

Improving the Technical Requirements Development Process for Weapon Systems

A Systems-Based Approach for Managers

LAUREN A. MAYER, WILLIAM SHELTON, CHRISTIAN JOHNSON, DANIEL ADDUCCHIO, RAZA KHAN, SUZANNE GENC, DANIELLE C. TARRAF, NAHOM M. BEYENE

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ISSUE

In preparing a request for proposals to design and produce a weapon system, the U.S. Department of the Air Force (DAF) develops a set of technical requirements—a set of statements or models defining what a system should do and how well it should do it—for the system's design so that the acquired weapon system provides the needed operational capability within budget and schedule constraints. However, oversights during technical requirements development in many U.S. Department of Defense (DoD) programs have resulted in cost or schedule overruns, unsuitable operational performance, or outright cancellation. RAND Project AIR FORCE was asked to develop an approach to help the DAF improve its technical requirements development process. This approach was to be informed by systems-based methods and tools, such as those used in systems engineering, and to include an exploration of the applicability and feasibility of one specific emerging hazard-analysis tool: systems-theoretic process analysis (STPA).



APPROACH

To inform development of our approach, we sought to answer three research questions:

- How does the DAF currently develop technical requirements and why?
- Can STPA be used in technical requirements development?
- What are best practices for developing technical requirements?

We used a variety of methods to answer these questions, including policy and literature reviews, discussions with DAF stakeholders and systems engineering and STPA subject-matter experts, and case studies of the T-7 and MH-139 programs. Insights from these methods were synthesized and filtered through the institutional roles, responsibilities, and constraints associated with the DAF's technical requirements development to inform our approach and develop associated recommendations.



CONCLUSIONS

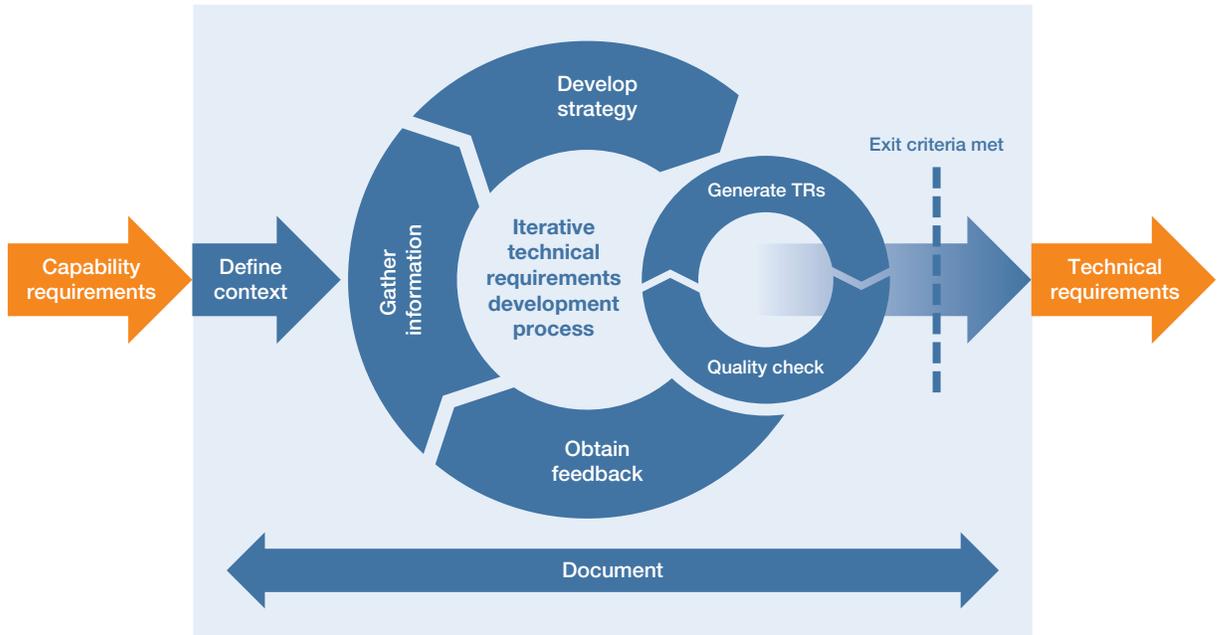
- Systems engineering activities in the DAF are constrained by the availability of expertise, manpower, training, and guidance. DAF policy and instructions further lack recommended roles and responsibilities for developing technical requirements.
- Possibly as a result, programs' development of technical requirements tends to
 - be ad hoc, often based on the previous experience of available personnel
 - rely heavily on technical requirements developed for similar programs, industry standards, market research, and subject-matter expert judgment instead of specific systems engineering methods
 - vary in stakeholder (e.g., operator, maintainer) engagement, with stakeholder roles being dependent on existing relationships and personalities
 - lack defined lines of authority between program offices and stakeholders, leading stakeholders to feel that their involvement in technical requirements development is constrained.
- STPA has the potential to support technical requirements development tasks, but there may not be enough evidence to determine its effectiveness. Other systems engineering tools have proven effectiveness and provide many of the same insights as STPA.
- As with other systems engineering tools, effectively implementing STPA for technical requirements development across DAF programs would require training, further strain personnel time, and entail a nontrivial amount of stakeholder coordination.



RECOMMENDATIONS

- Use the structured, iterative, and tailorable approach for technical requirements development (see figure):
 - Provide it to program managers as tailorable guidance to inform oversight and stakeholder engagement.
 - Update policy to define formal roles to implement it.
 - While implementing the approach may increase early acquisition costs and schedule, the DAF will likely benefit from significant cost and schedule reductions in later phases of acquisition.
- Increase the DAF's organic systems engineering expertise:
 - Work with Defense Acquisition University and the Air Force Institute of Technology to develop and implement training and education.
 - Create a standalone systems engineering field and track personnel who have completed this training, possibly through a specific acquisition workforce series identifier.

APPROACH TO TECHNICAL REQUIREMENTS DEVELOPMENT



NOTES: The approach aims to convert capability requirements (orange input arrow) to technical requirements (orange output arrow) suitable for inclusion in a request for proposals. It consists of seven elements, shown as blue arrows, with each approach element being comprised of a set of tasks, tools, and stakeholders. TRs = technical requirements.



PROJECT AIR FORCE

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