LCROSS: A Unique Spacecraft
For A Unique Mission

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“The Question…”

- Does Water Ice exists at the bottom of very deep, permanently-shadowed craters at the Moon’s poles?

Lunar South Pole Hydrogen concentrations (Courtesy Lunar Prospector)
The Means to “The Answer” is LCROSS

- The Concept: Drive a spent upper stage rocket into the bottom of one of these craters to kick up as much regolith as possible.

- The Bonus: If conditions are right, LCROSS will separate from the Centaur, perform a braking burn, analyze the Centaur impact, then impact in a nearby location to create a second observable plume.

- [ link to LCROSS Mission video]
LCROSS was Different than Usual Approach

- Northrop is used to building large, complex scientific and military spacecraft
- But LCROSS needed to be
  - **VERY** low-cost
  - Developed on a **VERY** short schedule
The Result: The LCROSS Spacecraft

Panel 1: Solar Array
Panel 2: Batteries
Panel 3: Power Distribution
Panel 4: Attitude Control and RF Comm Electronics
Panel 5: Computer
Panel 6: Science Instruments
Propellant Tank
ESPA Ring
Antennae
Nominal Mission Timeline

- **Pre-Launch**: VIF Ops, Pad Ops, LV Ascent, Park Orbit, LRO Inject/Sep Coast
- **Launch**: Centaur Venting & Re-Target, Centaur Handover To LCROSS
- **Transfer**: Check-out, TCM-1, TCM-2, TCM-3, Swing by Calibration [TCM-4]
- **Final Targeting**: TCM-11, Final Targeting Burn
- **Impact and Data Collection**: EDUS Separation, Braking Burn, Data Collection, EDUS Impact, S-S/C Impact

In-flight calibrations
Unique Design Challenges

• Technical: LCROSS had to support the weight of LRO during launch, plus support it’s electrical and mechanical interfaces.
  – LCROSS made extensive use of ESPA ring structure’s capabilities
  – Timely data exchanges with LRO, Launch Vehicle, & Launch Site Teams

• Cost: As a Class-D mission, LCROSS had to keep total mission cost under $79M fiscal limit.
  – Extensive re-use of designs reduced Non-Recurring Engineering costs
  – Small team of focused experts reduced documentation costs

• Schedule: LCROSS would only be allowed to use LRO’s Centaur if we could meet the 2008 LRO launch date
  – Designs could only use available parts
  – Tests had to be tailored or deleted
  – Risk Management used extensively in trades, implementation
EELV Secondary Payload Adapter (ESPA) Ring is mounted to Propulsion Tank Support
Integrating Electronics onto Panels
Next Stop...the Moon!
It isn’t often that a designer gets to add weight to a spacecraft, but when your mission is to kinetically dislodge as many tons of lunar regolith as possible, a unique design results. The Northrop-NASA Lunar CRater Observation and Sensing Satellite (LCROSS) team took advantage of weight margin and mission trajectory to simplify the spacecraft design (add extra power sources, eliminate costly deployables, re-use heritage spacecraft components). These simplifications allowed LCROSS to meet the 2008 launch date AND keep total mission cost under the $79M fiscal limit.