



Improving Mission Success of CubeSats

Catherine Venturini
The Aerospace Corporation

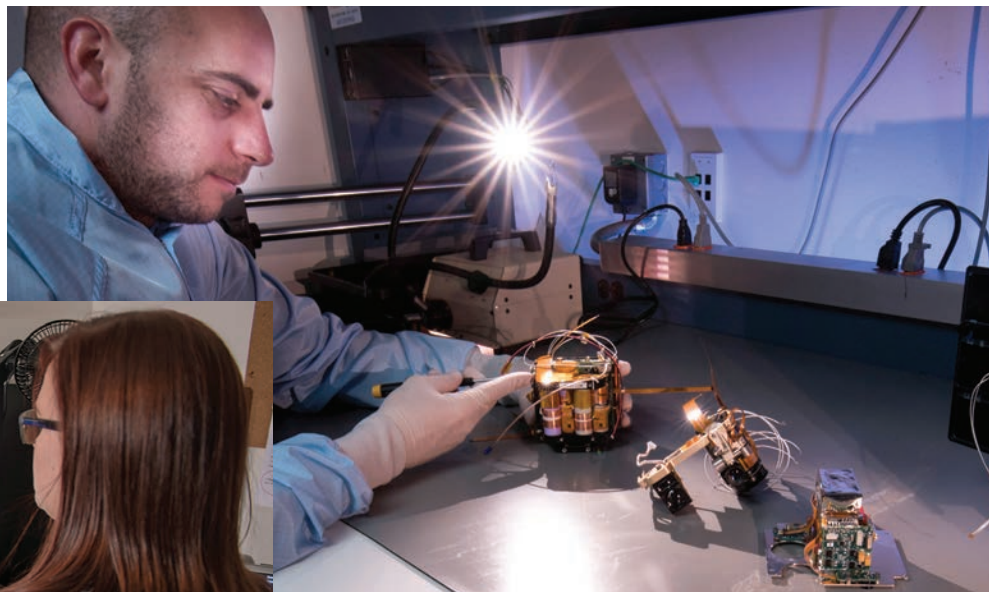
April 30, 2018

U.S. SPACE PROGRAM MISSION ASSURANCE IMPROVEMENT WORKSHOP
THE BOEING COMPANY | EL SEGUNDO, CA | MAY 2-4, 2017

**MISSION:
ACCOMPLISHED**

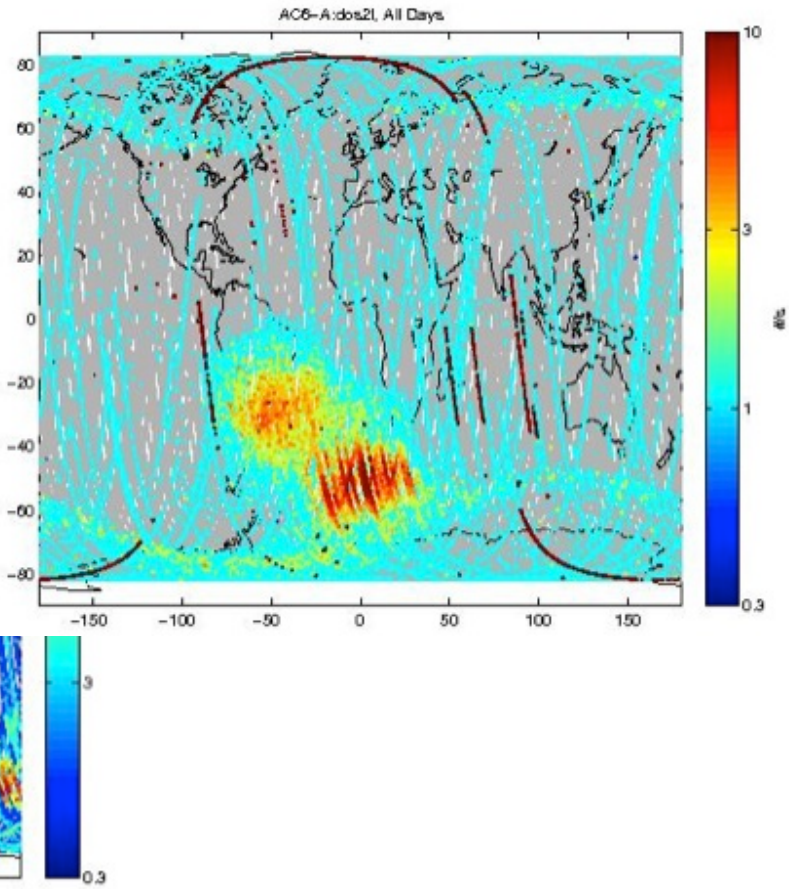
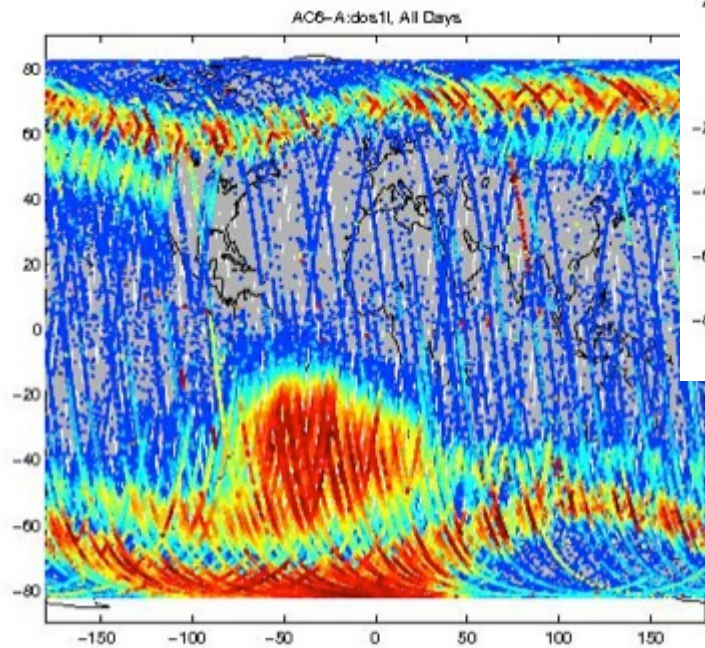


MISSION ACCOMPLISHED!



U.S. SPACE PROGRAM MISSION ASSURANCE IMPROVEMENT WORKSHOP
THE BOEING COMPANY | EL SEGUNDO, CA | MAY 2-4, 2017

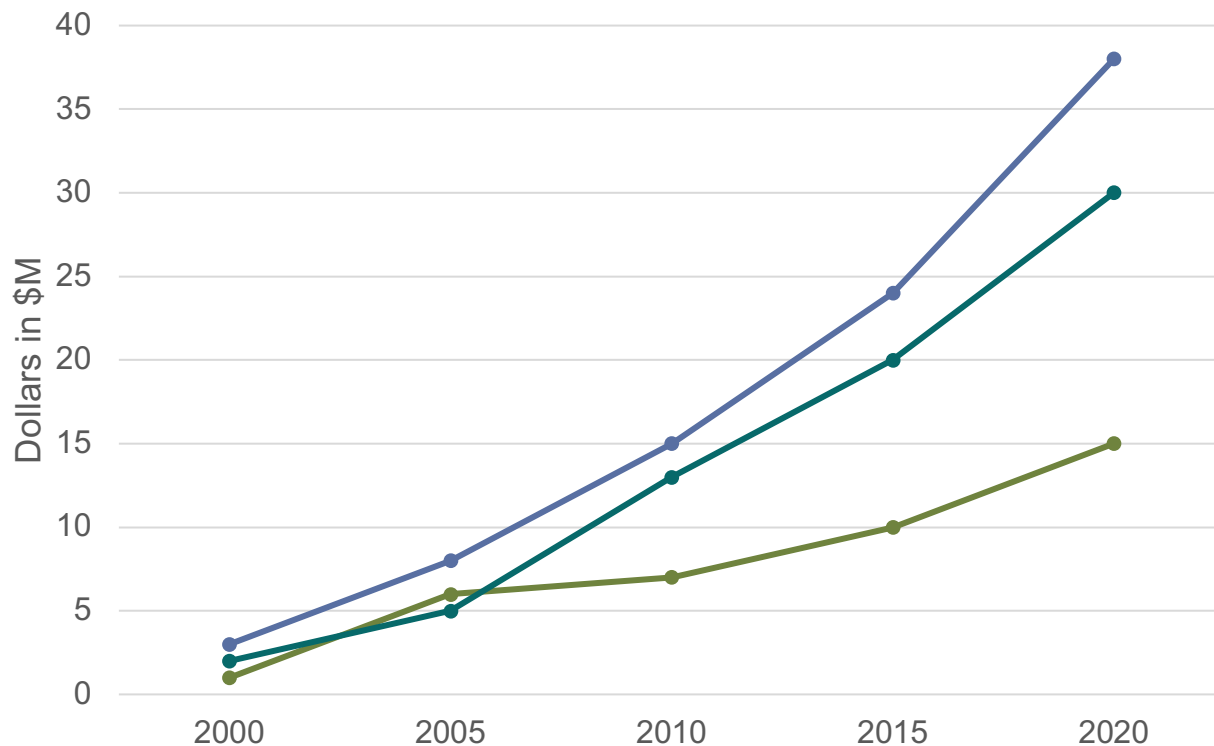
MISSION ACCOMPLISHED:



U.S. SPACE PROGRAM MISSION ASSURANCE IMPROVEMENT WORKSHOP
THE BOEING COMPANY | EL SEGUNDO, CA | MAY 2-4, 2017

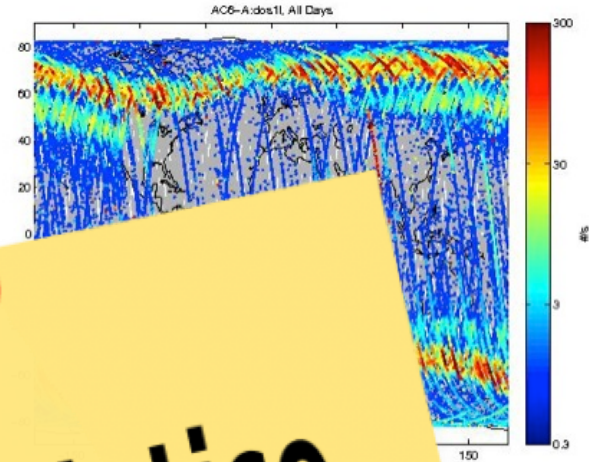
MISSION: ACCOMPLISHED:

Company X - Yearly Returns

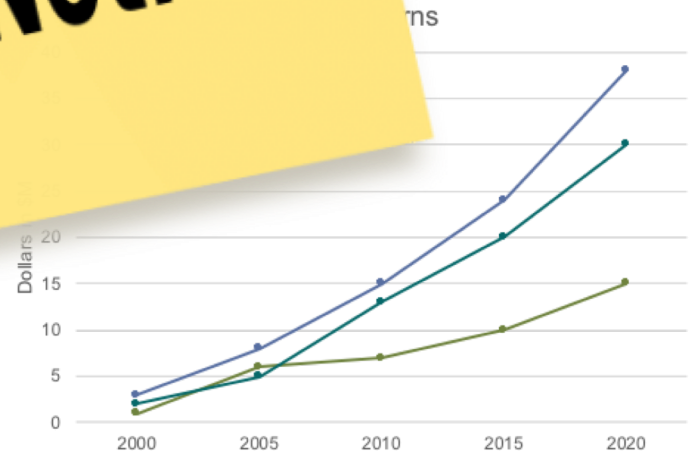


U.S. SPACE PROGRAM MISSION ASSURANCE IMPROVEMENT WORKSHOP
THE BOEING COMPANY | EL SEGUNDO, CA | MAY 2-4, 2017

MISSION ACCOMPLISHED:



Important Notice



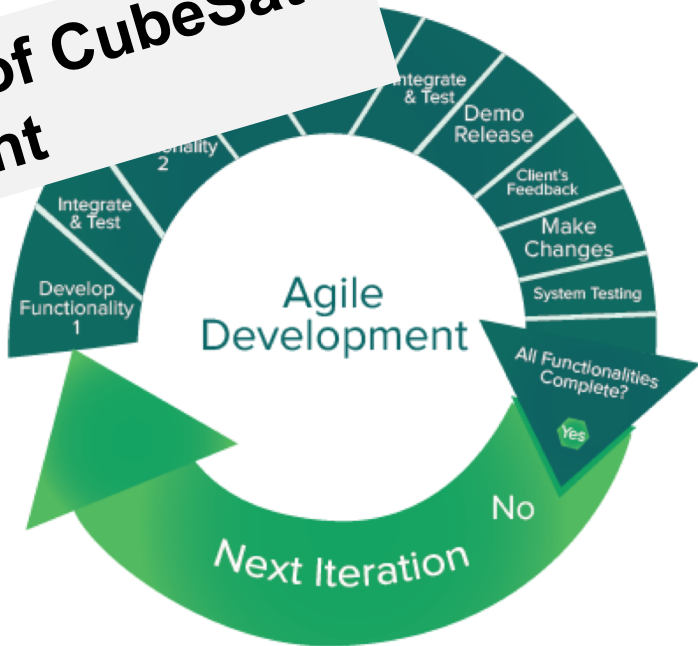
U.S. SPACE PROGRAM MISSION ASSURANCE IMPROVEMENT WORKSHOP
THE BOEING COMPANY | EL SEGUNDO, CA | MAY 2-4, 2017

**MISSION:
ACCOMPLISHED:**



**Improving Mission Success of CubeSats
Problem Statement**

COTS



What is the MAIW?

- The Mission Assurance Improvement Workshop is a national space program community of practice
- It brings together the entire U.S. space community (industry, academia, and government) to explore and document best practices and craft a common approach to Mission Assurance for the U.S. space program
- 2017 was the 10th year of the workshop

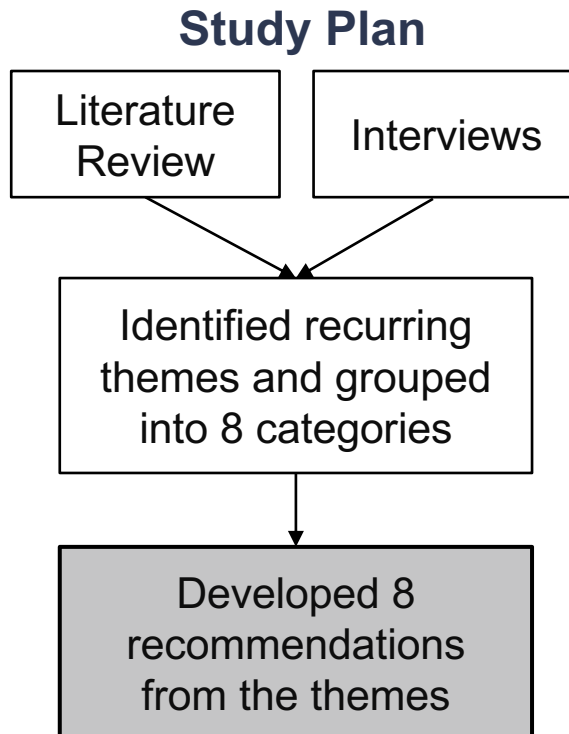


U.S. SPACE PROGRAM MISSION ASSURANCE IMPROVEMENT WORKSHOP
THE BOEING COMPANY | EL SEGUNDO, CA | MAY 2-4, 2017

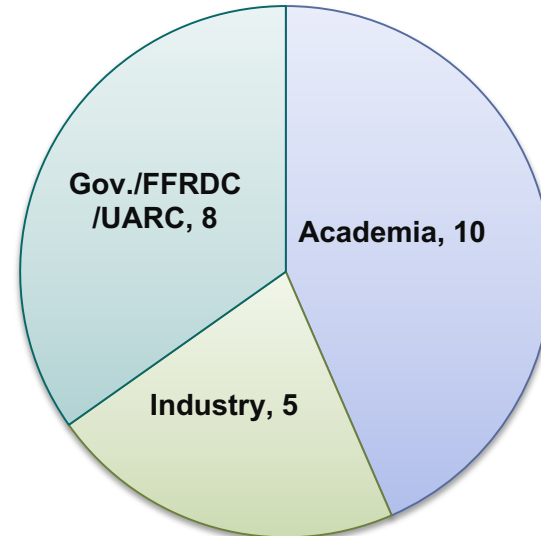
Study Background

Study Timeline

Kickoff August 2016 ending with workshop May 2017 (9+ month effort)

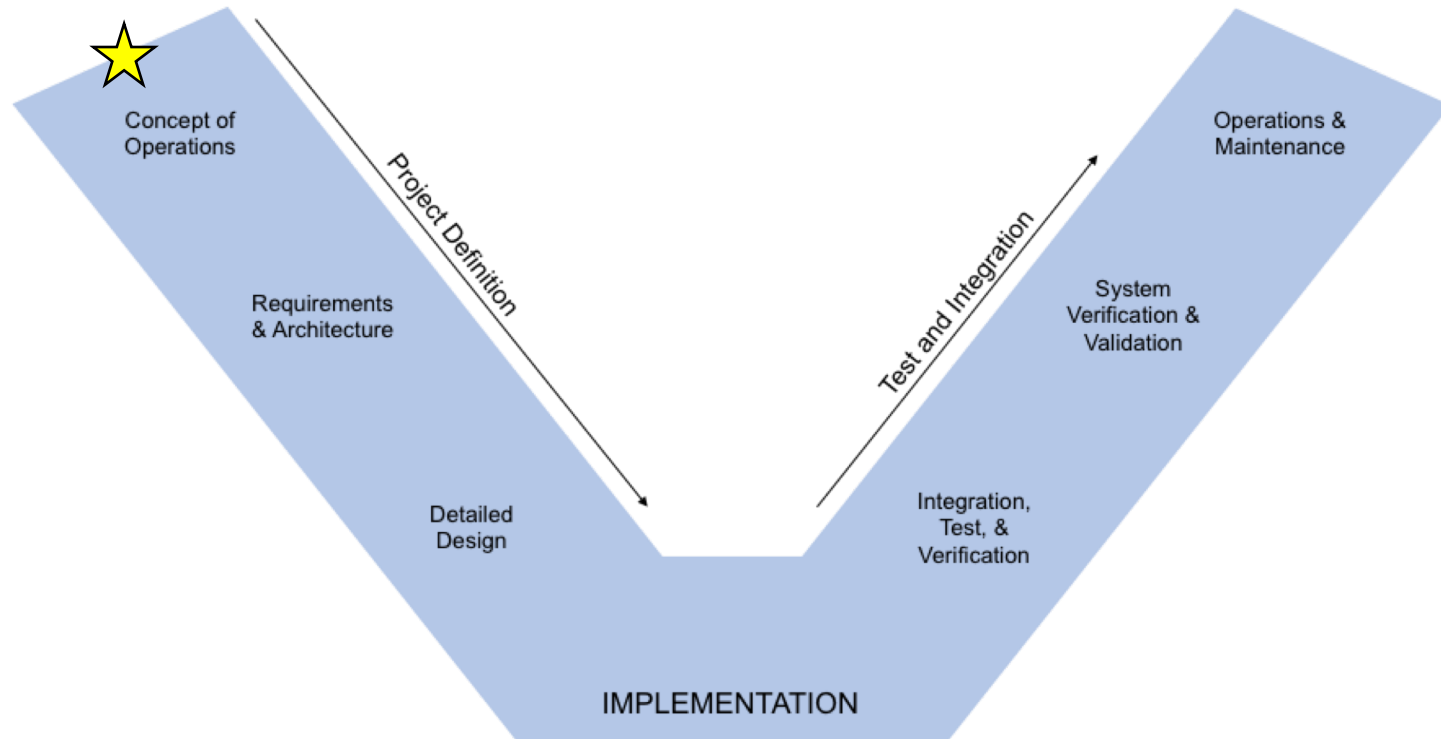


23 Interviews



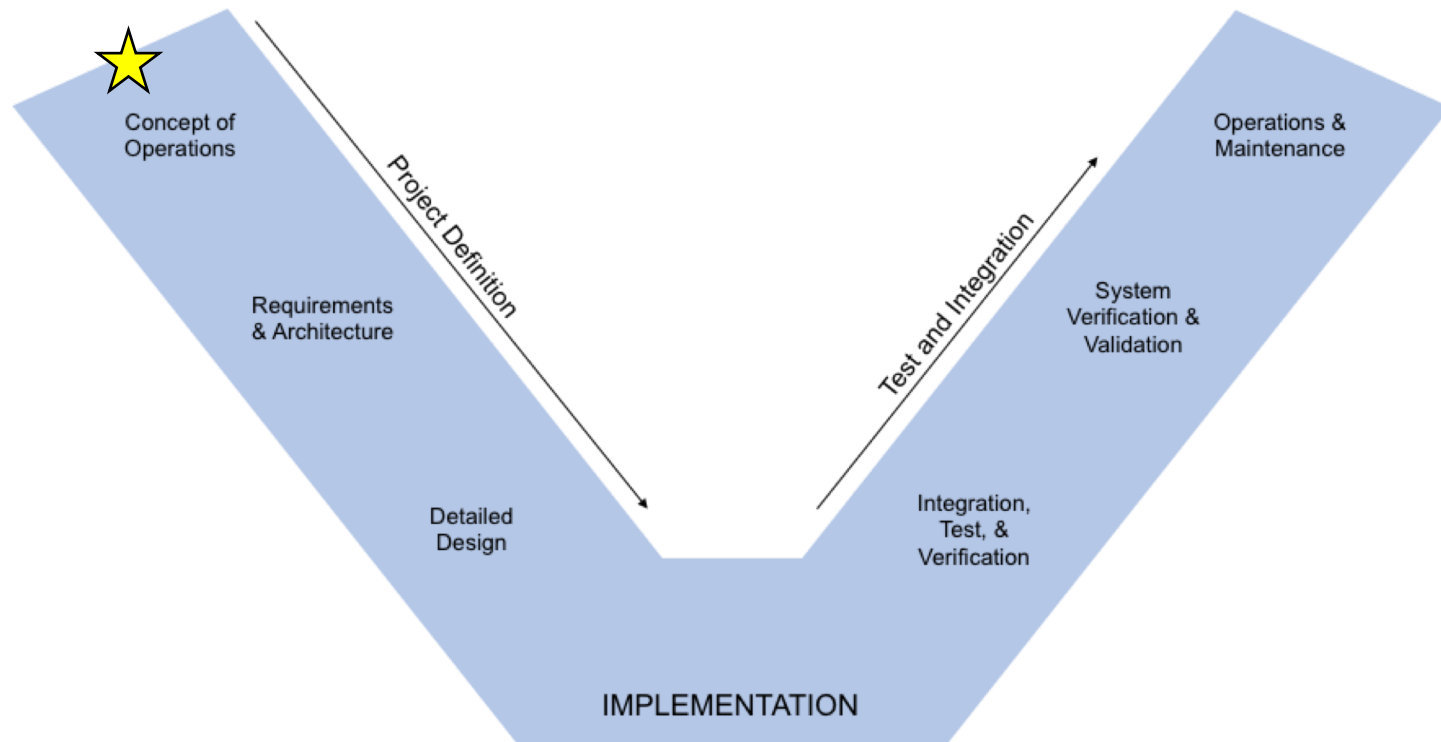
Study focused on 1U to 12U but recommendations are scalable to >12U

Recommendations



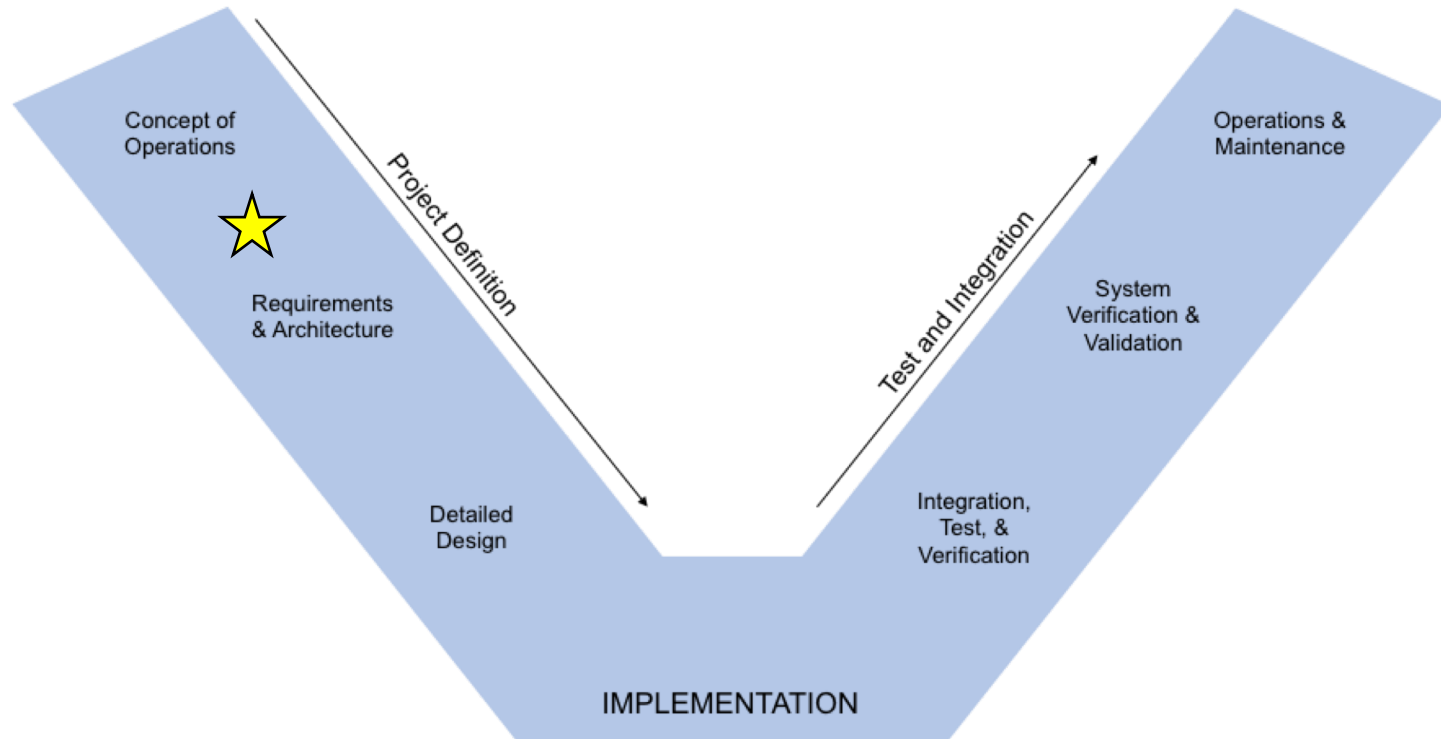
1. Build an experienced team—it matters
 - *A successful team has veteran member(s) and frequent informal peer reviews (discussions) with proven subject matter experts*

Recommendations



2. Define your scope, goals, and success criteria at program start
 - *Justify your ability to complete it within the available time using the available budget and resources*
 - *During the project lifecycle, aggressively defend it against growth, but have a plan to de-scope, if necessary*

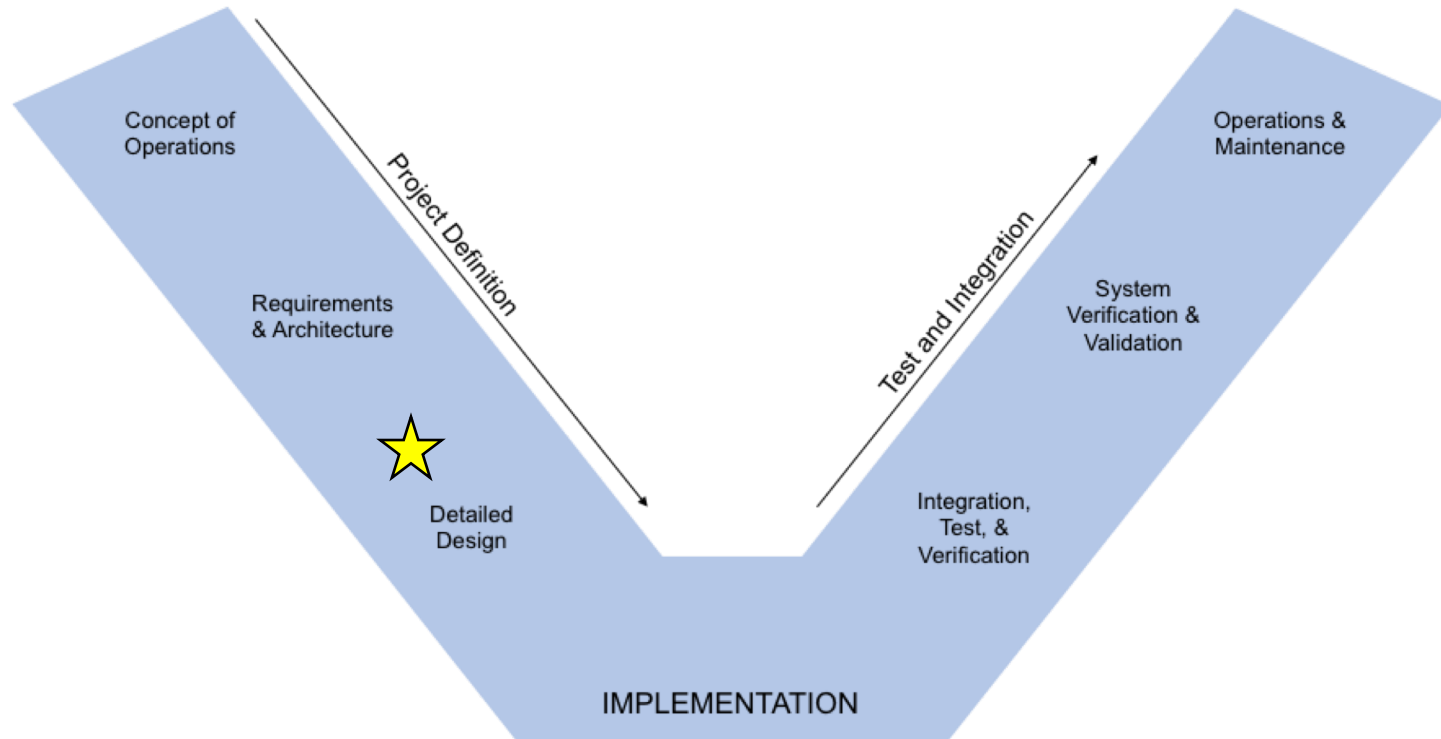
Recommendations



3. Conduct risk-based mission assurance

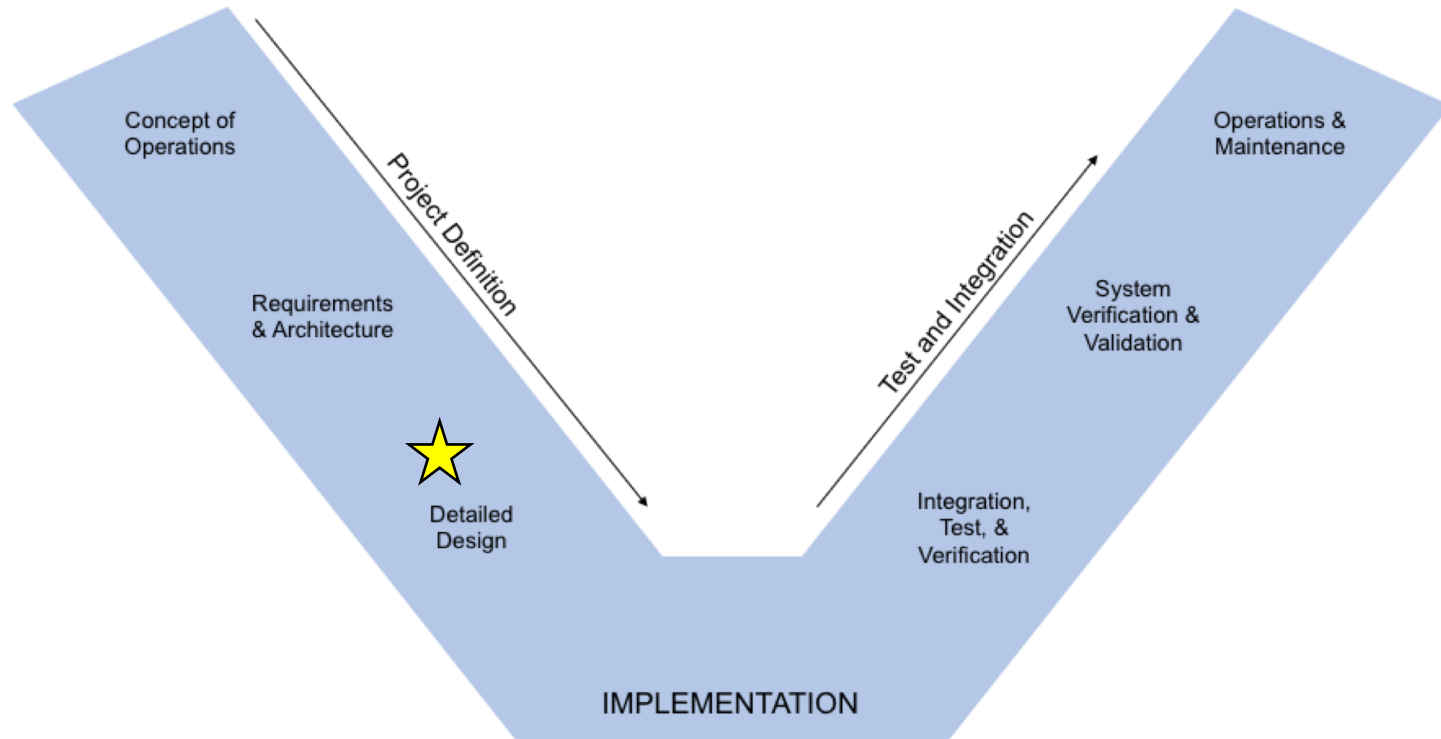
- *Perform a risk assessment at the beginning of the program to prioritize analyses, tests, reviews, and activities*

Recommendations



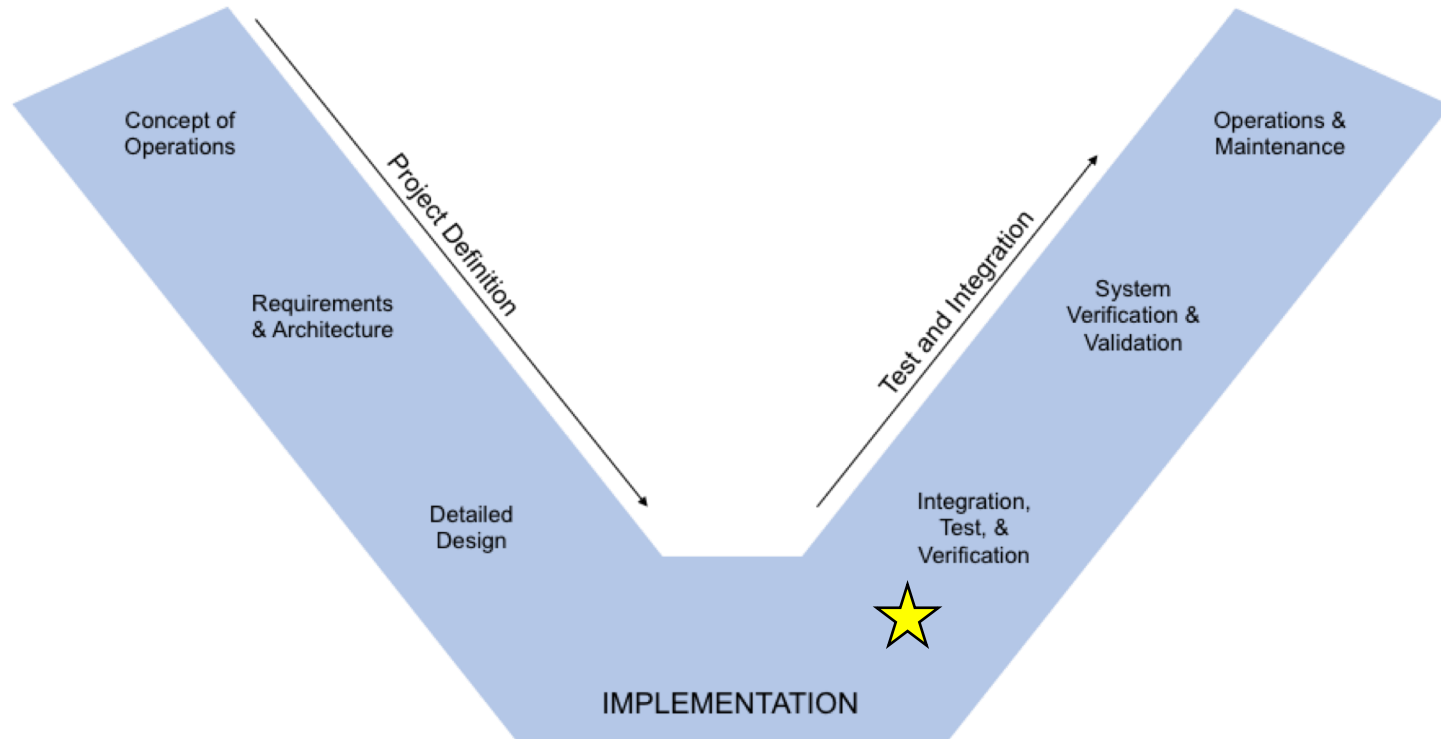
4. Design for simplicity and robustness
 - *Assume designs will fail and then prove they will work*
 - *Design the satellite for easy assembly and disassembly*
 - *Have respectable margins, robust safe modes, few deployables, graceful performance degradation, and frequent preventative satellite resets*

Recommendations



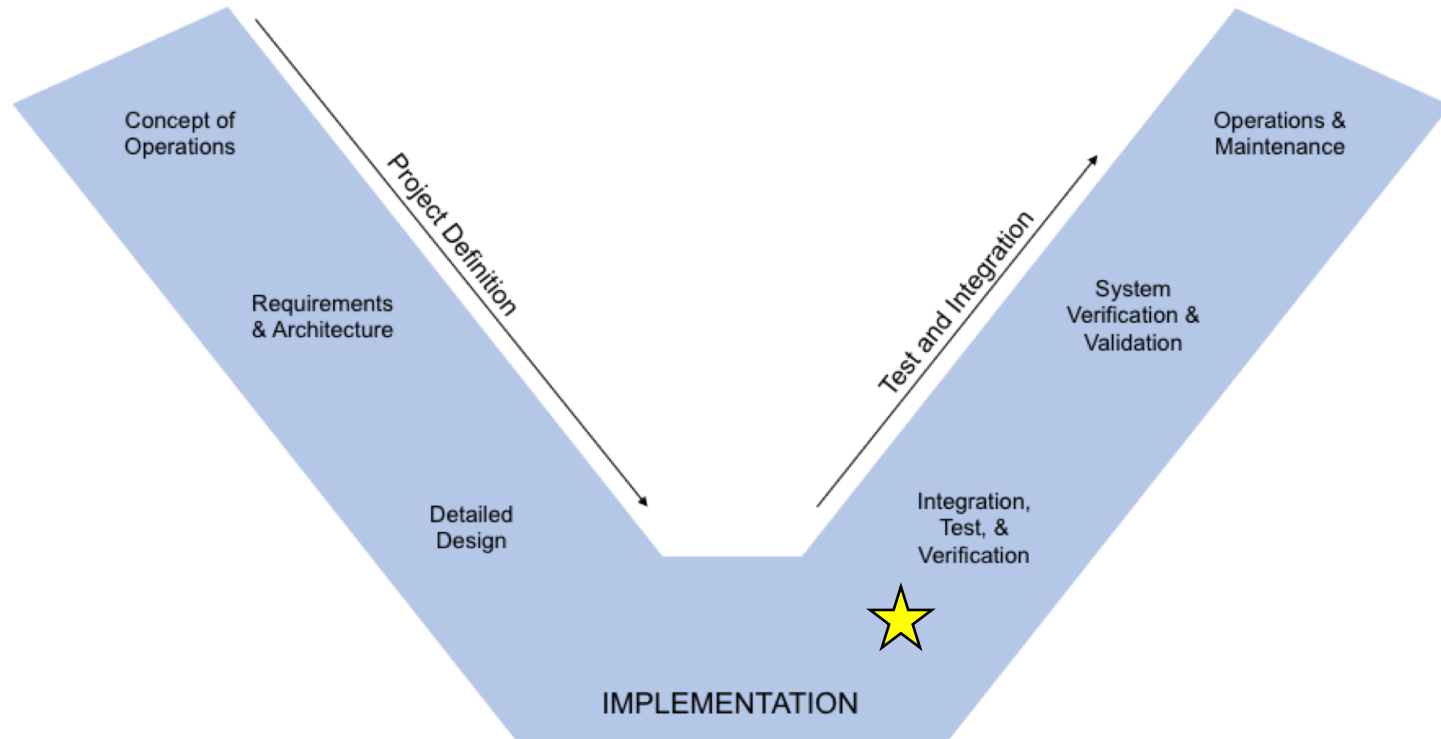
5. Maintain a healthy skepticism on vendor subsystem datasheets
 - *Hold margin on all performance numbers during design and verify after receipt.*

Recommendations



6. Plan for ample integration, verification, and test (IV&T) time
 - *Stick to the baseline IV&T of 1/3 to 1/2 of the overall schedule*

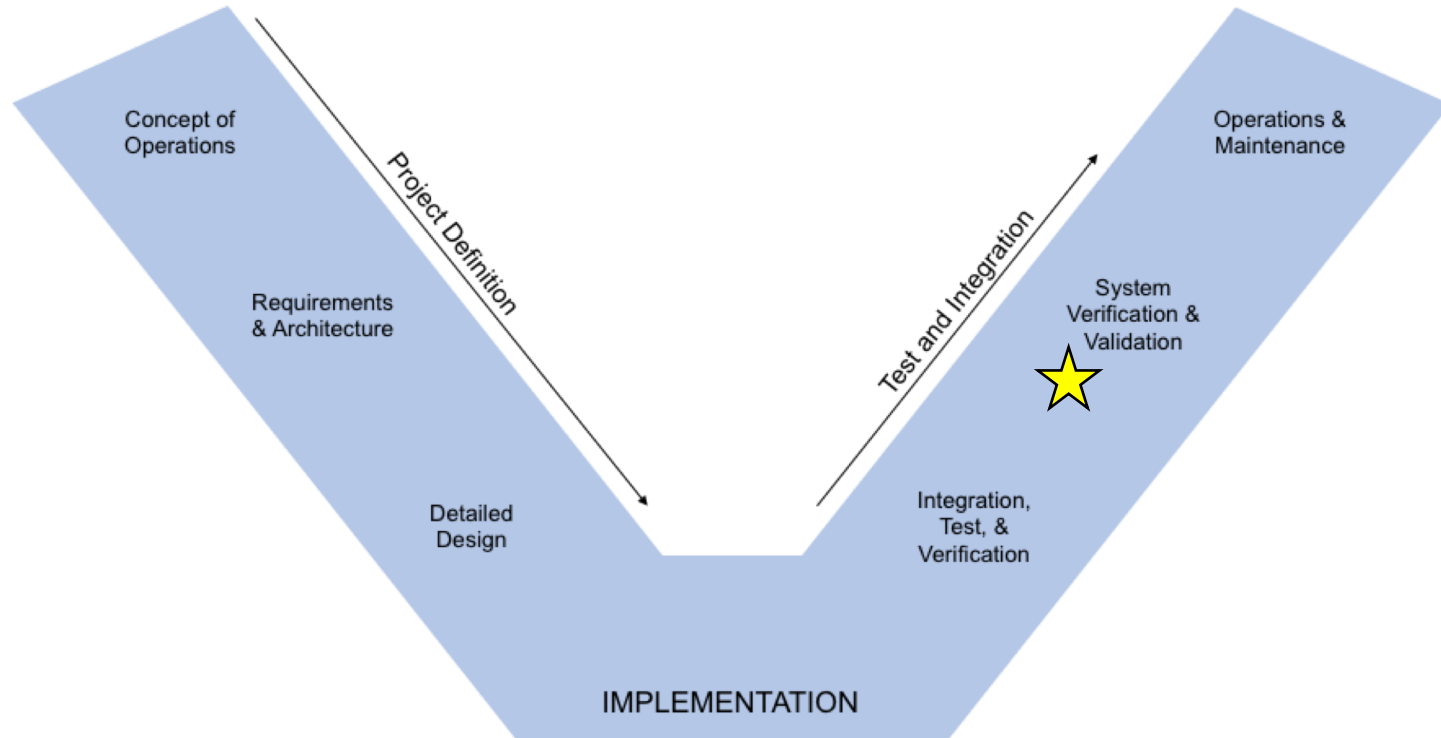
Recommendations



7. Stock spare components

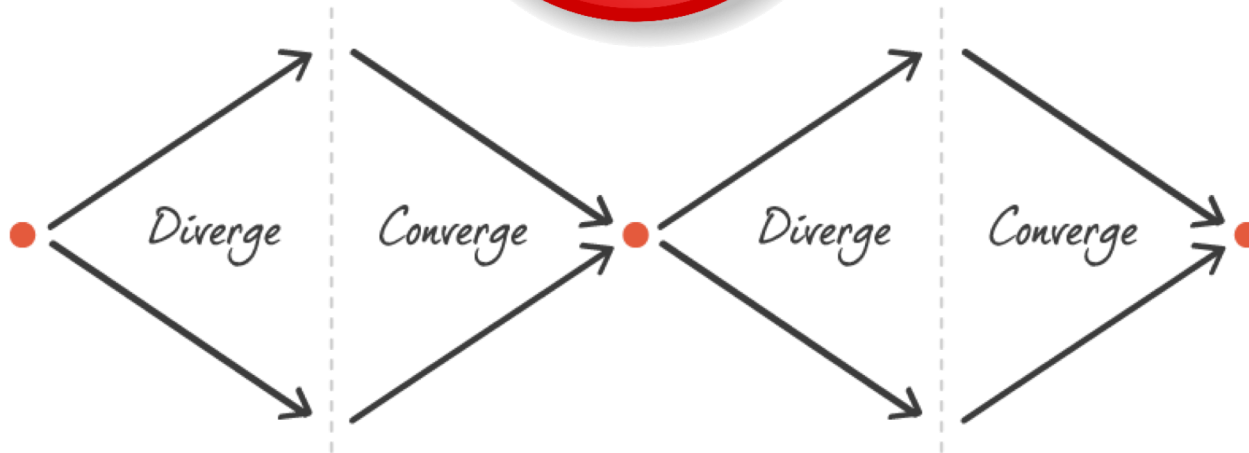
- *Extra boards support parallel software development and are flight spares*
- *Extra hardware protects schedule during mechanical testing*

Recommendations

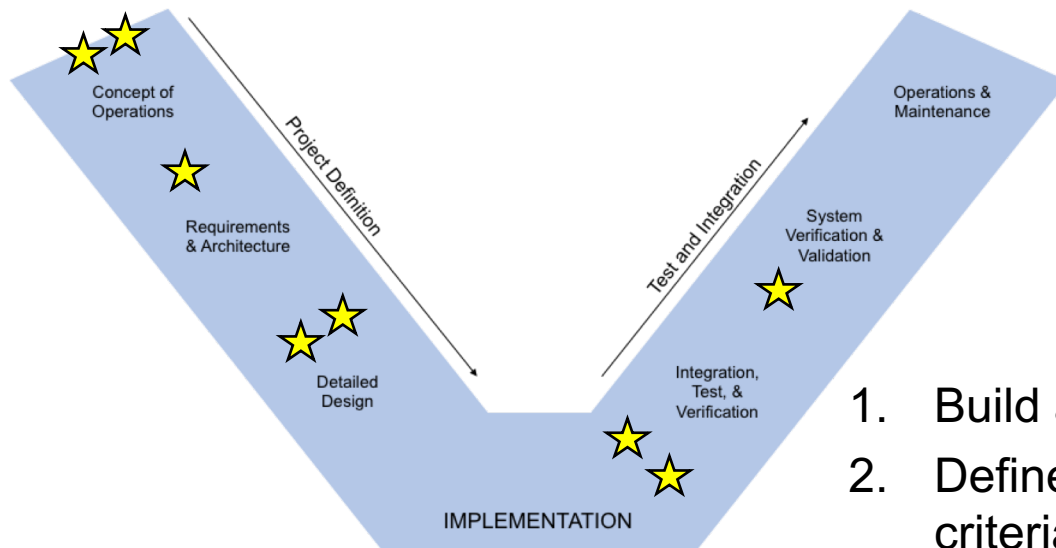


8. At a minimum, perform the four mission assurance tests
- *Day-in-the-life (or longer) testing*
 - *Communication link test with the ground station*
 - *Power system charge/ discharge testing*
 - *Thermal testing (in vacuum if at all possible)*

MISSION: ACCOMPLISHED:



Recommendations



1. Build an experienced team—it matters
2. Define your scope, goals, and success criteria at program start
3. Conduct risk-based mission assurance
4. Design for simplicity and robustness
5. Maintain a healthy skepticism on vendor subsystem datasheets
6. Plan for ample IV&T time
7. Stock spare components
8. At a minimum, perform the four mission assurance tests

Feedback

Full report available for download:

[Report @ NASA S3VI](#)
[Small Spacecraft Body of Knowledge](#)

We are interested in community feedback - did these recommendations improve mission success for your program?



Team Members – Topic Team

Company	Participant
The Aerospace Corporation	Barbara Braun David Hinkley Catherine Venturini (co-lead)
Ball Aerospace and Technologies Corporation	Bob Andrews
The Boeing Company	Greg Berg (formerly) Jeff Christensen Kim Hicks Mike Tolmasoff (co-lead, formerly) Andrew Whiting
Harris Corporation	Tom Wiedenbauer
Lockheed Martin Corporation	Gary Kushner
MIT Lincoln Laboratory	Rick Gebbie
SSL	Renelito Delos Santos (co-lead, formerly)



Team Members – Additional SMEs

Company	Participant
The Aerospace Corporation	Ron Duphily Lynn Friesen Larry Harzstark Gail Johnson-Roth Elizabeth Klein-Lebbink Art McClellan Charles Swenson
Ball Aerospace and Technologies Corporation	Reuben Rohrschneider
California Polytechnic State University, San Luis Obispo	Ryan Nugent
Johns Hopkins University Applied Physics Laboratory	Steven Pereira
Millennium Space Systems	Andrew Robertson
MIT Lincoln Laboratory	Conor Galligan
NASA	Sue Aleman Andrew Demo Kenneth LaBel Jesse Leitner Miquel Moe



Questions?



**U.S. SPACE PROGRAM MISSION ASSURANCE IMPROVEMENT WORKSHOP
THE BOEING COMPANY | EL SEGUNDO, CA | MAY 2–4, 2017**