Tailoring Mission Assurance Process To Individual Program Needs

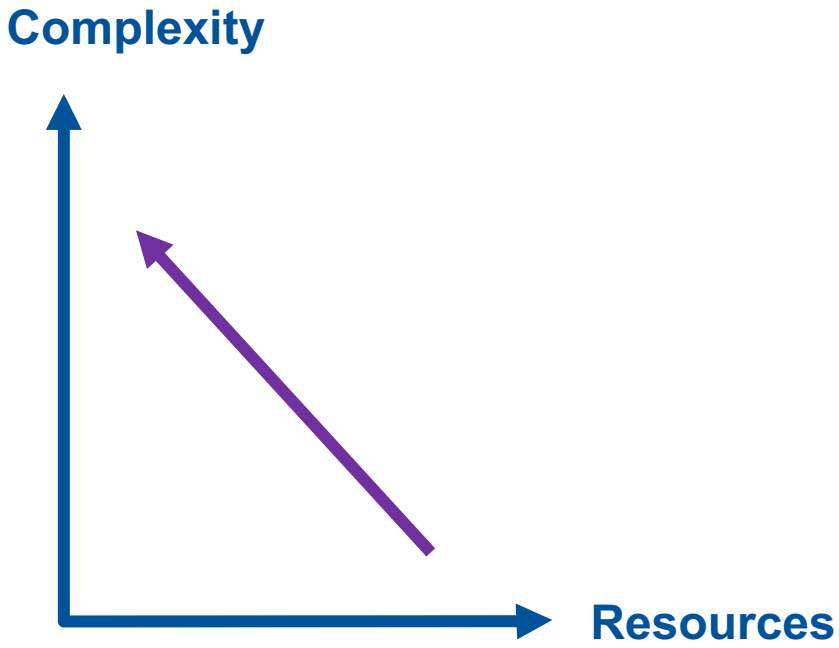
Daniel Marcus, Head, Mission Assurance Office, MIT Lincoln Laboratory

Adapting Mission Assurance Workshop

October 19th and 20th, 2022

Problem Statement

- Lincoln is a Federally Funded Research and Development Center, which does not compete with industry, and which focuses on proof of concept prototype demonstrations
- Complexity of new systems executed by Lincoln grows, while program budgets and schedules shrink
- Systems require ever more capability with ever smaller size, weight, and power (SWAP)
- Mission Assurance Office (MAO) must do more to enable mission success with the same or fewer resources
- To provide optimal support, decisions about Mission and Quality Assurance scope need to:
  - Focus on "Why"
  - Ensure all critical activities are completed, including meeting sponsor requirements
  - Account for what is necessary to achieve success, while also accounting for program risk posture



Overview

- Developed enhanced fully tailorable Mission Assurance (MA) process, and have used it to tailor scope of 4 new programs so far
- In addition to streamlining tailoring process, provides additional context and content:
  - Documents value proposition, decision factors, roles and responsibilities, timelines, and references for 140+ potential scope items
  - Provides tailoring starting point given specific mission type, mission level, environments, system complexity, etc.
  - Supports side-by-side comparison across programs
  - Working on enhanced resource estimation process
- In the future, may develop a more polished tool (vs. Excel) and leverage content to develop MA best practices and guidance document in support of Lincoln programs

Program Tailoring Process Example: 3-Year LEO Demo Space Mission, Full Satellites

- Review program specific details and requirements
- Select the following columns to see recommended starting point for tailoring:
  - Full Spacecraft
  - NASA/Aerospace TOR Class D Mission, Equivalent, or Lower
  - Demonstrations
  - Low Earth Orbit (LEO)
  - Complex Software or Firmware
- MAO performs first pass of tailoring based on program-specific needs
- Follow up with program team on any questions, update tailoring, and then review recommendations with program for concurrence
- Document in Mission Assurance Plan (MAP) and go through approval process
- Plan and execute scope

Image source: https://apod.nasa.gov/apod/image/2202/bluemarble_apollo17_3000.jpg

Excerpt of Tailoring Matrix For 3 Year LEO Mission With Multiple Spacecraft

Sub-Area / Discipline	Scope Element or Requirement	Scope or Requirement Details	Value Proposition and Decision Factors For Completing Scope- Lincoln Assessment	Relevant Documents, Standards, Approaches, Tools, and References	When to complete	Full Spacecraft	NASA/TOR Class D Mission, Equivalent, or Lower	LEO Orbit	Complex Software or Firmware	3 Year LEO Mission, Multiple Spacecraft
Reliability	Parts Stress/Derating Analysis	"Electrical and mechanical stress analyses are conducted to determine or verify design integrity against conditional extremes or design behavior under various loads to assure material properties can withstand stresses in the intended environments	The terms stress analysis and derating analysis are often used interchangeably. This is one of the most important and basic analyses, as it double checks that each part in the system can handle the stresses it will	NASA EEE-INST-002	Preliminary analysis by PDR, final version by CDR	Probably	Probably	Probably	Not correlated	Yes
Electrostatic Discharge protection	ESD precautions during build	General ESD mitigations for program Level 1 Areas should be performed during Level 1 Area commissioning. More program specific controls (custom fixturing, assembly stations, test setups,	Many electrical components are ESD sensitive. Electrostatic discharge can lead to immediate, or worse- latent, damage to systems. This can ultimately result in	MIT LL PP-09	Upon designating a Level 1 Area	Yes	Yes	Yes	Not correlated	Yes
Quality Assurance	Full system-build traceability records	This includes iBase, Unit Traveler Records, and program "as-run" procedures and work instructions, from serialized components "up through" printed circuit boards, subassemblies, and assemblies, including hardware, firmware, and software	End-to-end traceability provides confidence that we understand how all elements of a system were manufactured, as well as how the system was assembled, integrated, and tested. By ensuring that all aspects of an	MIT LL FAB-000 Fabrication Management of Large Programs and DD-000 Design and	Throughout the build process	Yes	Yes	Yes	Yes	Yes
Parts, Materials, and Processes	Limited Life Item (LLI) control	Assess parts and materials to ensure that no elements of the system will exceed their useful/rated life prior to the end of the mission. This includes ensuring that elements are installed within their use-by dates, ensuring that shelf life is tracked for all elements, and understanding limitations both	Use of parts and materials beyond their useful life can lead to issues during manufacturing, such as difficulty with soldering operations or ineffective structural bonds. It can also lead to early failure of the system.	MIT LL DD-005	Preliminary analysis by PDR, final version by CDR	Yes	Yes	Yes	Not correlated	Yes
Software MA	Software Requirements Management	Software, due to its flexibility and adaptability, is often subject to late requirements changes either because some complexity of the system is discovered late or because it's too late to change the hardware design. These late changes can be major schedule	Software, due to its flexibility and adaptability, is especially susceptible to late requirements changes. If the changes are not thoroughly analyzed prior to implementation they can easily become	PM-001	Throughout program lifecycle	If Relevant	If Relevant	If Relevant	Yes	Yes

Focus On What's Really Important For Program

- **Mission Assurance: Ensure design can enable successful mission**
  - **Do all critical engineering**
  - **Perform analysis and modeling to validate mission**
  - **Qualify design with "test like you fly" approach**
- **Quality Assurance: Ensure each unit is built correctly**
  - **End-to-end traceability of parts, materials, and integrated build to be confident it was built correctly**
  - **Protect hardware during AI&T (ESD, FOD, etc.)**
  - **Inspect and acceptance test individual units**
- **Beyond core elements that are needed to have confidence in mission success, match scope to agreed-to risk posture of the program**