Master's Forum of Project Managers Workshop

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A Program Manager's Life Made Easier Using Software Technology Assessment

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- The purpose of this briefing is to recommend the use of NASA Technology Assessment procedures for Software at the Program/Project level.

- The recommendations for NASA Technology Assessment procedures are based upon the work and information by James Bilbro at MSFC: james.w.bilbro@nasa.gov.

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- The Technology Assessment procedure results in a metric that determines the Technology Readiness Level (TRL) for technologies to be implemented for the system under development.

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Problem

- How to equate software technology risks to other system risks e.g., Hardware, Operations, Mission Design, and Science?

And

- How to perform project trade-offs i.e., money, schedule, staff, system design options?

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- Galileo Experience examples:
  - Spacecraft Memory requirements and margins (cost, schedule, s/c redesign)
  - GNC Control Laws – dual spin Spacecraft (prototyping, staff, cost, schedule)
  - Spacecraft Power subsystem algorithms (staff, simulation, cost, schedule)
  - Coding Algorithms for data and command transmission across spin bearing (analysis, prototyping,s/c redesing, buss bandwidth, memory)

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- **Solution**

- Perform Technology Assessment procedures for software.
- Define the TRL for software to be consistent with the TRL for hardware and other system elements

TRL Descriptions
Hardware & Software (William L. Nolte Re. 2)

TRL Definitions

Software TRLs

Level 1	Lowest level of technology readiness. Research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties.
Level 2	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
Level 3	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
Level 4	Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.
Level 5	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components.
Level 6	Representative model or prototype system, which is well beyond that of TRL5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high fidelity laboratory environment or in simulated operational environment.
Level 7	Prototype near or at planned operational system. Represents a major step up from TRL6, requiring demonstration of an actual system prototype in an operational environment, such as in aircraft, vehicle, or space. Examples include testing the prototype in a test bed aircraft.
Level	Technology proven to work in its final form and under expected conditions. In most cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets specifications.
Level 9	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions.

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- Approach:
  1. Use Software TRL definitions (Consistent with TRL for other system elements).
  2. Perform Technology Assessment at the very outset of system technologies predicted for the mission.
  3. As part of system design, trade-offs, and allocation of requirements to software, identify TRL for all software components.
  4. Document the TRL for each software component and integrate with TRL's of other system elements. Input low TRL elements into Risk Management Plan and procedure.

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5. Treat software components with TRL's:
   - Equal to or lower than 5 as Extreme High Risk & likely not doable
   - Equal to 6 as Very High Risk
   - Equal to 7 as High Risk
   - Equal to 8 as Medium Risk
   - Equal to 9 as Low Risk requiring astute and skilled management
6. Require Software Manager to update the Technology Assessment procedure on a continuous basis as you would for example margin management for power, weight, real estate.
7. Make design decision and resource trade-offs based on the integrated TRL's & Risk Management procedures to optimize system development and mission success.

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- References:
  - Jim Bilbro, MSFC Chief Technologist, james.w.bilbro@nasa.gov.
  - William L. Nolte, P.E., CQE, Sensors Directorate, Air force Research laboratory
  - Suzanne Garcia, Software Engineering Institute,smg@sei.cmu.edu-
  - Technology Assessment Workshop:

    "Process for Assessing Technology Maturity and Determining Requirements for Successful Infusion into Programs Workshop", September 16-18, 2003.