National Aeronautics and Space Administration

31 JULY 2024

Can Large Strategic Science Missions Benefit from Class-D/SmallSat Lessons Learned?

CAROLYN MERCER
Chief Technologist
NASA Headquarters / Science Mission Directorate

FLORENCE TAN
Deputy Chief Technologist
NASA Headquarters / Science Mission Directorate

CHARLES NORTON
Deputy Chief Technologist
NASA Jet Propulsion Laboratory / California Institute of Technology

AIAA ASCEND 2024 Las Vegas

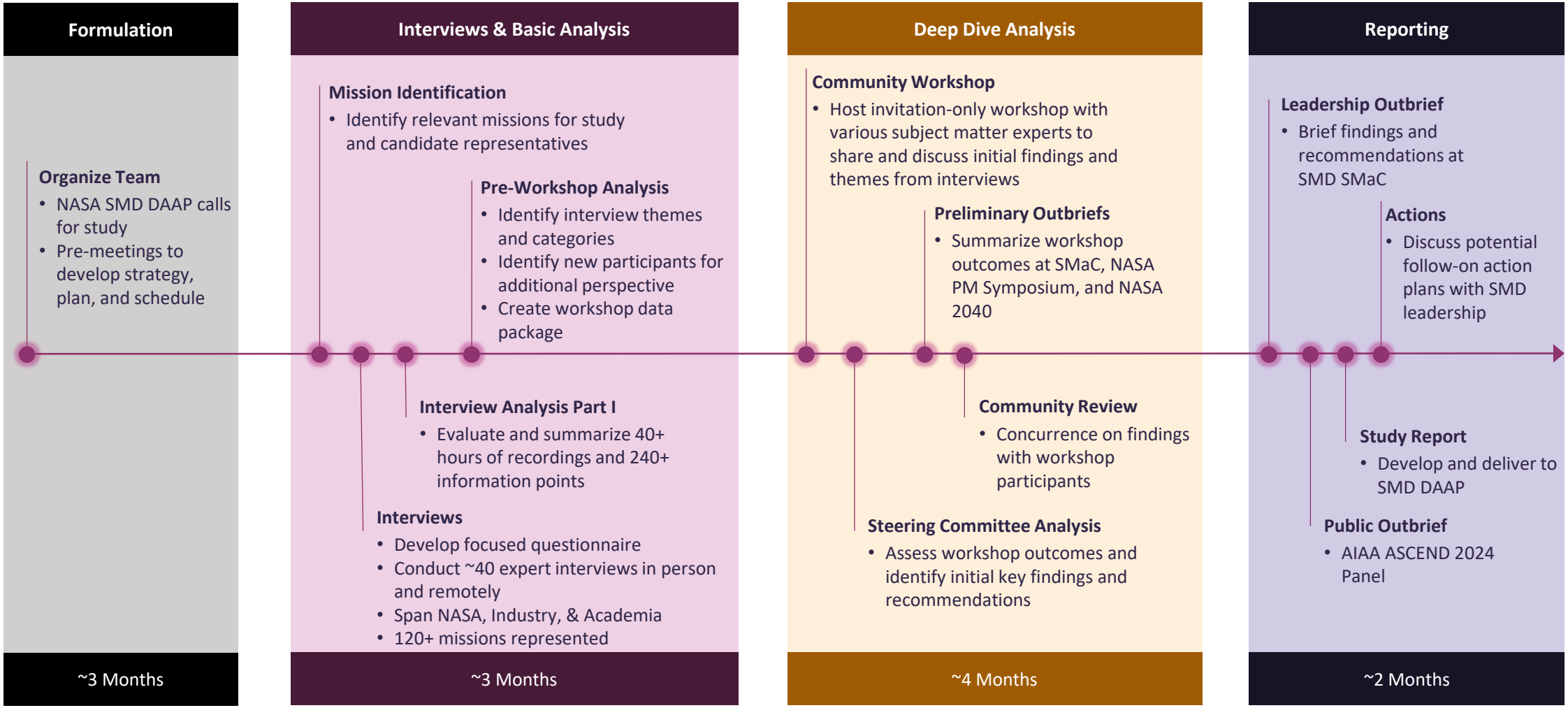
Study Objectives

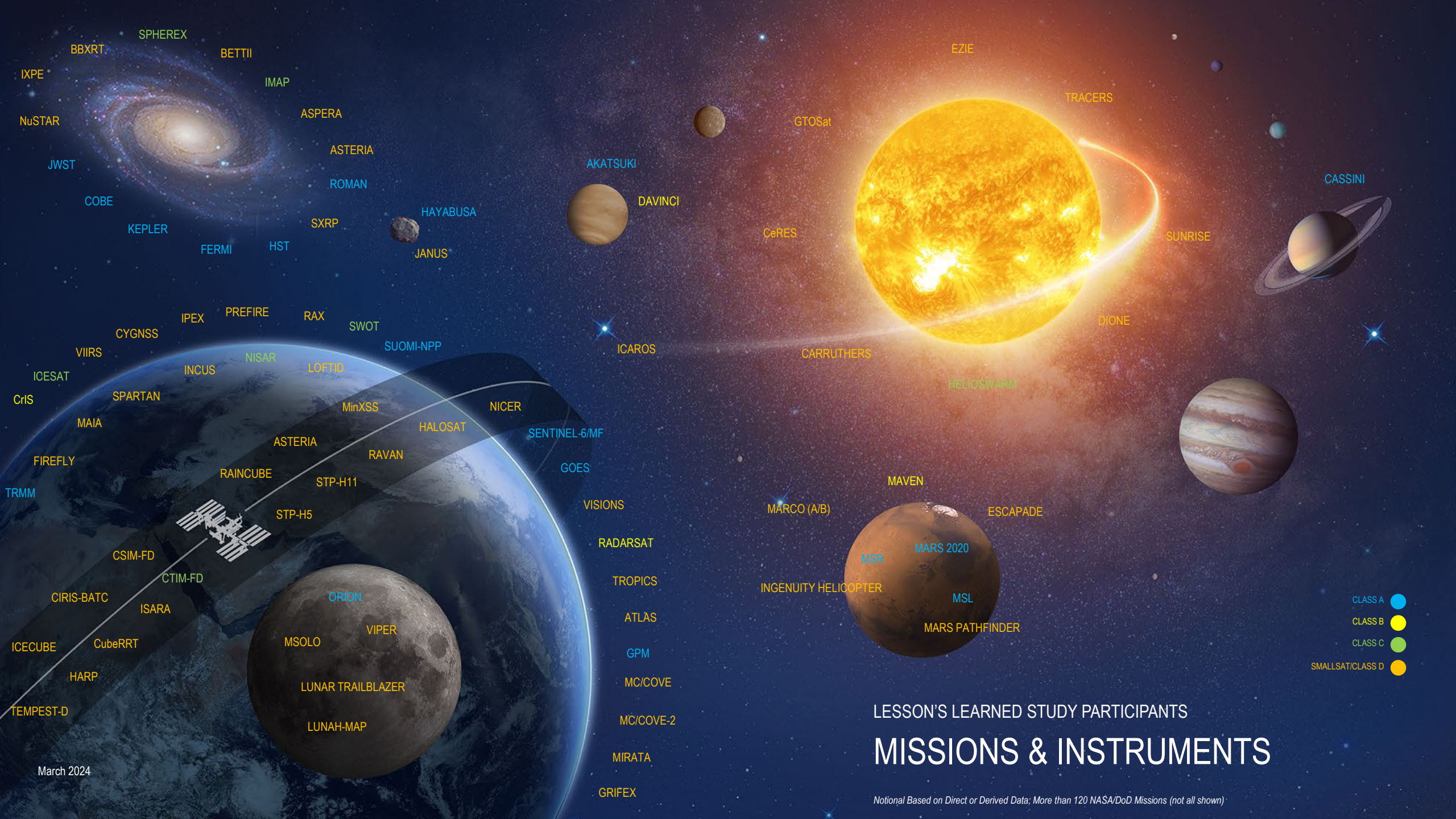
Informing Large Missions from Class-D/SmallSat Lesson's Learned:

- NASA SMD DAAP Charge to Identify Optimal Practices from SmallSat/Class D Missions Applicable to Large Mission Development
  - Evaluate the suitability of SmallSat/Class D processes for large missions
  - Explore innovative risk management approaches adopted by SmallSat/Class D missions that could be adapted for large missions
  - Uncover deeper strategies and value propositions inherent in SmallSat/Class D missions that can be leveraged for large missions

Study Leads / Organizing Committee
Alan Zide Program Executive, SMD Heliophysics
Alvin Robles Lead Engineer, Booz-Allen Hamilton
Carl Gelderloos Tech & Business Development Lead, LASP
Carolyn Mercer Chief Technologist, NASA SMD
Charles Norton Deputy Chief Technologist, JPL/Caltech
Florence Tan Deputy Chief Technologist, NASA SMD
Lena Braatz Lead Associate, Booz-Allen Hamilton
Pam Millar Director for Strategic Development, LASP

Development Process





March 2024

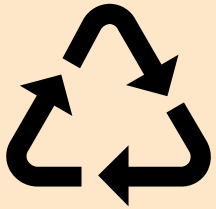
LESSON'S LEARNED STUDY PARTICIPANTS

MISSIONS & INSTRUMENTS

Notional Based on Direct or Derived Data; More than 120 NASA/DoD Missions (not all shown)

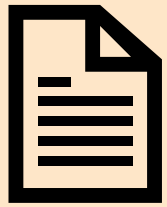
Categories Identified From Expert Interviews

Technical

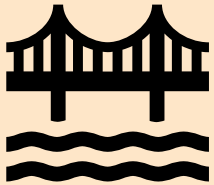


Reuse and COTS

Vendor/Partner Relationships



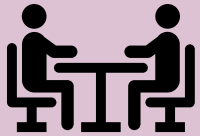
Documentation



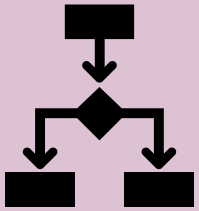
Engineering and Design

Tailoring

Managerial

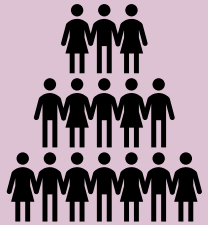


Mentoring



Decision Making

Team Communication



Roles and Responsibilities

Review Board Practices

Risk Management

- Categorized from more than 240 pre-workshop interview comments collected from 37 NASA, industry, and academic persons

Findings and Recommendations

Small, Cross-Disciplinary Teams:

- Finding
  - Class-D/SmallSat teams inherently benefit from **swift and open communication with system-wide awareness**, enabling quick decision-making with **individual and collective accountability.**
- Recommendations
  - **Shift the culture** of large missions to promote fostering personal and collective senses of ownership, open communication, and **system-wide awareness**
  - **Transform decision-making culture** at project start to declare HQ support with mutual agreement to share mission challenges in a timely fashion
  - **Create communication channels among the sub-teams in larger missions** to facilitate collaboration and to promote overall mission- and system-level awareness and contextual understanding

Findings and Recommendations

Reducing The Standing Army:

- Finding
  - Small missions are **more effective at utilizing people on an as-needed basis**, rather than maintaining a standing army, significantly impacting late-phase costs.
- Recommendation
  - Organizations should not deploy a standing army and should **deploy their workforce nimbly**

Findings and Recommendations

Essential and Bottom-Up Requirements Tailoring:

- Finding
  - Class-D/SmallSat missions, guided by the Class D MAR, allows bottom-up tailoring **only adding requirements that add value**. Large missions use an expansive MAR, often have a “checklist mentality,” and typically struggle to justify the removal of requirements.
- Recommendations
  - Establish a lean Class C MAR similar to the SMD Class D MAR

Findings and Recommendations

COTS Usage:

- Finding
  - Class-D/SmallSat missions **design around existing solutions significantly reducing costs** without introducing unacceptable risk. Large missions can also benefit while avoiding introduction of NASA requirements on commercial systems.
- Recommendations
  - Identify methods to **incentivize or promote** the acceptance and utilization of COTS parts
  - Team with **vendors to ensure they understand** the needs/goals of missions
  - Screen for **vendors that are transparent** and willing to work with NASA
  - **Modify NPR 8705.4a Appendix D** to allow design architectures to meet the reliability goals instead of requiring a waiver for the use of Level 1, 2, or 3 parts
  - **Relax documentation requirements** for parts that have flown successfully
  - Establish and **formalize a Preferred Parts List** that is reviewed in a regular basis
  - Establish a NASA **Parts Environment Assessment Lab** (PEAL) to implement such recommendations

Findings and Recommendations

Risk Management Practices:

- Finding
  - Class-D/SmallSat missions conduct risk management as a matter of practice every day, rather than spending significant effort on risk management products, while **focusing on understanding and mitigating operational risks**. Large missions spend significant effort on risk management before designs are complete (**i.e., developmental risks**).
- Recommendations
  - Differentiate between developmental risk vs. operational mission risk and employ simplified tools until CDR
  - Establish open working relationships to build trust between mission teams and OSMA

Findings and Recommendations

Small, Consistent, and Support-Based Review Boards:

- Finding
  - Class-D/SmallSat review boards are **small, support-based, and remain with the project consistently**, with experienced advisors focused on assisting the team. Large mission reviewers **focus on compliance**, and board members are often specialists rather than generalists.
- Recommendation
  - Employ peer review practices used by SmallSats where SRBs provide more informal expertise and build trust within the project

Findings and Recommendations

Identification and Combination of Critical Documentation:

- Finding
  - Class-D/SmallSat missions identify and tailor documents that are truly needed and used (i.e., a 6-page PowerPoint rather than a 50-page CM plan). Large missions create documentation that is oftentimes not referenced (i.e., the SEMP) and may stop work to prepare significant documents for reviews.
- Recommendations
  - Tailor the signature process to minimize the number of signatures required
  - Consider eliminating certain reviews, replacing them with a series of small meetings that produce required products without the formal paperwork
  - Perform a study to identify which documents Class-D/SmallSats successfully eliminated, combined, or reduced
  - Track costs of review preparation to quantify the overall impact to mission lifecycle cost

Summary Findings and Recommendations

No.	Findings	Category	Recommendations
1	*Small, Cross-Disciplinary Teams*	Team Communication	• Shift the culture of large missions to **foster personal and collective ownership, open communication, and system-wide awareness**. • Transform decision-making culture by **headquarters declaring support to teams at project start**. • **Foster cross-communication among sub-teams** in large missions to enhance collaboration, awareness, and technical understanding.
2	*Reducing The Standing Army*	Decision Making	• **Deploy the workforce nimbly** and recall SMEs as-needed to avoiding a standing army.
3	*Essential and Bottom-Up Requirements Tailoring*	Tailoring	• **Establish a lean Class C MAR** (similar to Class D MAR), **formulate training for Mission Assurance Managers**, and use SIMPLeX best practices for **common tailoring of NPR 7120.5 requirements**.
4	*COTS Usage*	Engineering & Design	• Incentivize use of **COTS parts within acceptable risk**. • Modify NPR 8705.4a appendix D for **reliability goals**. • Relax documentation and establish a **Preferred Parts List for parts that have flown successfully**. • Create a **Parts Environment Assessment Lab** (PEAL).
5	*Risk Management Practices*	Risk Management	• Differentiate between **developmental and operational mission risk**. • Use **simplified review tools** until CDR. • Establish open working relationships to **build trust between mission teams and OSMA**.
6	*Small, Consistent, and Support-Based Review Boards*	Review Board Practices	• Use SmallSat peer review practices where **SRBs provide more informal expertise** building trust within the project.
7	*Identification and Combination of Critical Documentation*	Documentation	• **Tailor the signature process** to minimize the number of signatures required. • **Replace certain reviews with small meetings** that produce required products. • Study which documents Class-D/SmallSats **successfully reduced or eliminated**.

National Aeronautics and Space Administration

Open Discussion

Can Large Strategic Science Missions Benefit from Class-D/SmallSat Lesson's Learned?


NASA
National Aeronautics and
Space Administration