

Challenging Decisions from a Career in Aerospace

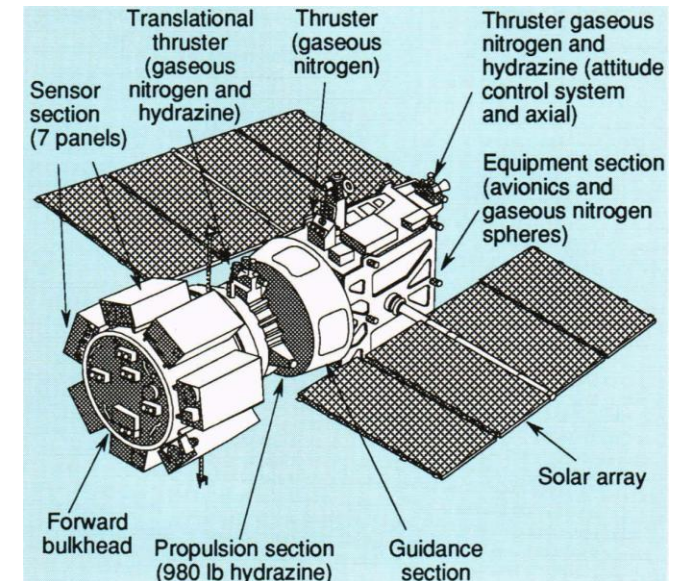
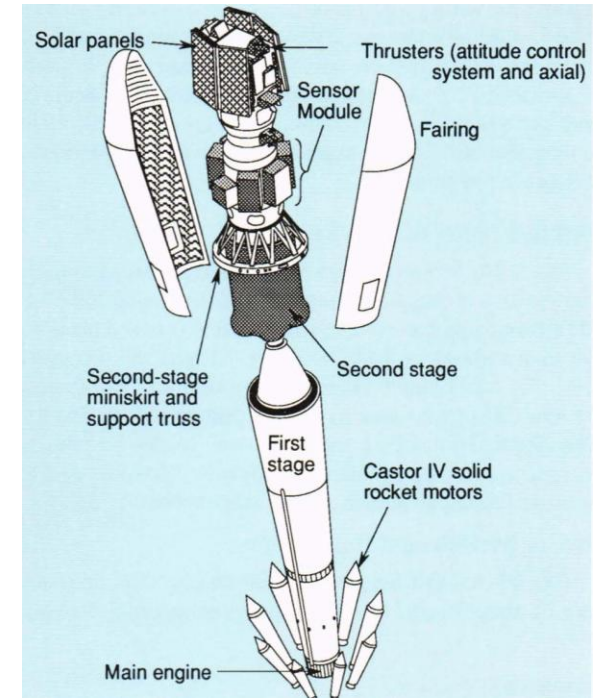
AIAA Huntsville Section

Michael D. Griffin

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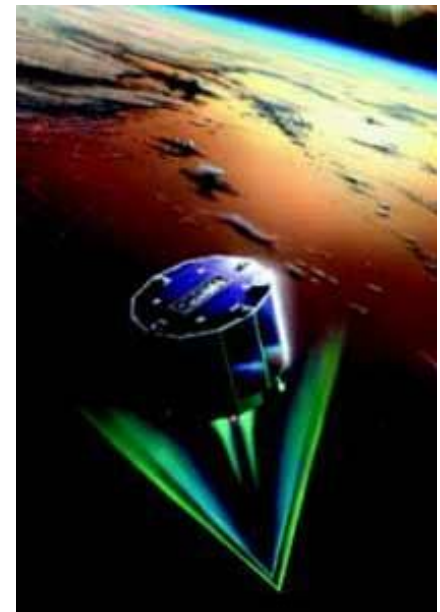
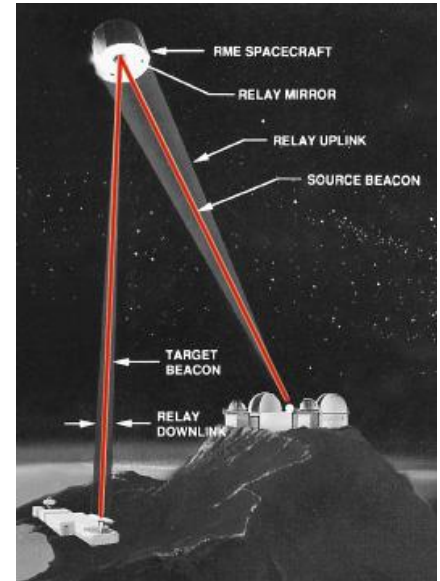
Delta 183/Delta Star

- DoD/SDIO mission to capture phenomenology of rocket plumes on Soviet launch vehicles.
 - Vacuum core of rocket exhaust key targeting point.
 - Upper stage of Soyuz uses hyperbolic fuel, as did the SS-18.
- IC fails on pad, days prior to launch.
- Options:
 - Remove box, repair, re-do functional and environmental flight acceptance tests, re-integrate.
 - Weeks or months of delay, loss of launch slot, high cost, potential for collateral damage when de-integrating spacecraft.
 - Open box on pad, dissolve conformal coating, remove and replace suspect IC, re-coat repaired region, perform key functional tests, launch.
 - Three days to complete, but obvious risk of skipping steps.
 - Violates everything we know about proper procedure.



Relay Mirror Experiment

- DoD/SDIO mission to demonstrate use of orbital relay mirror to steer ground-based laser beam to target.
 - Most advanced pointing-and-tracking demonstration to its time.
- Critical component: high-technology fast-steering mirror with delicate multi-layer coating to reflect laser beam from space back to ground reference target.
- Space qualification of mirror coating becomes significant challenge.
- Witness mirror used for design qualification develops significant cracks, delamination in testing.
- Flight mirror shows similar but lesser damage during flight acceptance testing.
 - Ability of flight mirror to meet one-year design reference mission in doubt.



STS-114 – First Shuttle Return to Flight Mission

- New Administrator confirmed on 14 April 2005.
- First of two planned return-to-flight Shuttle launches following loss of STS-107 Columbia on 1 Feb 2003 planned for mid-to-late May, following 2+ years of work to understand External Tank debris generation and mitigation.
- ISS one-third complete, being sustained by Progress and Soyuz only.
 - Need to get flying again.
 - Presidentially-mandated 2010 retirement date for Shuttle system.
 - About 20 missions remaining to "ISS complete"; can't fly all of them in the last year or two!
- Late-April decision meeting as to whether to maintain May launch date.
 - Unusual methodology used to assess Orbiter damage probability from ET and, especially, ice from lox feedline bellows.
 - Expert opinion claims six-week delay necessary to "do it right".



STS-121 – Second Shuttle Return to Flight Mission

- Second return-to-flight mission for Shuttle.
 - And, the first one had some problems.
- Loss of PAL ramp foam on STS-114 results in grounding Shuttle fleet (again!) until debris release mechanisms and fabrication process control more fully understood.
 - Promoted Gerstenmaier from ISS Program Manager to AA/Space Operations.
 - Established "tiger team" under Rick Gilbrech to lead debris analysis and mitigation.
 - Other management changes.
- By July 2006, a year after STS-114, the team is ready to try again.
 - But, not everyone agrees.



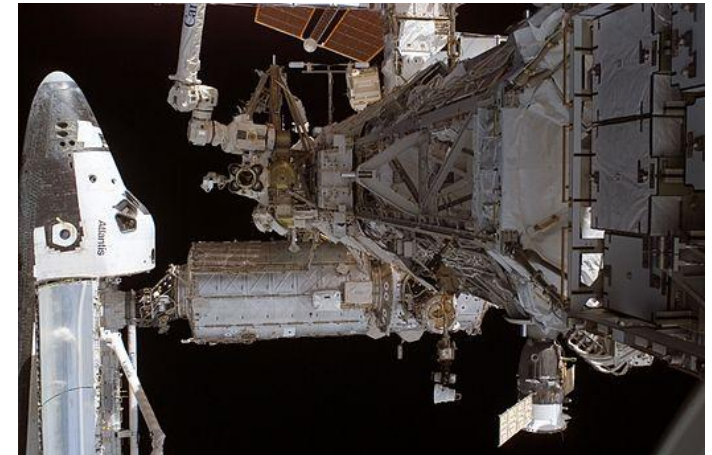
STS-121 (cont.)

- Published estimates for loss-of-crew due to ascent debris are in the 1:25 to 1:75 range.
 - Team is especially conservative after STS-114 experience.
 - Analytical methods still not completely mature.
 - Most of the team understands only their part of the problem.
- ISS offers "safe haven" for crew in event of a significant debris incident, but at the cost of extreme operational challenges, loss of a Shuttle orbiter, likely non-completion of ISS program, and major political and financial damage to NASA.
 - Other than that, Mrs. Lincoln...
- AA/Space Ops, Director of Flight Crew Operations recommend launch; Chief Engineer and Chief of Mission Assurance recommend standing down.
 - Decision goes to Administrator...



STS-115

- Long history of flight delays due to Engine Cut-Off (ECO) sensors.
- ECO sensors are the last line of defense against likely catastrophic oxygen-rich SSME shutdown.
 - Velocity cutoff always the nominal case.
 - LOX-biased propellant load to ensure fuel-rich shutdown if propellant-depletion cutoff does occur.
- ECO sensors notoriously problematic; four-of-four working sensor launch criteria has delayed several launches.
 - Propellant-load recycle often works.
 - Sometimes they recover during the count.
 - They always work when warm...
- On launch morning, sure enough, only three good ECOs.
- Management/launch team meets after tanking complete (many hours prior to launch), and concludes that we are "go" for launch with three-of-four ECO sensors.
- During final count, failed ECO sensor has not recovered, but launch team poll recommends "go" -- except for Flight Crew Operations, which non-concurs.



STS-125 – 5th Hubble Servicing Mission

- Hubble Space Telescope designed from Day 1 to be serviced/refurbished with the Space Shuttle.
- Four highly successful servicing missions of ever-increasing sophistication carried out prior to loss of Columbia.
- Fifth servicing mission cancelled after Columbia; judged to be too risky without the possibility of an ISS "safe haven" in the event of another debris event.
 - ISS and HST in orbits with substantially different inclinations, neither reachable from the other.
 - Two studies conducted to assess feasibility of robotic servicing mission; both conclude not feasible within reasonable schedule and cost.
 - Substantial scientific community, general public, and Congressional resistance to cancellation of 5th servicing mission.
 - Review of decision promised during 2005 Administrator confirmation hearing.



STS-125 (cont.)

- Risk not the only factor.
 - With Columbia gone, any HST servicing mission would take a "station Orbiter" out of play for over a year.
 - Not all Orbiters were equal; Columbia was heavier and not useful for ISS missions to 51.6 degrees. Thus, no conflict when used for Hubble or other scientific missions to 28.5 degree inclination, but a significant conflict if another Orbiter were to be used.
 - Thus, an HST servicing mission posed significant risk to ISS completion within mandated 2010 Shuttle retirement date.
 - OMB totally committed to retiring Shuttle as soon as possible.
 - Cost also non-trivial; each Shuttle mission cost at least \$300 M, and a Hubble servicing mission would be substantially more.
 - Needless to say, not in the budget; OMB opposed to increase.
 - Astronomy community not united in the desire for another Hubble refurbishment – money for Hubble was not money for them.
 - Other elements of the scientific community also not pleased; would rather have had the money for other missions.



STS-125 (cont.)

- So, how did we get there?
 - Two Orbiters on the pad at once -- never done before or since.
 - Provided a rescue capability even better than ISS safe haven.
 - Did not take the backup Orbiter out of play for ISS assembly.
 - If needed the rescue Orbiter would launch and return with its planned ISS payload in the cargo bay.
 - Sen. Mikulski arranged for both Congressional language and some additional funding for the mission.
 - Despite OMB disapproval, the Administration was not going to veto the bill just to kill the Hubble mission.
- But, oh by the way, this wasn't the last tough decision.
 - Data handling box failed a few months prior to planned launch.
 - Required more time, money, and crew training for repair.
 - To say nothing of the difficulty of obtaining a replacement unit for decades-old hardware.
- And yes, decisions have consequences.
 - The final Shuttle flight and ISS completion were delayed until 2011.

