Mastering Technical Authority: Strategies for Effective Leadership in Complex Environments

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What is Technical Authority?

- Technical Authority is the authority, responsibility, and accountability to establish, monitor, and approve technical standards, tools, and processes in conformance to higher authority policy, requirements, architectures and standards.

  (SECNAVINST 5400.15D)

- Foundational element in the federal government's approach to managing complex technical systems and processes, ensuring that they are safe, reliable, and meet the necessary standards and requirements

Who exercises Technical Authority

- Naval and Maritime Industries/Organizations
  - United States Navy
- Aerospace
  - United States Air Force
  - NASA
  - FAA
- Law Enforcement
  - FBI Firearms & Ammunition Technology Division
- International
  - Int'l Atomic Energy Agency
  - World Meteorological Organization
  - Engineers Australia
  - European Whole-Vehicle Type Approval System

- Construction Industry
- Information Technology Industry
- Cybersecurity Industry
- Automotive Industry
- Pharmaceutical Industry
- Health Care Industry
- Petroleum Industry
- Maryland Cannabis Administration

How is Technical Authority used

- Technical Authority (or TA) brings an independent view (or a new set of eyes) to aid in providing insight and direction for:
  - Engineering and Design
  - Technology Integration
  - Assessing conformance
  - Instill engineering rigor
  - Provide checks and balances
  - Safeguards and Verification
  - Creating standards and recommended practices
- TA applies systems thinking through their experience, knowledge and insight to apply lessons gained from other programs/events
- TA provides the program manager and corporate leadership an independent assessment of the maturity, and risks, issues, and opportunities

Examples of Technical Authority in Action

- Engineering Technical Reviews
- City Planner Reviews (Residential and Commercial)
- Creating and evaluating new standards
- Product or Process certification
- Failure Review Boards/FMECA/FMEA
- Design Planning
- Requirements Analysis, Verification & Validation
- Providing expert testimony
- Systems Testing and Evaluation

Technical Authority spans the life cycle

Technical Authority across the Life Cycle

Business/Mission Needs Analysis (Domain TA)

Requirements Analysis (Reqmts TA)

System Architecture Design (Architecture TA)

System Design (SE, CM, T&E, Logistics, Interoperability TA)

System Development (System/Domain TA)

System Integration (System TAs)

System Verification and Validation (T&E TA)

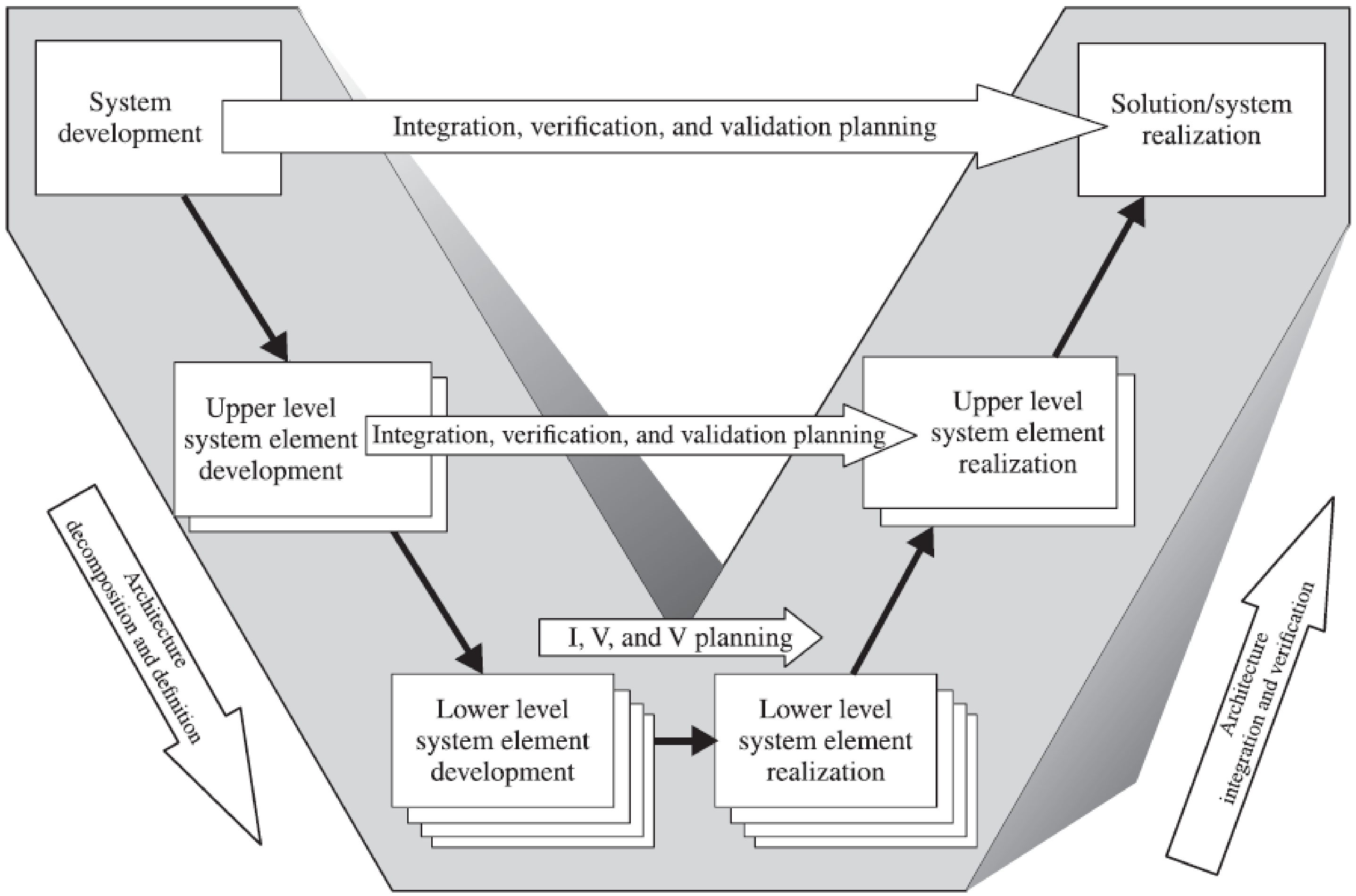

FIGURE 2.6 The SE Vee model. From Forsberg, et al. (2005) with permission from John Wiley & Sons. All other rights reserved.

System Deployment (Installation TA)

System Operations (MPT, HSI, and 508 TA)

System Sustainment (Logistics TA)

System Disposal (Environmental TA)

Challenges to Technical Authority

- The Program Manager has the final say (They control the $$$)
- Pressures due to schedule and cost
- We’ve always done it this way with no problems
- No prior history of failures (not including “near misses”)
- Unclear governance and oversight
- Requirements compliance (Can vary across states/countries)
- Changing technology
- Poor articulation of risk
- Business and Technical needs not aligned or not well understood

Establishing Technical Authority in your Organization

- You may need TA, You may not. If you do, some thoughts
  - Define their role and scope of authority, responsibilities, and decision processes
  - Find the right personnel with extensive expertise or understanding of the technical areas
  - Provide a reporting structure, preferably independent of the program manager
  - Identify or develop the technical standards to use
  - Create a plan for checks and balances (reviews, audits, validations)
  - Use them to foster continuous improvement (training, knowledge sharing)
  - Manage change effectively; avoid compromising the project
  - Ensure clear communications and effective collaboration

Using Technical Authority for Complex Projects

- A **complex system** has elements, the relationship between the states of which are weaved together so that they are not fully comprehended, leading to insufficient certainty between cause and effect.

(Complexity Primer for Systems Engineers, 2021, INCOSE)

- **TA provides diversity in the expertise, experience, knowledge, skills and abilities**

	Requirements Elicitation and Derivation	Trade Studies	Solution Architecture and Design	Development Process
Complexity in the Environment General	Use multiple methods for requirements elicitation. Elicit requirements from multiple perspectives and at multiple levels of aggregation. Emphasize capture of system objectives and desired outcomes rather than thousands of detailed requirements.	Emphasize robustness over local efficiency and performance.	Include both positive and negative feedback mechanisms to provide mechanisms to compensate for the effects of higher-than-linear positive feedback and runaway system behavior.	Employ soft systems methodologies to surface the nature of the problem space, its internal structure and information flows, and produce simple representations, for example 'rich pictures' to communicate these.
Intricate and Evolving/Self-Organizing Interactions with the Environment	Include requirements for the system to provide adaptive local control, rather than strong, deterministic control.	Trade end-to-end system performance and behavior against problem space complexity.Think hierarchy rather than flat networks.	Early implementation (or at least prototyping) of external interfaces.	Early deployment of system functionality with feedback to developers.
Environment Susceptible to "Black Swan" Events (Unlikely, Unpredictable, High-Consequence Events) and/or Recursive Complexity	Use power laws rather than Gaussian distributions to characterize phenomena in requirements and sell-off criteria. Focus requirements elicitation on resiliency, robustness and adaptiveness vice optimizing to particular assumptions.	Make resilience a key trade-space attribute and use trades to identify aspects of the problem space that will drive the system architecture.	Design for resilience to "beyond-design-envelope" events to provide robustness and timely recovery to a minimally functional state.	Resilience analysis. Enterprise development: study how enterprises or societies survive catastrophes.
Complexity in the Problem/Mission	Emphasize identification of constraints as well as requirements. Capture scenarios and mission threads in preference to large numbers of requirements.	Use scalability and agility as criteria in appropriate trade Studies.	Use solution elements which are adaptable and/or reconfigurable. Design to achieve scenarios rather than detailed requirements. Satisfice at the system level rather than satisfy detailed requirements.	Use Agile, evolutionary systems engineering processes instead of Waterfall systems engineering processes. Define multi- layer processes and their interface points.
Complexity in Stakeholder Relationships	Use multiple scales (or a Balanced Scorecard approach) instead of a single utility function to determine "goodness" or fitness for use.	Seek stakeholder buy-in to trade studies.	Use modeling and simulation to enable stakeholders to experience (rather than just be briefed about) interactions of solution elements and the environment.	Employing a multi-methodological approach, for example, soft systems methodologies plus systems engineering plus boundary critique, to identify stakeholders and achieve buy-in.

Table 3 Complexity Primer for Systems Engineers, 2021, INCOSE

Early Planning

- Use TA to perform Requirements Analysis and understand the challenge (or opportunity) as much as possible
- Bring in diversity of expertise (mission TA, platform TA, system(s) TA. Understand the planned life cycle and define the unknowns
- Collaborate with project manager to understand the parameters for cost, schedule and performance. Define the knowns
- Create use cases, scenarios, mission threads, and abstract models to gain understanding

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(Complexity Primer for Systems Engineers, 2021, INCOSE)

Design and Development

- Use Systems, Interface, Interoperability, Cyber, CM, HSI, Training and other TA to:

- Employ modeling and experimentation to ensure relevant effects of trades are explored at different levels of aggregation
- Conduct development activities always within context of the whole
- Perform prototyping and holistic testing to explore and check for emergent behavior
- Use SoSE methodologies to synchronize constituent systems

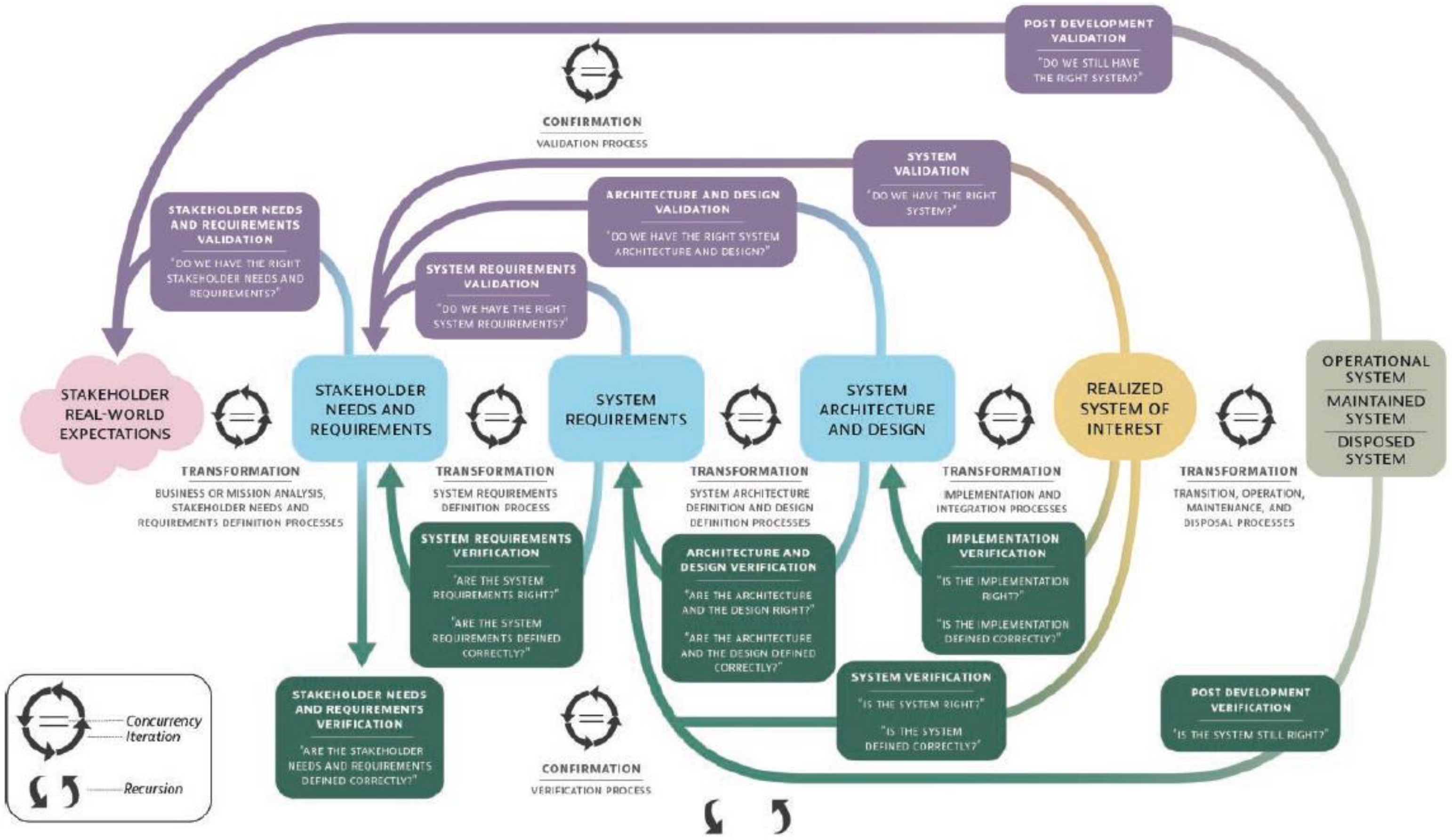

FIGURE 2.38 Technical Processes in context. INCOSE SEH original figure created by Roedler, Walden, and Wheatcraft derived from INCOSE NRM (2022). Usage per the INCOSE Notices page. All other rights reserved.

Systems Engineering Handbook V5, 2023, INCOSE)

Integration, Verification and Validation

- Use Systems, Interface, Interoperability, Cyber, T&E and other TA to:

- Conduct IV&V activities always within context of the whole
- Use prior M&S work to find potential emergent behavior to test (eliminate surprises and risk)
- Focus on the interfaces, minimize change there
- Think about a build, test, build approach with smaller, faster cycles
- Use SoSE methodologies to synchronize constituent systems

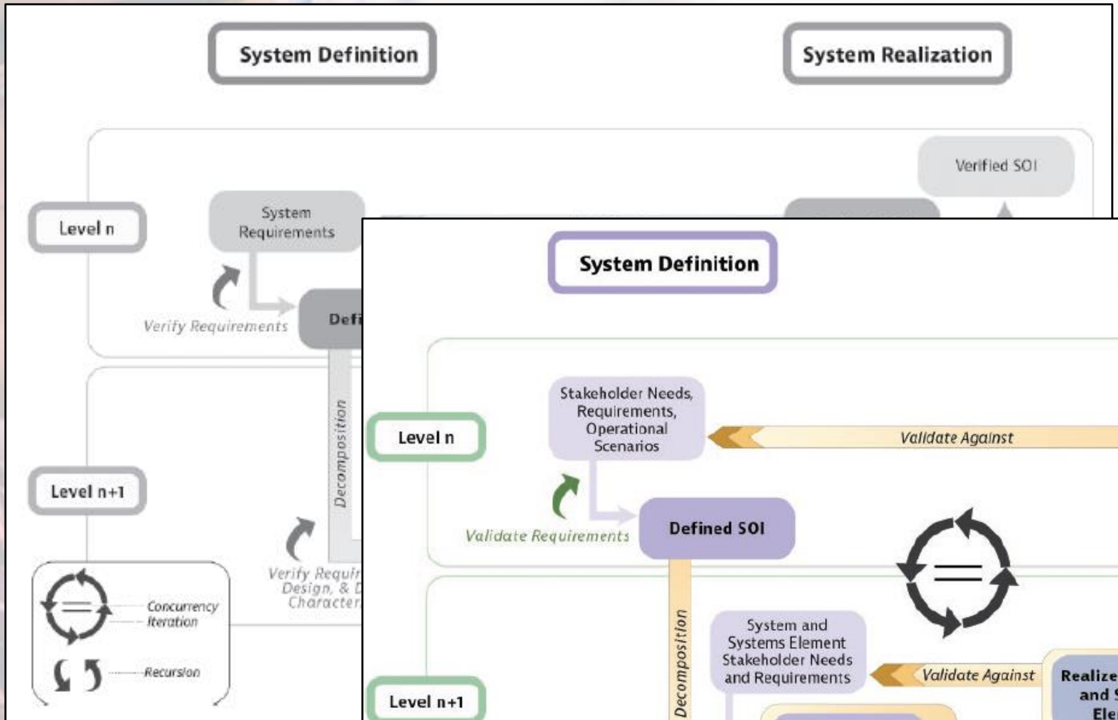

FIGURE 2.50 Verification per level. I
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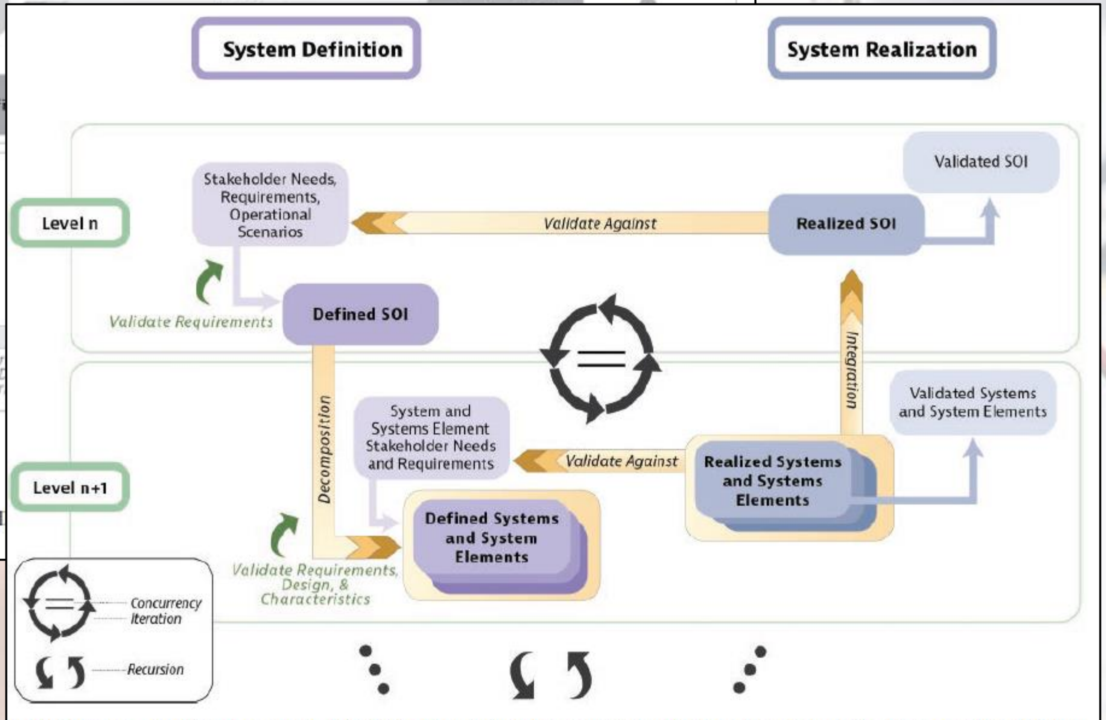

FIGURE 2.53 Validation per level. INCOSE SEH original figure created by Walden from Faisandier. Usage per the INCOSE Notices page. All other rights reserved.

(SEHB V5, 2023, INCOSE)

Deployment and Sustainment

- Utilize TA familiar with the deployment, operations and sustainment phases
- Use this to evaluate the deployment plans and proposed execution. Does it fit the agreed upon life cycle model, does it meet the users/stakeholders needs, how will it be sustained (replacement, upgrades?)
- Spare parts, repair parts, training, manpower, personnel, modernization/upgrades, support (local / remote)

	Requirements Elicitation and Derivation	Trade Studies	Solution Architecture and Design	Development Process
Complexity in System Deployment & Operation	Employ soft systems methodologies to surface the nature of the deployed solution, and its internal structure and information flows; produce simple representations, for example, 'rich pictures' to communicate these. Use problem definition methods from an evolutionary systems engineering or SoSE methodology.	Trade criteria need to value cost and ease of training and logistical support over acquisition cost. Model system evolution with genetic algorithms.	Use self-organizing and self-repairing elements when possible. Model the cost of change, the benefits, and the balance.	Employ soft systems methodologies to surface issues, engage stakeholders, identify approaches to improve the deployed system, and to achieve stakeholder buy-in to the solution. Use an evolutionary systems engineering or SoSE methodology. Identify utility and cost of using and modifying legacy systems.

(Complexity Primer for Systems Engineers, 2021, INCOSE)

End of Life / Disposal

- Start with the end in mind (Covey). What should be done with the system which it has reached end of life
  - Repurpose / Reuse
  - Donate
  - Recycle

- Environmental TA can assist to ensure any compliance requirements are known, understood and planned for
  - Think about Zero Footprint, Zero Emissions, creating a Circular Economy

Summary

Effective Technical Authority supports Systems Engineering to build the right system(s) the right way