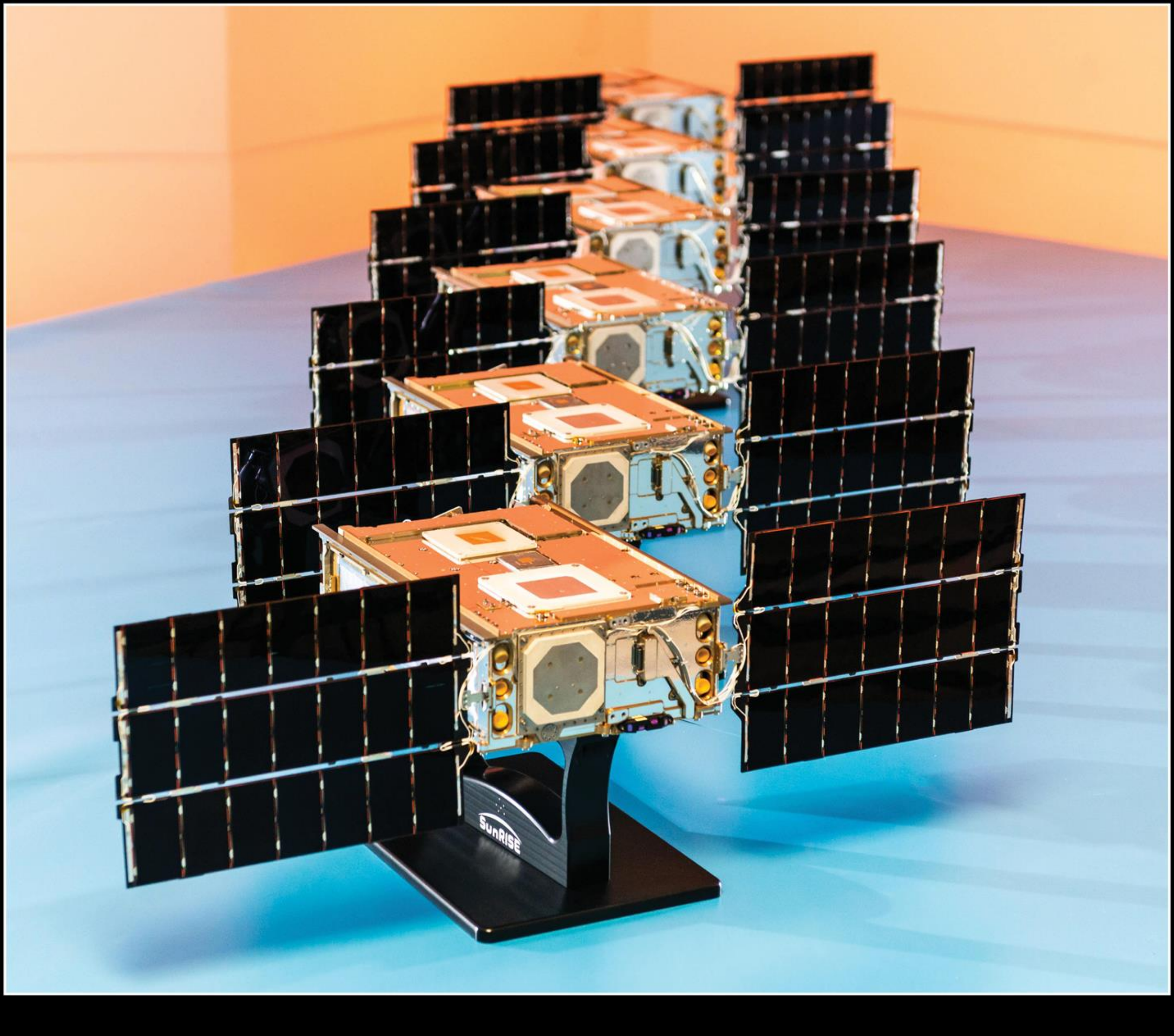
National Aeronautics and Space Administration

SMALL MISSIONS, BIG LESSONS



Informing Large Missions from SmallSat/Class D Lessons Learned

NASA Science Mission Directorate
September 2024

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Contents

1. Background

Small satellites[1] have long played a role in the National Aeronautics and Space Administration (NASA) space exploration effort, including Pioneer 10 and 11 launched March 1972 and April 1973, respectively. In successive decades, however, science satellites became larger, more complex, and expensive to meet the agency's challenging science objectives.

In 1999, CubeSats (satellites using standardized 10x10x10 cm platforms) were invented by academia to provide a cost-effective method to enable student-led space exploration projects. The wider space community latched onto this new platform and its potential uses. NASA Ames launched the agency's first CubeSat, GeneSat, in December 2006 and the Earth Science Technology Office (ESTO) launched the Science Mission Directorate's (SMD) first CubeSat—the Michigan Multipurpose Minisatellite (M-Cubed)—in 2011.

Following the success of these and other small spacecraft in the community, the National Academies of Science, Engineering, and Medicine conducted a study to review the scientific potential and technological promise of CubeSats. Released in 2016, the National Academies' report, "Achieving Science with CubeSats, Thinking Inside the Box," focused on determining the potential for CubeSats to obtain science data that would align with the priorities identified in the 2014 NASA Science Plan.

In response to the National Academies' report, SMD created several processes to encourage broader use of small satellite (SmallSat) platforms for science. NASA has subsequently developed over 100 small satellite missions, including CubeSats, to provide useful science data and/or demonstrate new technologies. SMD manages and implements these small satellite missions differently than larger, traditional science satellites, primarily by reduced oversight and insight, heavier reliance on commercially available systems, and increased risk tolerance. Now that SMD has significant experience successfully implementing these small space platforms, the question arises as to whether some of the small satellite practices and lessons learned can benefit its larger, science spacecraft efforts.

Workshop Purpose and Goals

This report is the result of an activity sponsored by Dr. Wanda Peters, Deputy Associate Administrator of Programs to gather insights from NASA SmallSat/Class D missions that could be extrapolated to improve the management of SMD's Class A-C missions. To obtain these insights, NASA convened a workshop titled, "Informing Large Missions from SmallSat/Class D Lessons Learned," to enable personnel from the agency, academia, and the private sector to discuss this topic in detail. Workshop participants had experience with SmallSat missions, large missions, or both.

Workshop Preparation

To provide input for workshop discussions, the steering committee interviewed more than 35 senior program and project managers, review chairs, and senior engineers from industry, academia, and NASA. Collectively, these individuals have worked on more than 120 different satellite missions. The interviews yielded more than 235 key inputs, which the steering committee summarized into 11 categories to

[1] A Small satellite (SmallSat) is defined as a spacecraft that is interface-compatible with an Evolved Expendable Launch Vehicle (EELV) Secondary Payload Adapter (ESPA) Ring, a dedicated small- or medium-lift launch vehicle, or a containerized dispenser, and has an upper mass limit of 500 kg.

inform discussions at the workshop. The interview questions and the summarized information gleaned from the interviews are found in 3. Appendix A.

Workshop Execution

The workshop was held at the Laboratory of Atmospheric and Space Physics in Boulder, Colorado, on March 19, 2024. (See the workshop agenda in3. Appendix B.

Overall, workshop discussions focused on:

- Identifying optimal practices from SmallSat missions that are applicable to Class A-C missions.
- Evaluating the suitability of SmallSat processes for Class A-C missions.
- Exploring innovative risk management approaches adopted by SmallSat missions that could be adapted for Class A-C missions.
- Uncovering deeper strategies and value propositions inherent in SmallSat missions that can be leveraged for large missions.

During the workshop, the attendees explored the 11 categories of information gathered from experts prior to the event. Concurrent breakout sessions were held to enable participants to discuss how this information pertains to technical and managerial aspects of science missions. Members of the two breakout sessions shared the results of their discussions with the larger group. At the end of the event, workshop participants developed consensus findings, which are summarized in this report.

2. Workshop Results

Following the workshop, the steering committee analyzed the notes assembled during the workshop and distilled the information into seven key topics:

1. Small, Cross-Disciplinary Teams
2. Reducing the Standing Army
3. Essential and Bottom-up Requirements Tailoring
4. Commercial Off-the-shelf (COTS) Product Use
5. Risk Management Practices
6. Small, Consistent, and Support-based Review Board
7. Identification and Combination of Critical Documentation

Each of these topics is discussed in detail below, including corresponding findings and suggested actions. The workshop participants were provided an opportunity to review the information in this report. Note that some of the findings from this workshop align with those documented in the SMD Large Mission Study and the Psyche Independent Review Board Assessment report.

Topic 1: Small, Cross-Disciplinary Teams

Findings: SmallSat/Class D teams are small, which enables **swift and open communication** (SA1.3) among team members and quick decision-making. Additionally, their cross disciplinary/ multidisciplinary composition enables system-wide awareness (SA1.1) and understanding, which improves overall design and facilitates early identification of potential problems, especially those that cross system boundaries. Small teams foster additional checks and balances throughout the system and cultivate a sense of individual and collective accountability (SA1.2). SmallSat/Class D missions have substantial independence and accountability at the local level in decision-making. Team members' influence does not stop at interface control documents (ICDs).

The culture in large missions is such that decisions tend to involve the project manager too often; decision making is diffused among multiple people, and much time is spent engaging multiple groups before arriving at a decision. Larger missions are very complex and involve specialized sub-teams whose interactions can become siloed, making it hard for team members to understand end-to-end processes and goals at the system and mission levels. Without constant communication among team members with big-picture perspectives, systems engineering can devolve into simply an accounting function.

Suggested Actions:[2]

SA1.1 **Shift the culture** of large missions to promote fostering personal and collective senses of ownership, open communication, and **system-wide awareness**.

- SA1.1.1. Promote culture change to build an environment where everyone has a mindset of responsibility and system-wide awareness to ensure the success of the entire mission. A way to change the culture to provide big-picture thinking, without diluting attention to detail, would be to institute an environment akin to Stephen Covey's Circle of Control, Circle of Influence, and Circle of Concern[3]. In large missions, a Cognizant Engineer's Circle of Control ends with their responsibility to meet requirements within the ICD, but it would be beneficial to encourage them to broaden their perspective to encompass other subsystems as their Circle of Influence, and the entire mission as their Circle of Concern, as is routinely done in small missions. Providing frequent opportunities for informal communication, coupled with this mindset, can go a long way toward unearthing opportunities and potential problems.

SA1.2 Transform decision-making culture.

- SA1.2.1. Based on the culture change above, sub-teams will have increased situational awareness; well-established, open communication channels; and increased trust with other sub-teams up and down the project management chain. Therefore, sub-teams can be empowered with greater decision-making authority, which should speed the decision-making process.
- SA1.2.2. NASA Headquarters plays an implicit role in establishing the decision-making culture for projects. Headquarters should inform missions early in the mission lifecycle that being well-informed in a timely manner about mission challenges will enable Headquarters to support decision makers if issues arise.

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[2] These recommendations are aligned with the following recommendations from the SMD Large Mission Study:

(1) "Formulate Pre-Phase-A teams with the following characteristics:

- They are streamlined to facilitate collaboration and rapid decision-making.
- They are composed with succession planning in mind, i.e., to ensure continuity over the 15– 30 years between Decadal Survey and launch."

(2) "Missions are better able to identify and resolve problems when there is a team culture of open communication, truth-telling, and accountability that is led, modeled, and promoted from the top down."

[3] Covey, S. R. (2004). The Seven Habits of Highly Effective People. New York, NY: Free Press.

SA1.3 **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 (i.e., eliminate siloed communication, root out the “not my problem” attitude).

- SA1.3.1. Institute organizational practices that foster **cross-communication** among the sub-teams (e.g., encourage more frequent informal communications[4] and esprit de corps activities).
- SA1.3.2. Promote the **exchange of ideas and awareness** in a large team by **encouraging members of sub-teams to participate in peer and/or tabletop reviews** of other sub-teams. This practice allows for sub-teams to understand how subsystem changes could potentially affect one another.

Topic 2: Reducing the Standing Army[5]

Findings: Small missions are effective at utilizing people on an as-needed basis rather than maintaining a standing army. A change in personnel management could reduce labor costs[6] by more than 60% by retaining key full-time equivalents (FTEs) and re-calling other SMEs on an as-needed basis, rather than keeping every FTE on the payroll from Integration and Test (I&T) to launch.

Suggested Actions:

SA2.1 Organizations should not deploy a standing army and should deploy their workforce nimbly, acknowledging that this approach demands careful planning to ensure mission continuity without relying heavily on a fixed workforce.

Topic 3: Essential and Bottom-up Requirement Tailoring

Findings: SmallSat/Class D missions are guided by the Class D MAR, which allows them to **tailor their requirements using a bottom-up approach**, only adding those that add value. Large missions use an expansive MAR, often have a “checklist mentality,” and typically struggle to justify the removal of requirements.

Suggested Actions:

SA3.1 Encourage requirements tailoring: Establish a lean set of Class C Mission Assurance Requirements (MAR) like the SMD Class D MAR (see related Findings and Recommendations for COTS Usage)

- SA3.1.1. Formulate training guidelines for Mission Assurance Managers (or equivalents). Have the Office of Safety and Mission Assurance (OSMA) and the NASA Office of the Chief Engineer (OCE) conduct presentations to educate all stakeholders (internal and external) on new Class C MAR Principles and significant departures from common practices.

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[4] The Psyche IRB Recommendations 11/4/2022 also referred to this as *Reestablish informal communications, such as “walking the floor” and “drop-in discussions.”*

[5] This finding was not discussed in the workshop but emerged from discussions within the steering committee post-workshop.

[6] The On-Orbit Servicing, Assembly and Manufacturing (OSAM)-1 mission reduced the number of FTEs/WYEs from 600 to 200

SA3.2 Following SIMPLeX best practices, work with current Class C missions to feed lessons learned forward by developing suggestions for common tailoring of NPR 7120.5 requirements for future Class C missions

Topic 4: Commercial Off-the shelf (COTS) Product Usage

Findings: SmallSat/Class D missions effectively use COTS products and processes by designing around existing solutions/systems, which significantly reduces mission costs[7]. Early in the design process, many SmallSats explained how they will reduce mission costs to embrace the Class D philosophy and have now demonstrated that COTS parts do not necessarily introduce unacceptable risks.[8] **Large missions can benefit from using COTS products and systems.** When designing their systems, large missions often disregard existing commercial solutions or impose NASA requirements on commercially available systems.

Suggested Actions:

SA4.1 **Identify methods** to incentivize or promote the acceptance and **utilization of COTS parts**.

- SA4.1.1. The burden of proof should be on the large missions to justify why commercial products and processes aren't adopted.
- SA4.1.2. Large missions should expend effort designing around the performance of COTS parts including selective redundant systems and/or spacecraft.
- SA4.1.3. Encourage cost savings by eliminating margin on margins.
  - SA4.1.3.1 Perform Technical, Cost, Management, and Other Factors (TMCO) study on design and test practices that build in margin on margin to determine the effect on total cost.

SA4.2 **Team with vendors;** make sure that vendors understand the needs/goals of missions.

- SA4.2.1. If vendors **allow NASA to audit and examine their processes, NASA could then accept certain COTS parts** and products as qualified and accept them "as is." NASA can then avoid imposing its standards and still get acceptable reliability when using these COTS parts. Consider adding contractual language to require the audit.
- SA4.2.2. **Ensure vendors grasp which requirements** are mission-critical to facilitate risk-based discussions and ensure product alignment with intended goals.
  - SA4.2.2.1 Review and update the flow-down process for Mission Assurance Requirements onto contracts by filtering and interpreting them.
  - SA4.2.2.2 Avoid the "blanket" flow down of requirements by including references to documents that contain requirements that are not directly pertinent to project needs.

SA4.3 **Screen for vendors that are transparent and willing to work with NASA** if an issue were to arise.

SA4.4 **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.

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[7] For example, ESCAPADE currently has greater than 50% cost reserves against lien at the end of Phase D and within three months of launch.

[8] Jesse Leitner 5/22/24: "**No failures of system due to COTS EEE parts** except in one case parts that we damaged by screening them before (SAC-D) and on manually produced parts that are used at or beyond their boundaries (Magnetospheric Multiscale [MMS] mission). MIL-SPEC parts are more likely to fail (and they do fail)."

SA4.4.1. The design architecture would be required to provide a verifiable approach to safely use COTS parts.

SA4.5 **Relax the documentation requirement** for parts that have been flown successfully multiple times in a relevant environment (e.g., 8705.4, flowdown of embedded documents, MAR).

SA4.6 **Establish a Preferred Parts List** by tapping into expertise of other comparable missions. Consider formalizing this list within NASA while ensuring it is reviewed on a regular basis.

SA4.7 Consider establishing a **Parts Environment Assessment Lab (PEAL)** within NASA to accomplish steps SA4.3 and SA4.6 for all missions.

Topic 5: Risk Management Practices

Findings: NPR 7120.8 missions do not use formal risk management. **Engineers on small missions conduct risk management as a matter of practice every day**, rather than spending significant effort on risk management products. SmallSat/Class D missions leverage existing risk assessments and focus on understanding and mitigating operational mission risk. **Large missions spend a significant amount of effort on risk management before designs are complete (developmental risks).** Risk management is tied to resource management. Small missions cannot afford to eradicate all risks while large missions not only try to mitigate all risks but often overcompensate to provide margins on margins.

Suggested Actions:

SA5.1 **Differentiate between developmental risk vs. operational mission risk**.

SA5.1.1. **Employ simplified risk management tools until Critical Design Review (CDR)** and levy fewer requirements for documenting developmental risk. Simply listing the design elements of concern and discussing the risks with the Standing Review Board (SRB) could be sufficient until Key Decision Point (KDP)-C.

SA5.1.1.1 Spend effort solving problems instead of documenting potential risks.

SA5.2 Clearly assess risk mitigation activities (like test protocols) to assure that critical risks are addressed and unnecessary activities are eliminated.

SA5.3 Establish open working relationships to build trust between mission teams and safety and mission assurance personnel.

SA5.3.1. The Principal Investigator (PI) and Project Manager (PM) should establish team norms to ensure that teams have ongoing conversations about which risks can be just worked vs. those that must be documented.

Topic 6: Small, Consistent, and Support-based Review Boards

Findings: SmallSat/Class D 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.[9]

[9] The SMD Large Mission Study Report recommended that “SRBs for large missions should contain more scientists, project managers, and systems engineers--and fewer technical specialists--than they do currently.”

Suggested Actions:

SA6.1 Employ peer review practices used by SmallSats.

SA6.1.1. Have SRB provide **more informal expertise**.

SA6.1.1.1 Conduct informal small group discussions outside of formal gate reviews.

SA6.1.2. Build trust between SRB and mission personnel.

SA6.1.2.1 Like SmallSats, large missions could recommend SRB members who are familiar with the mission team to facilitate open communication.

SA6.1.2.2 Select SRB members who have good communication skills as well as technical expertise.

Topic 7: Identification and Combination of Critical Documentation

Findings: SmallSat/Class D missions identify and tailor documents that are truly needed and used. For example, one SmallSat mission used a six-page PowerPoint presentation instead of a 50-page document for its Configuration Management (CM) plan. Large missions create documentation that is oftentimes not referenced (i.e., the Systems Engineering Management Plan [SEMP]). Large mission teams may stop work to prepare significant documents for reviews. (SA7.4)

Suggested Actions:

SA7.1 Tailor the signature process; minimize the number of signatures required. For documents that require NASA Headquarters approval, reduce the number of signatures to include the person who did the work, the backup, the supervisor, and the responsible NASA official, and anyone else who is required to commit resources.

SA7.2 Consider eliminating reviews such as the System Integration Review (SIR) and replacing them with a series of small meetings that produce required products without the formal paperwork.

SA7.3 Perform a study to identify which documents SmallSats successfully eliminated, combined, or reduced, so that documents can be modified where appropriate.

SA7.3.1. Create baseline template for barebones Contract Data Requirements List (CDRL).

SA7.4 Track costs of review preparation to quantify the overall impact to mission lifecycle cost (LCC) with the ultimate goal of motivating change.

SA7.4.1. All missions gain value from review preparation, but the small missions have determined how to identify and combine documentation preparation to minimize the overall cost/time impact to the mission lifecycle; large missions might be able to learn from these practices.

3. Conclusions

NASA SMD's experiment to expand use of small satellites for science was a success; such missions now routinely acquire high-quality science data at greatly reduced cost. As documented in this report, the discussions at the SMD workshop suggest that there are numerous best practices and lessons learned from the agency's SmallSat experience that could be applied to improve the management of larger, Class A-C satellite missions. Now is an opportune time to take action to reduce costs while maintaining the quality of upcoming larger science missions.

Appendix A. Pre-workshop Interview Questions and Summary of Key Points Obtained

Prior to the workshop, the organizing committee interviewed more than 35 subject matter experts with experience in small satellite missions; many interviewees also had experience working on large satellites. The key points gained from these interviews (summarized below) informed the workshop discussions.

Pre-workshop Interview Questions

1. Describe your experience working on big and small satellite missions. What roles have you played in these missions?
2. Did you learn anything from your experience developing a Class D/SmallSat mission that might be useful for application to larger missions; if so, what?
3. For those who worked both large and small missions: From the viewpoint of working the smaller mission, what positive or negative requirements-related aspects do you believe could impact larger missions?
4. As a Class D/SmallSat mission developer, your team likely worked differently than they would have on a larger mission. E.g., multiple people may have acted as system engineers. Are there lessons learned about team management from your Class D/SmallSat experience that could be replicated on a larger mission, particularly if your workforce was not stable (e.g., students came and went)?
5. Class D/SmallSats take advantage of tailoring documents as well as reviews. Are there any benefits reaped from this practice that could apply to larger satellites?
6. What is the most impactful lesson learned?
7. Is there anything else you would like to share?

Summary of Key Points Obtained from Interviews

1. **Reuse and COTS**
   - Make more use of COTS where appropriate.
   - Reuse existing resources (designs, tools, hardware, test equipment).
   - Use modular designs.
2. **Vendor/Partner relationships**
   - Actively manage vendor activities, but do not hold them to the same level of NASA insight/oversight for proven products.
   - NASA should have insight not oversight. Some technical items can be held at the contractor level (i.e., not every drawing is needed and we don't need to have people look at those kinds of deliverables).
   - Build relationships and trust with vendors and technicians/facility operators at other NASA centers.
   - SmallSat/Class-D projects usually work more directly with NewSpace organizations applying innovative processes. Can we learn from them?

3. **Mentoring**
   - Need senior experienced people on the team to serve as mentors to junior engineers in key roles; co-location can be key. Smaller teams need to have very experienced people that can serve in multiple roles.
   - Provide crash course for new PIs.
   - The experience of Class D junior engineers, having been exposed to the entire life cycle, can benefit Class A-C mission implementation in terms of identifying cross-disciplinary technical issues and team communication.
4. **Decision making**
   - Empower engineers to tailor decisions from the start of the project.
   - Make decisions at the lowest level possible, and empower lower levels to make decisions.
   - Be flexible to change if you learn something new.
   - Challenge the purpose of what you are doing; only do what adds value.
   - Evaluate risk and use engineering judgment; don't overprescribe
   - Be transparent to upper management, and NASA Headquarters must also be responsive.
   - SmallSat/Class D decisions are made more quickly.
5. **Team Communication**
   - Create a small-project feeling; a small close-knit team enables flexibility and responsiveness.
   - Cross-team contacts lead to better management of risk and people can learn from each other.
   - Make sure everyone is onboard regarding mission purpose/goals.
   - Provide a narrative about how things will come together; explain "what is your piece of the puzzle".
6. **Roles, Responsibilities and Use of Personnel with Interchangeable Roles**
   - Small teams with shared roles (not siloed) enables
   - Class-D missions benefit from end-to-end functional ownership of flight system development that is not common for Class A-C. This end-to-end functional ownership can simplify the transition across mission phase development.
   - Class A-C missions tend to have people in fixed roles while Class D persons are multi-skilled. This brings added checks/balances which could reduce risk.
   - A small core team of people devoted to the mission full-time is effective; get appropriate expertise when needed; a large mission could be cheaper if part-time support is used.
   - Use a flatter team structure.
7. **Documentation**
   - Identify the documents that are truly needed and used; consider risk when assessing need. Many required contractual documents may not be needed if they are never used/examined.
   - Combine documents to minimize effort; only require what is necessary. We are not really tailoring at higher levels. One should combine documents and add language to eliminate other documents.
   - Keep important information (e.g., ICD requirements) in a single location.
8. **Engineering and Design**
   - Prioritize analysis over testing where appropriate; focus more on doing what is needed, not what is required.

- Focus on creating no systemic design flaws by building multiple flight-like prototypes before the flight model systems for constellations of satellites.
- Peer reviews are extremely valuable.
- Smaller systems are more highly integrated (i.e., spacecraft and payload), so one needs to be aware of the impact of single string concerns.
- SmallSat/Class D systems are often software-driven and this may be an increasing trend for Class A-C missions.
- For SmallSat/Class D failures one can replace a part without root-cause analysis, where appropriate, based on risk.
- Requirements that dictate implementation cost time and money, so more effort can be placed on looking for vendor solutions for the implementation.

9. Review Board Practices

- Governance board should act as a technical resource, not a gate.
    - i) Large satellites focus on convincing the panel they should pass.
    - ii) SmallSats/Class D talk about issues and problems and the board helps solve them.
- Consider combining reviews (based on risk assessment) and updating required products for the review.
- Board members should meet with team and reviews should focus on what the review board wants to see and where more information is needed.

10. Risk Management

- Establish risk criteria early, especially for multi-spacecraft missions.
- Missions should not be held to one risk category; could be plus/minus depending on purpose.
- Leadership should define risk thresholds.
- Carry draft risks for things that could be a problem and should be revisited.
- Take advantage of the Class D MAR.
- Use advanced autonomy software technique and system level characterization to mitigate anomalies prior to major negative impacts.
- More data-driven and risk-based decisions on what requirements we levy and have is a lesson learned from SmallSat/Class-D.

11. Tailoring

- Sometimes it’s easier to do the work instead of getting the waiver.
- Assess intent of requirements; consider turning “shalls” into “shoulds” unless absolutely needed. Follow Goddard Open Learning Design (GOLD) Rule (intent) not letter of the law.
- Tailoring can be different depending on the team’s experience level. Tailor based on what the requirement is intending to achieve and to reduce risk.
- Class A-C missions have too much overreliance on process than technical knowledge at the level of the team. Pulling back added processes, while ensuring personnel are well trained, could improve on ability to manage/deliver on commitments.
- Increase awareness in Class A-C missions that tailoring is possible

Appendix B. Workshop Agenda

Tuesday, March 19, 2024 - LASP, Room W120A/B; 3665 Discovery Dr, Boulder, CO Workshop on Informing Class A-C Missions from SmallSat/Class D Lessons Learned		
Time	**Topic**	**Speaker**
07:30 - 08:00	Registration, Coffee and refreshments	
08:00 - 08:30	Welcome and Purpose of Workshop Logistics Structure of Workshop and Guidelines	Wanda Peters (recording) and Carolyn Mercer Pamela Millar and Steering Committee Members
08:30 - 09:00	Participant Introductions and Goal Setting	All
09:00 - 10:00	GROUP DISCUSSION: Mission Class Definitions Handout and Summary Outcomes from Expert Interviews	Alan Zide, Charles Norton, Pam Millar
10:00 - 10:30	Coffee Break and Post-Discussion Informal Interactions	
10:30 - 12:00	BREAKOUT GROUPS 1: - Management Lessons - Technical/Implementation Lessons	Imagine you're embarking on a Class A, B, or C mission with NASA. Drawing from your experiences in a Class D mission, what key insights and practices would you advocate for adoption in Class A, B, or C missions?
12:00 - 13:30	Lunch (with Continued Discussion)	
13:30 - 14:30	LEAD-IN TALK: Persistent Challenges in Large Missions and Exploring how Insights Gleaned from Smaller Missions could Offer Solutions	Rob Manning and Nick Jedrich
14:30 - 15:00	GROUP ACTIVITY: Review of Technical and management sessions (15 min each)	High level summary of each group's discussion: Group leads to report out

15:00 - 16:00	BREAKOUT GROUPS 2: - Management Lessons - Technical/Implementation Lessons	Identify initial findings
16:00 - 16:30	Coffee Break and Post-Discussion Informal Interactions	
16:30 - 17:00	GROUP DISCUSSION: Formulation of Initial Findings Discussion of Workshop Report	High level summary of each group's discussion: Group leads to report out
17:00 - 17:30	Workshop Concludes	