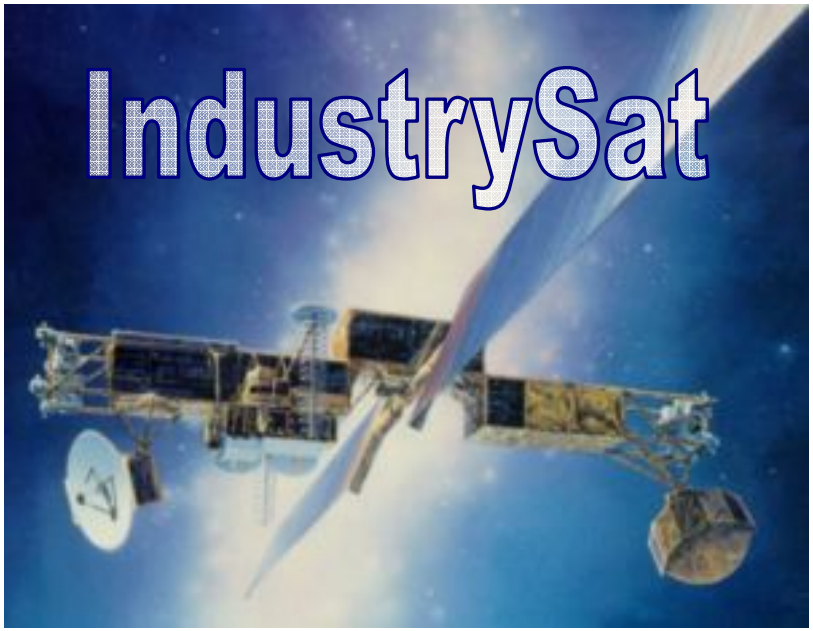
CubeSats vs. IndustrySats

Not to Scale!



CubeSats		IndustrySats
1-2 yr to build	4X	4-8 yr to build
0.1-1 yr design life	20X	2-20 yr design life
1-3 kg	1,000X	500-5,000 kg
1-3 L	1,000X	1,000-10,000 L
1-3 W	5,000X	1000-15,000 W
$40-80K per kg to build	1X	$40-80K per kg to build
$40-80K per kg to launch	1X	$40-80K per kg to launch

1X Specific Mass

5X Specific Power

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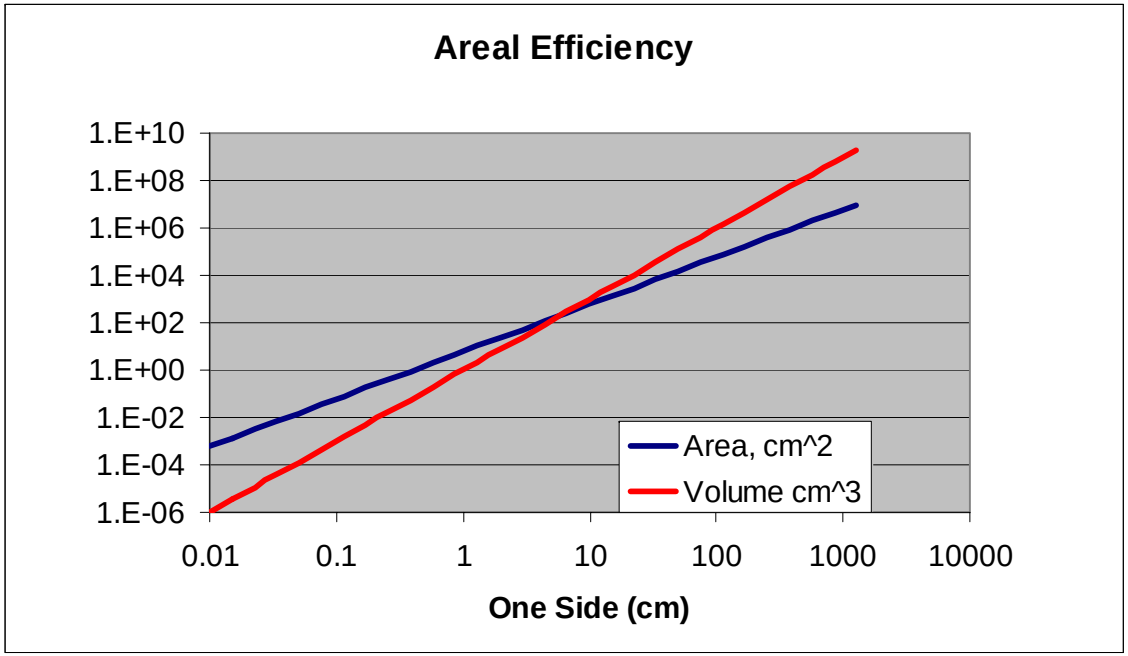
SE Look at CubeSats

- **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



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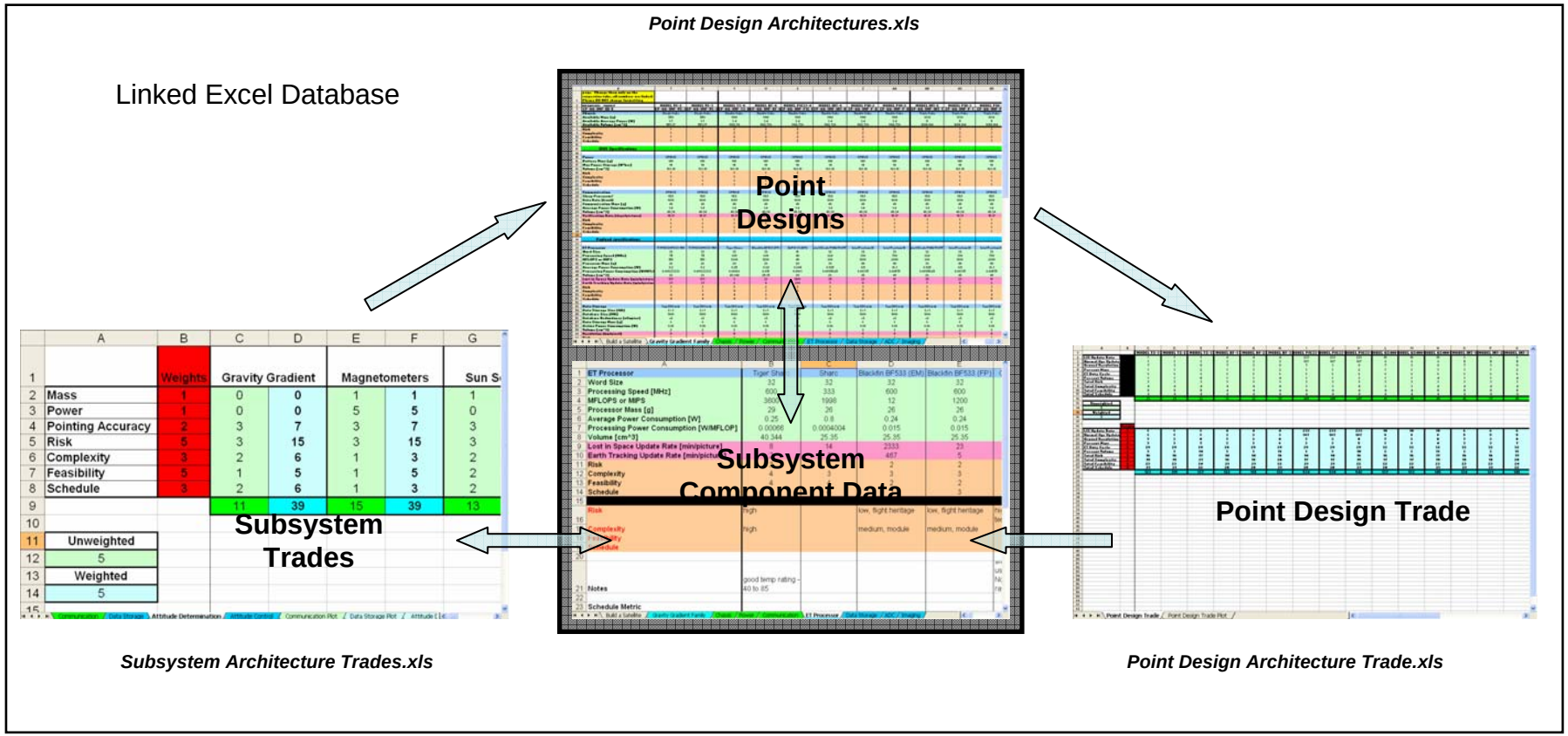
Example CubeSat Project Results

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



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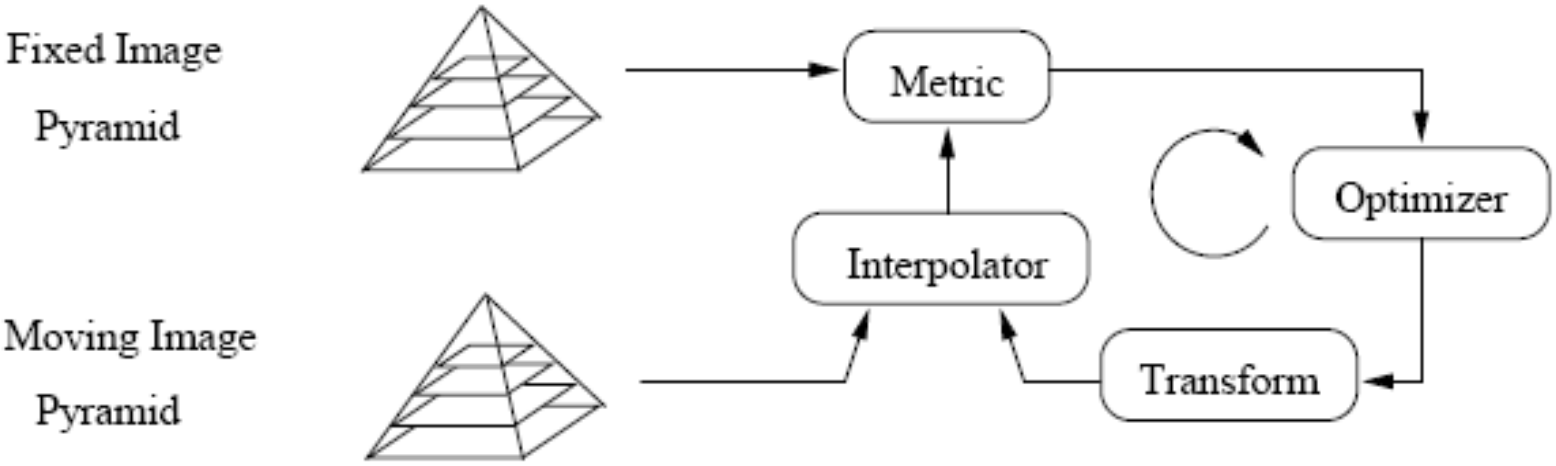
Example CubeSat Technology Spinoff

- 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

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