CubeSats: From Launch to Deployment

Necessity for a standard.

• Creation of a standard to facilitate the design process of small satellites.
• Deployment system to support the standard.
  – Safe and reliable.
  – Efficient and cost effective.
  – Versatile.
CubeSats: From Launch to Deployment

Poly Picosatellite Orbital Deployer.

• Basic P-POD Design.
  – Developed by Stanford and Cal Poly.
  – Hollow, spring-loaded design.
  – Holds 3 single sized CubeSats.

• P-POD Mk. I
  – Planetary Systems Line Cutter used for deployment.
  – On board power and timing circuits.
  – Accepts standard pyro pulse.
CubeSats: From Launch to Deployment

P-POD Mk. I

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Flight Heritage.

• Eurokot Launch Vehicle.
  – Launched from Plesetsk.
  – June 30, 2003
  – Coordinated by University of Toronto.

• 4 CubeSats on 2 P-PODs.
  – Quake Finder
  – P-POD mission successful!
CubeSats: From Launch to Deployment

Lessons learned and improvements.

Issues addressed in redesign of P-POD to make it a more attractive secondary for future missions:

• Difficulty in Tracking.
• Door displacement during vibration.
• Deployment System.
• Telemetry Sensor.
Tracking CubeSats in the cluster.

- Initially difficult to tell which CubeSat is which.
  - Need better beacons.
  - Ground Station’s need to be better prepared and coordinated.
  - Considering radio fingerprinting for identification.
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Door Redesign.

- Door flexing puts unnecessary load on CubeSats.
- Redesigned door is 200% stiffer.
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Starsys Release Mechanism.

- Fast and very reliable.
- No on-board electronics needed.
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Telemetry Data.

- Confirmation of successful deployment.
- Signal is sent when door opens 90°.
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P-POD Mk. II

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P-POD Specifications.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
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<tbody>
<tr>
<td>Mass</td>
<td>2.23 kg (empty)</td>
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<tr>
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<td>5.23 kg (loaded)</td>
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<tr>
<td>1st Natural Frequency:</td>
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<tr>
<td>Exit Velocity:</td>
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<td>Deployment Force:</td>
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</table>

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CubeSats: From Launch to Deployment

DNEPR Video.
CubeSats: From Launch to Deployment

DNEPR Mission.

- October 2004
- 14 CubeSats
- 11 Universities
- 5 P-PODs
- $40,000 per single sized CubeSat

- What will happen from now until then?

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CubeSats: From Launch to Deployment

Launch Flowchart.

P-POD Testing
May 2004

Integration
August 2004

Acceptance Testing
August 2004

Delivery
October 2004

CubeSat Testing
??????
CubeSats: From Launch to Deployment

Qualification Testing.

• P-POD Prototype.
  – Tested to NASA worst-case specs.
• Qualification
  – 125% of launch loads.
• Acceptance
  – 100% of launch loads.
  – Fully integrated P-POD.
CubeSats: From Launch to Deployment

Getting to Integration.

• Where? When? How Long?
  – Cal Poly CubeSat Lab
  – August 1\textsuperscript{st} to 30\textsuperscript{th}
  – Integration & Acceptance = 1 week

• Deliverables (1 month prior).
  – Charging Procedures
  – Diagnostic Procedures
  – Remove Before Flight (RBF) Procedures
  – Special Needs Requests
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Integration...

- Class 100,000 clean room.
- Shipping handled by developers.
CubeSats: From Launch to Deployment

...and Acceptance.

• Integrated P-POD with actual CubeSats and launch interface.
• 100% of launch loads.
Integration Schedule.

- Each developer assigned a week during August.
- Integration, testing and diagnostics.

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<th>TESTING SCHEDULE DETAIL</th>
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CubeSats: From Launch to Deployment

DNEPR 2004 Schedule.

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- April 8\(^{th}\) – 10\(^{th}\) .......... Cal Poly Workshop (Fit Check)
- June 20\(^{th}\) – 30\(^{th}\) .......... DNEPR Fit Check for P-POD
- August 1\(^{st}\) ............... Delivery to Cal Poly
- October 10\(^{th}\) ............ Nominal Delivery Date
- October 31\(^{st}\) ............ Nominal Launch Date

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Future Missions (US Launches).

- Space X – Falcon
- Boeing – Atlas V
- Lockheed – Delta II and Delta IV
- Orbital Sciences Corp. – Pegasus
- Other small launch vehicles.

- Working with CSA to procure funding for future US CubeSat missions.
CubeSats: From Launch to Deployment

Shuttle.
CubeSats: From Launch to Deployment

Shuttle Capabilities.
CubeSats: From Launch to Deployment

Where’d they go?!
**CubeSats: From Launch to Deployment**

**Future Missions (DNEPR).**

**DNEPR 2005**

- What you need to know:
  - Launch in Fall 2005.
  - $40,000 per single CubeSat.
  - Need 12 – 15 CubeSats.
  - MOU signed in Summer 2004.
  - Contact us if interested.

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