The Acquisition Process as a Vehicle for Enabling Knowledge Management in the Lifecycle of Complex Federal Systems

Position paper for the President's Information Technology Advisory Committee

by

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Introduction

This white paper explores how to increase the success and operation of critical, complex, national systems by effectively capturing knowledge management requirements within the federal acquisition process. Although we focus on aerospace flight systems, the principles outlined within may have a general applicability to other critical federal systems as well.

Fundamental design deficiencies in federal, mission-critical systems have contributed to recent, highly visible system failures, such as the V-22 Osprey and the Delta rocket family. These failures indicate that the current mechanisms for knowledge management and risk management are inadequate to meet the challenges imposed by the rising complexity of critical systems. Failures of aerospace system operations and vehicles may have been prevented or lessened through utilization of better knowledge management and information management techniques. Currently there appears to be no clear standard to ensure that the necessary data, information, and knowledge requirements are readily available for thoroughly assessing systems in a timely, cost-effective way.

The federal government has a number of complex, critical information systems. Nearly all government systems involve partnerships between government, industry, academia, and/or foreign bodies, resulting in the definition, design, development, testing, implementation, and operation of these systems being performed by multiple contracting companies, organizations, or agencies. Such a system may have further dependencies on individuals, groups, and other systems outside the control of those charged with building and maintaining the system, such as constituent subsystems being implemented by disparate groups of people working at geographically dispersed locations.

Issues in the Lifecycle of Complex Federal Systems

A greater, proactive, systemic understanding of the organizational and system engineering processes relevant to the lifecycle of national systems is critical. History has shown us that implementing a complex system without understanding the design requirements and assumptions will significantly increase the probability of sub-optimal operation or failure. Such an understanding requires clear and open communication between the customers, designers, and implementers. As there may be tens or hundreds of people involved in the lifecycle of a complex system, knowledge management is critical in facilitating, capturing, and archiving that communication.

The current approaches to creating complex systems often fail to take into consideration the impact of cultural, behavioral, and sociological issues, such as communication, coordination, and trust. Often, the main instrument that the federal government has to influence these processes is the documents created during the acquisition process. Included in these acquisition documents, knowledge management requirements can provide a comprehensive, standardized way of addressing system-specific attributes that will address the shortcomings within current, complex, critical, national system lifecycle processes.

The Role of Knowledge Management

To enable better decisions throughout the lifecycle and organization, knowledge, information, and data on a system needs to be well integrated and processed for continuous systemic risk management in a streamlined process. People at all phases of the lifecycle need to have access to knowledge (expertise), information, and data on any given government system for the goals of continuous risk management and assurance of system health.

The constituent parts of knowledge management revolve around people, process (system engineering), and technology. The most often asserted estimate is that 70% of the effort focuses on people and process. We can provide many technical solutions, but the problems involved in mitigating risk on complex systems will not be solved until we can work the issues of trust across all partners involved in a system and, of course, that means change in much of the process. Such changes might include a more system-specific knowledge representation, proactive maintenance of system expertise ensuring adequate supported and optimized design, and analysis and testing processes throughout the systems' lifecycle. Some of those specific issues are noted below.

- Systemic process issues involving trust and communication include
  - Interagency rivalries, intra-agency competition for available resources, mistrust between civil servants and contractors, competing federal contracting companies, internal competition between groups within a contracting company, and/or interpersonal issues between individuals within a group.
  - The "not invented here" syndrome related to agreements on methods and technologies enabling information leveraging for quality assessments and auditing. People are much more likely to agree on these methods or approaches within a specific, trusted community, than they are across communities or organizations.
- Systemic process issues involving standards and processes include
  - Lack of clearly defined information auditing requirements for national, system partnership agreements/acquisitions necessary for clear and thorough continuous, systemic risk assessments across a given complex system.

- Poorly understood proprietary and sensitive data and knowledge issues possibly due to contextual inhibitors within the contracting mechanisms and structures, such as the Contract Office Technical Representative (COTR) training and contractual agreements.

- Intellectual property rights issues for expertise and experience maintenance in the systems.

  - The standard government statement of work regarding rights to data and materials is potentially lacking an essential, clear contextual statement of knowledge. The government needs a systemic view of its *knowledge* (implicit and explicit expertise and experience) of a system and its development along with the data and information.
  - There is a perceived lack of time to publish and share knowledge when it is not part of an explicit process. As a result, when knowledge sharing is expected to happen outside of the normal statement of work or process, it does not occur with any regularity.
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- Export Control Regulations

Recommendations

Several solutions come to mind in addressing the problems noted above. The first set revolves around remedies to the acquisition process itself

- Education should be provided across the procurement process to the contractors, contracting officers (CO), contract officer's technical representatives (COTRs), and staff managing our systems' development on key knowledge management concepts such as the difference between data, information, and knowledge, how to capture knowledge, and how to share it

- Basic knowledge management aspects should be noted as deliverables and clearly defined in requirements, especially in the many types of agreements the government forms

- A standard set of agreements on knowledge management practices and use of applications to ensure better methods and approaches to doing systemic risk analysis would enable integration of newer, autonomous, probabilistic intelligent tools for identifying previously unknown risks and precursors within these systems

- Acquisitions' documents should include a comprehensive oversight and compliance plan

- Agreements should be reached for information auditing and collection requirements

In addition to the acquisition process, solutions to mitigating the risk on complex federal systems also focus on building consistent, streamlined information and knowledge management capabilities across the Government. To build on work in progress and inter-government working teams, some of the agency trust issues can be addressed by

- Establishing colloquia on information requirements for systemic quality and assurance of national systems

- Evaluating the current state of existing systems for streamlining communication and achieving better organizational and system interoperability

- Identifying cultural barriers for sharing information and forming short- and long-range plans to overcome them

- Designing an acquisitions standard surrounding a system (systemically binding) incorporating or surrounding knowledge management for national systems that can be agreed upon and that integrates well with current standards

- Getting support from the executive counsel and headquarters [isn't this NASA specific terminology?]

- Defining what the information and knowledge requirements are for continuous risk and safety assessments in support of systemic, legal, contractually advisory support on national systems

- Arranging for resources to complete the initial round of strategic efforts

Conclusion

For complex systems, proper knowledge management is critical to perform risk management. Most current knowledge management systems fail to recognize and deal with system-specific issues. Technological knowledge management solutions will most likely fail to perform as expected if they do not deal with cultural and behavioral issues such as trust, coordination, and error management. Since many governmental processes as currently evolved are inimical to effective system-specific knowledge management, a concerted effort to implement knowledge management methodologies capable of addressing coordination, trust, and human error issues may require buy-in not only from the individuals participating in a particular effort, but from their organizational management as well. Including knowledge management requirements in the acquisition process may be the most effective way for the government to effect the process and cultural changes necessary to properly design, implement, and operate critical national systems.

Appendix A- Questions regarding COTR process:

In most COTR training it is stated that the Contracting Officers, the COTRs, and technical monitors have the responsibility to survey all work done on government funded agreements, this is, of course where there is an advantage to collect the implicit and explicit knowledge.

> *Question: So, does this mean we have the right to survey the people/process and gain knowledge of our processes along with receiving system products and services in order to maintain 'knowledge'?*

Further questions:

a. *Is the issue management responsibility clearly defined and understood across government agency legal, procurements, and R&D processes?*

b. *When writing contracts, is there any training and standards to following insuring that contracts take into consideration the mission or vehicle systemic issues surrounding the projects being contracted?*

c. *Do all contracting officers and COTR's understand what can and cannot be elicited from contractors on data, information, and knowledge to do System Knowledge Management to insure a continuous risk management process? (Note: of course, there is also the limitations in resources to do a thorough job in knowledge elicitation and management in our acquisitions, R&D, and services processing).*

d. *Are there procedures for our COs and COTRs managing contracts and agreements, communicating with R&D and Services Mgmt to collect, manage and report knowledge?*

e. *Are there strategies being considered in integrating information in a systemic view to insure compliance and quality assurance throughout a government system along with architectural hardware and software issues?*

f. *Are there legal references in the contracts and laws that give clear enough understanding on the what the government's "Knowledge Rights" are vs. "Data Rights" to it's systems?*

To sum up these queries, it is acknowledged that there are many efforts going on within government to mitigate risks in government national systems; and there is significant published evidence, similarly stating that effective risk and knowledge management requires coordination and information sharing between the people/groups involved in the design, implementation, and operation of a complex system. Effective coordination

consists of much more than ensuring that all groups have the most recent version of the system design specification. Basic coordination issues include:

- Communication between groups and individuals
- Understanding of purpose of interconnects between work and knowledge performed by different groups
- Understanding of other groups' requirements, dependencies and assumptions when designing and implementing systems
- Understanding evolving mission, system and program risks more systemically