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Complex System Governance for Acquisition

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Panel 16. Improving Governance of Complex Systems Acquisition

Thursday, May 5, 2016	
11:15 a.m. – 12:45 p.m.	**Chair: Rear Admiral David Gale, USN,** Program Executive Officer, SHIPS ***Complex System Governance for Acquisition*** Joseph Bradley, President, Leading Change, LLC Polinpapilinho Katina, Postdoctoral Researcher, Old Dominion University Charles Keating, Professor, Old Dominion University ***Acquisition Program Teamwork and Performance Seen Anew: Exposing the Interplay of Architecture and Behaviors in Complex Defense Programs*** Eric Rebentisch, Research Associate, MIT Bryan Moser, Lecturer, MIT John Dickmann, Vice President, Sonalysts Inc. ***A Complex Systems Perspective of Risk Mitigation and Modeling in Development and Acquisition Programs*** Roshanak Rose Nilchiani, Associate Professor, Stevens Institute of Technology Antonio Pugliese, PhD Student, Stevens Institute of Technology

Complex System Governance for Acquisition

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Abstract

As acquisition processes have become more complex, they appear to no longer be governable by traditional approaches. Missed budgets, delayed deliveries, and expensive canceled systems appear to becoming more prevalent. Numerous investigations have been conducted attempting to elicit the factors that prevented success. Those systems that succeed in terms of usability, budget, and delivery schedule are the rarity and often become case studies themselves as we try to extract the characteristics that differentiate success from failure. A different viewpoint is to look at the acquisition system from the perspective of Complex Systems Governance (CSG). Recent developments in the field of CSG are poised to offer insights into the domain of complex system acquisition. CSG, an emerging field grounded in Management Cybernetics and System Theory, offers a set of nine essential and interrelated functions that enable effective governance—which includes acquisition.

In this paper, after an introduction of our perception of the problem space, we outline the nine essential meta functions and briefly describe the inter-relationships that form a coherent governance scaffold. An exposition of the corresponding CSG reference model is then profiled. We then examine how the meta functions can be applied to acquisition, using the CSG reference model as the framing for an effective governance system. Finally, we offer suggestions and contributions offered by a research thrust in CSG to examine acquisition in a live case setting with implications for the wider acquisition field.

Introduction

As acquisition processes have become more complex, they appear to no longer be governable by traditional approaches. Missed budgets, delayed deliveries, and expensive canceled systems appear to be becoming more prevalent. Numerous investigations have been conducted attempting to elicit the underlying factors that prevented success (Berteau, Levy, Ben-Ari, & Moore, 2011; Francis, 2008, 2009; Rascona, Barkakati, & Solis, 2008). Those systems that succeed in terms of usability, budget and delivery schedule are the rarity and often become case studies themselves as we try to extract the characteristics that differentiate success from failure (Boudreau, 2007; O'Rourke, 2014). Unfortunately, to date there is not a resolution to the problems that delineate acquisition of major systems. Rather than rehash prior approaches or viewpoints, complex system governance (CSG) is offered as an alternative perspective to look at the acquisition system. The hope is that this alternative perspective might provide new insights to an all too familiar problem domain. CSG is an emerging field grounded in Management Cybernetics and Systems Theory. CSG has posited nine meta functions required for effective governance, which will be briefly examined in the next section.

The problems facing practitioners dealing with modern complex systems appear to be intractable. These problems continue to proliferate into all aspects of human endeavor and the systems designed to orchestrate those endeavors. They are not the privilege, or curse, of any particular field or sector (energy, utilities, healthcare, transportation, commerce, defense, security, acquisition, services), as none are immune to the effects of this problem domain. Problems stemming from this domain do not have a precise cause–effect relationship that would make understanding and resolution easy or reducible to the precision demanded by mathematical applications. Arguably, complex systems and their associated problems have been in existence as long as man has been designing, acquiring, operating, and maintaining systems. However, the landscape for modern systems has changed appreciably into a much more "complex problem space." We have previously offered Figure 1 as a visual representation of this problem space (Keating, Katina, & Bradley, 2015) and noted how it (Figure 1) is marked by difficulties encountered across the holistic range of technical, organizational, managerial, human, social, information, political, and policy issues. The different aspects of this "new normal" complex problem space has been previously established (Jaradat & Keating, 2014; Keating, 2014; Keating & Katina, 2011; Naphade et al., 2011) as being characterized by conditions identified in Figure 1. To practitioners of complex systems, this listing is likely recognizable and represents nothing that is not or has not been faced on a routine basis with varying results.

Figure 1. The Complex System Problem Domain Characteristics

This listing in Figure 1 is not presented as exhaustive, but rather it illustrates two important points. First, the issues emanating from this domain continue without consistent resolution methods, thus leaving the door open for new thinking and approaches to address this domain. Second, the conditions identified are not likely to recede in the future, but are more likely representative of the “new normal” for the practitioners dealing with complex systems. As a summary of this domain, we suggest that it is marked by the following five characteristics:

- Uncertainty—incomplete knowledge casting doubt for decision/action consequences
- Ambiguity—lack of clarity in interpretation
- Emergence—unpredictable events and system behaviors
- Complexity—systems so intricate that complete understanding is not possible
- Interdependence—mutual influence among related elements

These conditions are not going away. To ignore them is shortsighted, leaving practitioners (owners, operators, performers, designers) of systems in a precarious position. These conditions are certainly not isolated for complex systems of any particular system or sector, but are rather endemic to complex systems in general. As an illustrative example, we can examine the defense acquisition sector to demonstrate the pervasive nature of the complex system problem domain. Figure 2 is a compilation of challenges facing the defense acquisition sector compiled from several sources (Fauser, 2006; Gansler & Lucyshyn, 2015; Kadish et al., 2006; Mills & Goldsmith, 2014). As evident from the circumstances marking the defense acquisition sector, we can certainly extrapolate those to the complex system problem domain we have established (Figure 1). In addition, we can also project the majority to a wider array of enterprises, sectors, and systems facing similar circumstances.

Effectiveness in dealing with these problem domains beckons for individuals and organizations capable of engaging in a different level of thinking, decision, action, and interpretation to produce alternative paths forward. As one response, CSG is proposed as an emerging field to enable practitioners to build capabilities to better diagnose and effectively respond to deeper level systemic issues that impede system performance (von Bertalanffy, 1950; Skyttner, 2005; Whitney et al., 2015). Thus, CSG seeks to identify and "design through" fundamental system issues such as those identified earlier (Figure 1). Unfortunately, these issues exist at deep tacit levels and appear only as symptomatic at the surface. Thus, efforts to address the problems at the surface level, although providing temporary "fixes," continually fail to resolve the deeper fundamental system issues. This deeper fundamental system level resolution is necessary to preclude recurrence of the symptomatic issue in another superficial form. For instance, a deep fundamental system issue may appear in one system acquisition program as a budget overrun. However, in another acquisition program, the same fundamental underlying system flaw may manifest itself as a major schedule problem. In both instances, addressing the issues at the surface may provide "temporary" relief but not make the necessary deep system "fix" necessary to preclude future occurrences, albeit in different forms. Exploration and insight at this deep system level is where CSG is targeted to operate with an emphasis on elements of *integration* (continuous maintenance of system integrity), *coordination* (providing for interactions between a system, its entities, and the environment), *communication* (accounting for flow and interpretation of information), and *control* (proving minimal constraints necessary to maintain system performance while maximizing entity autonomy).

Figure 2. Challenges Facing the Defense Acquisition Sector

The purpose of this paper is to examine the challenges and practice implications for CSG. To fulfill this purpose, CSG is developed against the backdrop of the complex system problem domain established above. The remainder of the paper is organized to

1. Provide a brief outline of the nine meta functions required for CSG, and the corresponding CSG reference model, focusing on the responsiveness of this field to enhance effectiveness in dealing with the problems of complex systems.
2. Examine some recent challenges in the defense acquisition field from the CSG perspective.
3. Explore the potential of the CSG field for improving defense acquisition capabilities to more effectively engage the complex system problem domain.

The Nine Meta Functions and the Reference Model for Complex System Governance

A quick appraisal of the situation for dealing with complex systems and their constituent problems appears as dismal as the science of economics. However, CSG is developing as a conceptually grounded field that can provide insights and a fruitful path forward. In this section, we develop a detailed explanation of CSG as “Design, execution, and evolution of the metasystem functions necessary to provide control, communication, coordination, and integration of a complex system” (Keating, 2014, p. 274). The conceptual foundations of CSG are primarily based in Systems Theory (von Bertalanffy, 1968; Skyttner, 2005; Whitney et al., 2015) and Management Cybernetics (Beer, 1972, 1979, 1985) and the field has been built upon their philosophical, theoretical, and methodological underpinnings. Systems Theory has been described as a set of axioms and propositions that define the function of any system (Whitney et al., 2015), while Management Cybernetics has been identified as the science of effective (system) organization (Beer, 1972). Following from the conceptual underpinnings of Systems Theory and Management Cybernetics, the following elements of the CSG definition are elaborated as an essential foundation:

- ***Design***—purposeful and deliberate arrangement of the governance system to achieve desirable performance and behavior.
- ***Execution***—performance of the system design within the unique system context, subject to emergent conditions stemming from interactions within the system and between the system and environment.
- ***Evolution***—the change of the governance system over time in response to internal and external shifts as well as revised trajectory.
- ***Metasystem***—the set of nine interrelated higher level functions that provide for governance of a complex system.
- ***Control***—invoking the minimal constraints necessary to ensure desirable levels of performance and maintenance of system trajectory, in the midst of internally or externally generated perturbations of the system.
- ***Communication***—the flow and processing of information within and external to the system, that provides for consistency in decisions, actions, and interpretations made with respect to the system.
- ***Coordination***—providing for interactions (relationships) between constituent entities within the system, and between the system and external entities, such that unnecessary instabilities are avoided.

- ***Integration***—continuous maintenance of system integrity. This requires a dynamic balance between autonomy of constituent entities and the interdependence of those entities to form a coherent whole. This interdependence produces the system identity (uniqueness) that exists beyond the identities of the individual constituents.
- ***Complex system***—a set of bounded interdependent entities forming a whole in pursuit of a common purpose to produce value beyond that which individual entities are capable (Keating et al., 2015, p. 4).

Foundational to the formulation of CSG is the unique role of the "metasystem." The metasystem construct relies on five essential elements: (1) the metasystem operates at a logical level beyond the elements that it must integrate, (2) the metasystem construct has been conceptually grounded in the foundations of Systems Theory and Management Cybernetics, (3) a metasystem is a set of interrelated functions—which only specify *what* must be achieved for continuing system viability (existence), not *how* those functions are to be achieved, (4) the metasystem functions must be performed if a system is to remain viable—this does not preclude the possibility that a system may be poorly performing, yet still continue to be viable (exist), and (5) a metasystem can be purposefully designed, executed, and maintained, or left to its own (self-organizing) development (Keating et al., 2015, p. 4).

The CSG paradigm can be stated succinctly as follows:

> From a systems theoretic conceptual foundation, a set of nine interrelated functions is enacted through mechanisms. These mechanisms invoke metasystem governance to produce the communication, control, coordination, and integration essential to ensure continued system viability. (Keating et al., 2015, p. 4)

As part of understanding the metasystem and its relationship to the environment, context, and system of interest (Figure 3), the following descriptions are provided to focus our discussion:

- ***Environment***—The aggregate of all surroundings and conditions within which a system operates. It influences and is influenced by a system.
- ***Context***—The circumstances, factors, patterns, conditions, or trends within which a system is embedded. The context acts to constrain or enable the system, including its development, execution, and evolution.
- ***System(s)***—The set of interrelated elements that are subject to immutable system laws and are governed through the metasystem functions to produce that which is of value and consumed external to the system.
- ***Metasystem***—The set of nine functions, which are invoked through mechanisms, to govern a system such that viability (existence) is maintained (Keating et al., 2015, p. 5).

In Keating et al. (2015), we discuss the details of the relationship of these four elements (environment, context, metasystem, system), most of which we omit here for brevity. However, we must note that the separation of the environment, context, system, and metasystem is for convenience and permits analysis. In reality, these four elements exist as an inseparable whole. The separation of these elements always requires judgments. Judgments of boundaries, relevant aspects of the environment, contextual definition, and articulation of the metasystem are always subject to "abstraction error." Therefore, CSG requires purposeful decisions with respect to abstraction of the context, system(s), and metasystem from the environment (Figure 4).

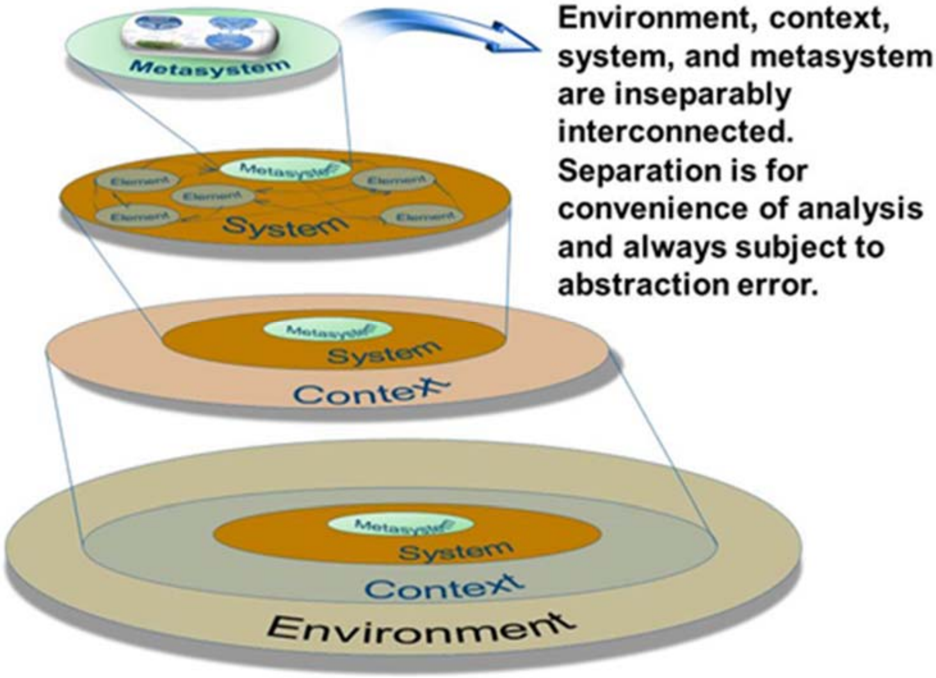

Figure 3. Interconnected Elements of Environment, Context, System, and Metasystem

As noted earlier, the fundamental foundation for CSG is found in Systems Theory and Management Cybernetics, including the philosophical, theoretical, and conceptual underpinnings that serve as a grounding for the field. The metasystem is a construct that defines the set of nine interrelated functions that act to provide governance for a complex system (Figure 4).

The nine metasystem functions included in the metasystem for CSG include the following:

1. ***Policy and Identity*: ** Metasystem Five (M5)—focused on overall steering and trajectory for the system. Maintains identity and defines the balance between current and future focus.
2. ***System Context*: ** Metasystem Five Star (M5*)—focused on the specific context within which the metasystem is embedded. Context is the set of circumstances, factors, conditions, patterns, or trends that enable or constrain execution of the system.
3. ***Strategic System Monitoring*: ** Metasystem Five Prime (M5′)—focused on oversight of the system performance indicators at a strategic level, identifying performance that exceeds or fails to meet established expectations.
4. ***System Development*: ** Metasystem Four (M4)—maintains the models of the current and future system, concentrating on the long range development of the system to ensure future viability.

5. ***Learning and Transformation*:** Metasystem Four Star (M4*)—focused on facilitation of learning based on correction of design errors in the metasystem functions and planning for transformation of the metasystem.
6. ***Environmental Scanning*:** Metasystem Four Prime (M4′)—designs, deploys, and monitors sensing of the environment for trends, patterns, or events with implications for both present and future system viability.
7. ***System Operations*:** Metasystem Three (M3)—focused on the day to day execution of the metasystem to ensure that the overall system maintains established performance levels.
8. ***Operational Performance*:** Metasystem Three Star (M3*)—monitors system performance to identify and assess aberrant conditions, exceeded thresholds, or anomalies.
9. ***Information and Communications*:** Metasystem Two (M2)—designs, establishes, and maintains the flow of information and consistent interpretation of exchanges (through communication channels) necessary to execute metasystem functions (Keating & Bradley, 2015).

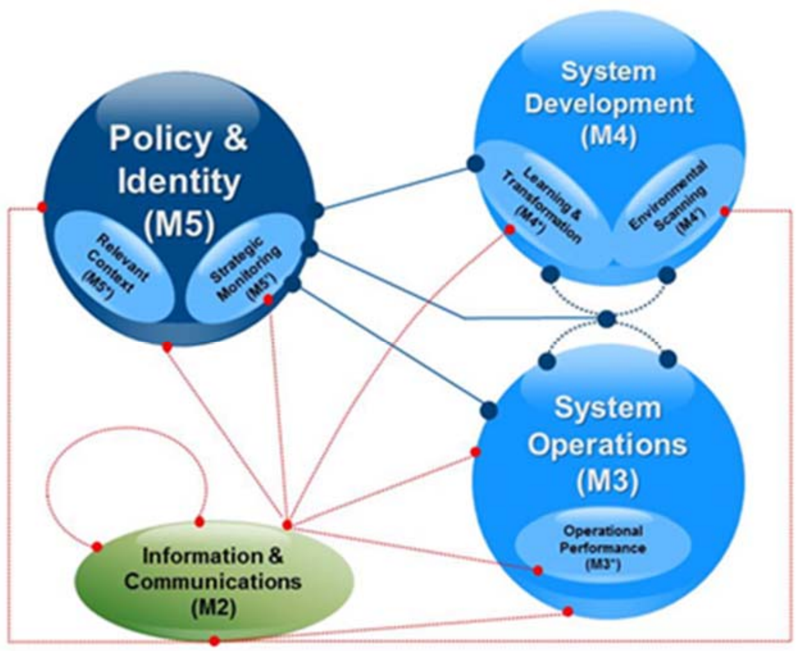

Figure 4. The Nine Interrelated Functions of the Metasystem in CSG

Implementing mechanisms is the final element that forms a CSG triad which also includes *Conceptual Foundations* and *Metasystem Functions*. Conceptual Foundations help to explain and understand *why* systems behave and perform as they do, drawing from the laws and principles of Systems Theory and Management Cybernetics. These laws and principles are immutable and cannot be negotiated away or ignored as if they do not exist. The consequences for violation of the laws are real, carry significant impacts, and are influential in the maintenance of system viability. Ignorance of systems laws will not lessen either their existence or the consequences stemming from their violation. Systems laws and principles operate much as physical principles (e.g., the laws of physics). The laws and principles are (1) omnipresent in explanation of system behavior/performance, (2) cannot be selectively applied or endorsed when convenient, (3) not subject to value judgments regarding applicability, and (4) the principles are value free—meaning that attribution of goodness/badness of the consequences for the performance or nonperformance of a system in accordance with the principles comes from interpretation of the consequence, not the law itself (7, pp. 6–7). Merely naming the nine interrelated metasystem functions with their brief descriptions provides little value, and in fact as a predecessor in the model development, a complete Complex System Reference Model was developed and is highlighted in Table 1. This table is focused on the four primary functions (M2-5) which is inclusive of the subfunctions designated by the prime (′) or star (*) designations (M5′, M5*, M4′, M5*, M3*; Keating & Bradley, 2015).

The Metasystem Functions identify *what* must be achieved to ensure continued system viability. ALL systems must perform these functions at a minimal level to maintain viability. However, viability is not a guarantee of performance excellence, and in fact, we often see performance issues as the system continues to exist. There are degrees of viability, the minimal of which is existence. We turn now to an examination of a selection of high-profile defense acquisitions that might be susceptible to improved outcomes with an advanced understanding of governance.

Table 1. Complex System Governance Reference Model
(Keating & Bradley, 2015)

Metasystem Function	Primary Role	Responsibilities	Implications for Acquisition
Metasystem Five (M5) – Policy and Identity	Primary function is to provide direction, oversight, accountability, and evolution of the System. Focus includes policy, mission, vision, strategic direction, performance, and accountability for the System such that: (1) the System maintains viability, (2) identity is preserved, and (3) the System is effectively projected both internally and externally.	▪ Establishes and maintains system identity in the face of changing environment and context ▪ Defines, clarifies and propagates the system vision, strategic direction, purpose, mission, and interpretation ▪ Active determination and balance for system focus between present and future ▪ Disseminates strategic plan and oversees execution ▪ Provides for capital resources necessary to support system ▪ Sets present and future problem space for focus of product, service, and content development and deployment ▪ Sets strategic dialog forums ▪ Preserves autonomy – integration balance in the system ▪ Marketing of system products, services, content, and value ▪ Public relations planning and execution ▪ External mentorship development (e.g., Board of Directors) ▪ Establishes system policy direction and maintains identity of the system -- executed through strategic direction ▪ Represents the system interests to external constituents ▪ Defines and integrates the expanded network for the system (strategic partnerships) ▪ Evolves scenarios for system transformation and implements strategic transformation direction	▪ Each acquired system has its unique identity that establishes its appropriateness for performing a particular mission, in a particular context, within a particular environment. ▪ Diffusion or ambiguity of system identity can degrade design trade-offs, capabilities, or compromise mission performance ▪ The *acquisition system* also has an identity (tacitly or explicitly known) that guides consistency in thinking, decision, action, and interpretation—ambiguity in this identity is an invitation to inconsistent performance ▪ Acquisition system identity is a reference point that is non-negotiable—if the identity is challenged, the system responds in kind to protect that identity ▪ A weak or muddled acquisition identity fosters inconsistent execution of the system and that which it produces ▪ The articulation, propagation, and maintenance of acquisition identity by active design is a leadership function that cannot be relegated ▪ If the acquisition system is continually disappointing expectations, core identity must be questioned ▪ Acquisition system identity must be compatible with the context, environment and supporting infrastructures (policy, implementing systems, strategies, etc.) ▪ The performance and evolution of the acquisition system must be guided by a strategy for metasystem development that exist beyond traditional system measures in time, depth, and nature

Metasystem Function	Primary Role	Responsibilities	Implications for Acquisition
Metasystem Four (M4) – System Development	Primary function is to provide for the analysis and interpretation of the implications and potential impacts of trends, patterns, and precipitating events in the environment. Develops future scenarios, design alternatives, and future focused planning to position the System for future viability.	▪ Analyzes and interprets environmental scanning results for shifts, their implications, and potential impacts on system evolution ▪ Guides development of the system strategic plan and system development map ▪ Informs the development of the strategic plan ▪ Guides future product, service, and content development ▪ Guides investment priorities ▪ Identifies future relationships critical to system development ▪ Identifies future development opportunities and targets that can be pursued in support of mission and vision of the System	▪ Just as individual systems are developed, so to must the system that provides for acquisition of those systems be developed *(acquisition system)*—this is the acquisition system that in essence is the *System that Acquires Systems* ▪ The governance challenge is acquisition system advancement by purposeful, holistic, and evolutionary development ▪ The acquisition system development should not be left to chance (self-organization), piecemeal (fragmented), limited (non-comprehensive), or sporadic (intermittent) development. ▪ Robust and purposefully designed scanning of the acquisition environment should be engaged across not only technical developments, but also organizational, managerial, human, social, political, policy, and information dimensions. The design, processing, and interpretation of this scanning is an acquisition leadership function. ▪ The acquisition system should evolve by comprehensive system design, based in "deep" system learning generated from detection and correction of system design as well as execution errors.

Metasystem Function	Primary Role	Responsibilities	Implications for Acquisition
Metasystem Three (M3) – System Operations	Primary function is to maintain operational performance control through the implementation of policy, resource allocation, and design for accountability.	▪ Oversight for products, services, value, and content delivery ▪ System planning & control for ongoing day to day operational effectiveness ▪ Develop near term system design response to evolving operational issues and monitor operational performance measures ▪ Operationally interprets and ensures implementation of the system policies and direction ▪ Interpretation and translation of implications of environmental shifts for operations (based on inputs from System Development) ▪ Informs the development of the strategic plan ▪ Determines resources, expectations, and performance measurement for operational performance ▪ Design for accountability and performance reporting for operations	▪ Value provided by the *acquisition system governance* is consumed by acquisition professionals, not the community receiving the ultimate products from that acquisition system. ▪ Care should be taken to measure acquisition system performance beyond the performance of individual systems being acquired—this is a different, higher level (metasystem governance) set of measures (e.g., identity fragmentation). ▪ The audit of governance functions should be both routine and ongoing. Routine should encompass continual evaluation of acquisition health. In contrast, for aberrations (e.g., GAO audit findings), the acquisition system design should be questioned to determine if the issue has "deeper" systemic implications across the governance functions. ▪ The acquisition system should focus on providing maximal autonomy to programs while preserving acquisition system (governance level) integration to meet performance expectations. Over constraint is wasteful of scarce resources and indicative of ineffective/inefficient system design.

Metasystem Function	Primary Role	Responsibilities	Implications for Acquisition
Metasystem Two (M2) – Information and Communications	Enables system stability by designing and implementing the architecture for information flow, coordination, transduction and communications within the metasystem and between the metasystem, the environment and the governed system.	▪ Designs and maintains the architecture of information flows and communications within the metasystem, between the metasystem and environment, and between the metasystem and the governed system ▪ Ensures efficiency by coordinating information accessibility within the system ▪ Identifies standard processes and procedures necessary to facilitate transduction and provide effective integration and coordination of the system ▪ Informs the development of the strategic plan ▪ Identifies and provides forums to identify and resolve emergent conflict and coordination issues within the system	▪ The acquisition system must have a compatible architecture for governance that provides the necessary coupling of entities through information exchange and communications. ▪ The design of information and communication of acquisition system governance operates and must be appreciated beyond the simple information "availability" and "exchange" models. ▪ The acquisition system design must support information flow and communication that is "actionable" for decision and interpretation consistency. ▪ Design, execution, maintenance, and evolution of information and communication for acquisition system governance should be purposeful. It is too important to be left to self-organization or chance development.

Defense Acquisition Challenges

We identified a number of high profile defense acquisitions, primarily through GAO reports and Berteau et al. (2011) that had open sourced analyses of the acquisition program. We used those open source reports to attempt to answer several questions: (1) Does the problem/failure appear to be governance related? (2) Does the language in the report indicate a similar meaning for governance as the CSG meaning? and (3) Is there any concrete indication that the tools and methods of CSG would have helped this program? The results of this analysis are portrayed in Table 2.

Table 2. Analysis of Troubled Programs Through the Lens of CSG

DoD program/ Report Source	Does the problem/failure appear to be governance related?	Does the language in the report indicate a similar meaning for governance as the Complex System Governance?	Is there any concrete indication that CSG would have helped this program?
Zumwalt Class Destroyers (DDG1000) GAO-08-904 [1,2]	Yes	No model/framework of governance – Milestone C suggested – won't help with alignment of perspectives or understanding decisions and actions (communication channel – dialog) among others	Yes – this initiative seems to lack clear vision/strategy. Report suggests that channels of communication are weak (p. 45 for example)
Ford Class Aircraft Carrier (CVN78) GAO-16-847 [26]	Yes	Yes, the report seems to identify many governance issues that can be mapped to metasystem functions within the CSG Reference Model	Yes – contextual assessment to evaluate acquisition culture. The ship is already built, though, so now the asset needs to be protected and maintained.
Total Asset Visibility (Air Force) GAO-08-866 [3, 27]	Yes	Yes, especially the "transformation plans" demonstrating initiative to evolve meta-systemic functioning	Yes – systems thinking likely not present in development, poor coordination of unsuccessful program
Major Automated Information Systems (MAIS) GAO-12-629 [25]	Yes	Yes, GAO seems to have an idea of the metasystem governance expected of a complex system, as well as realistic expectations regarding scope	Yes – some metasystem functions are clearly missing or inadequate, ex. poor coordination and communication (25, pp. 57, 58)
National Security Cutter (Coast Guard/Navy) GAO-16-148 [24]	Yes	Yes, report seems to capture design/execution elements necessary for control/communication/ coordination/integration (but possibly not sufficient?)	Yes – CSG embraces varying perspectives – the CG & Navy did not seem prepared to align perspectives and have poor communications

Results from this preliminary review of the "real world" cases of acquisition suggest that CSG can make a substantial contribution to the acquisition field. Through the lenses of CSG, the deficiencies identified in the programs can be understood at a different level. However, presently the attributions of deficiencies in the CSG of the acquisition programs is little more than an academic exercise in hindsight. We suggest that the true realization of value in the application of CSG to the acquisition field can come from four primary contributions. First, CSG can offer a different set of insights concerning application of the "systems view" to the acquisition field. The inculcation of this systems view can serve to inform a different level of thinking, support a more enlightened decision space, drive different courses of action, and invoke different interpretations. Second, CSG offers a rigorous formulation of the structure and execution of a system (e.g., acquisition program). This structure and its execution ultimately determine the level of performance achieved from a system. Unfortunately, in most instances, the design, execution, and evolution of the nine

CSG metasystem functions are performed on an ad hoc basis. The explicit consideration of the metasystem functions can provide a more "holistic" and rigorous approach to design, analysis, operation, maintenance, and evolution of a governing system (e.g., acquisition system and programs). Third, using the strong systems theoretic basis of CSG can allow a different and deeper level of analysis of acquisition system and program design. This can identify an entirely different view of the surface manifestations of poor performance (e.g., missing cost, schedule, performance expectations). Instead, more fundamental systems based pathologies (i.e., aberrations from healthy system conditions) can be identified and explored from an entirely different (holistic) systems paradigm provided by CSG as presented in this paper. Fourth, CSG can enhance acquisition practitioner capabilities to more effectively perform essential governance functions. All acquisition programs perform governance functions, even if they are not explicitly acknowledged. By accounting for the CSG functions in design and execution of acquisition programs, practitioners can enhance their capabilities to more effectively engage the increasingly complex environments and programs they must direct.

We now shift our attention to the future directions for the inclusion and development of CSG the acquisition field.

Considerations for Future Exploration

Thus far we have presented the case for the potential of CSG contributions for the acquisition field. In this section, we examine specific developmental directions for further inculcation of CSG into the acquisition field. There has been significant literature that has developed the foundations of CSG as an emerging field (Keating, 2014; Keating & Bradley, 2015). However, CSG has not been disseminated or projected to the acquisition field or community of practitioners. CSG has the potential to significantly improve capabilities for practitioners (owners, operators, performers, designers) in the acquisition field. We suggest that the utility of CSG for acquisition can proceed along three interrelated streams of development, including science, technologies, and application (Figure 5).

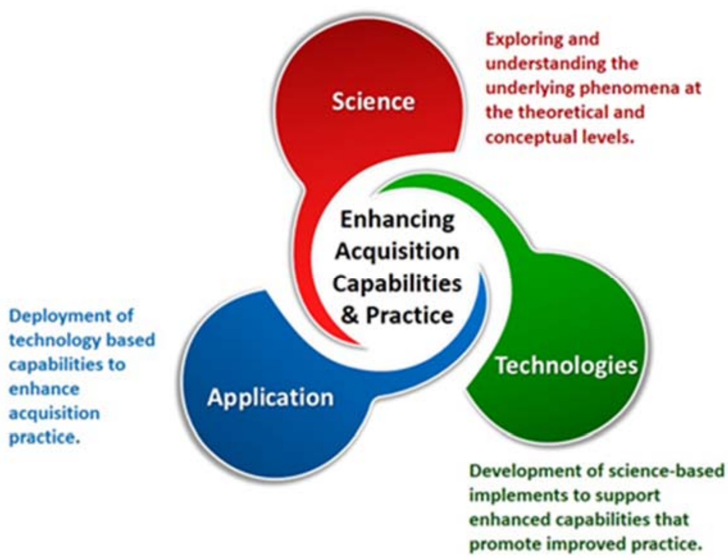

Figure 5. Three Interrelated Streams of Development for CSG in Acquisition

For purposes of this discussion, we take *science* broadly as the search for knowledge to develop testable theory and laws related to a field (e.g., acquisition). The tenets of good science include disciplined inquiry that can withstand the scrutiny of a particular field. The results of science must be theories and laws that can be tested to determine their continued power to provide confirmation or be refuted. For acquisition, this suggests that discovery of new tenets of "acquisition science" may be found at the intersection with the CSG field's foundations in Systems Theory. It would be easy to dismiss development of the science thrust for acquisition as nonessential or a frivolous waste of scarce resources. However, technologies and applications developed without grounding in the underlying science miss an important stable base. While technologies and applications can change rapidly, the underlying theoretical/scientific basis for a field provides long term stability. The importance of this stable science based foundation for the acquisition field cannot be overstated. This is particularly the case given the increasingly turbulent conditions faced by acquisition professionals and programs.

Technology engages science to develop innovations that solve problems and increase the capabilities of practitioners to more effectively function. Thus, technology becomes a bridge between science and application. Finally, *applications* involve putting science-based technologies into action to achieve human purposes (e.g., system acquisition). Ultimately, the applications by practitioners provide utility for science-based technologies. We believe that acquisition research must be engaged and integrated across each of the three levels (science, technologies, applications) if it is to provide sustainable improvement for the acquisition field. The interrelated advancement across these three developmental thrusts for acquisition improvement will (1) accelerate development of each of the other thrusts, (2) provide a grounding to better inform each of the thrust areas such that different directions and insights might be possible, and (3) draw the worlds of science and practice closer to provide a more balanced development of CSG for the acquisition field.

The pursuit of CSG development for acquisition must appreciate the interrelationship and development of science, technology, and application in concert. To look at these three aspects of the development of a field as independent and mutually exclusive of one another is false and somewhat naive. The acquisition field faces a major challenge to pursue parallel integrated paths of development for the science, technology, and application of CSG for acquisition. The easy, and more traditional, research approach is to separate the development of underlying science from corresponding technologies and eventual applications. However, there is much to be gained by permitting the triad to constrain as well as enable one another. The research path that emerges through the integration of science, technology, and application may be very different than had joint development not been considered. It is certainly arguable that the acquisition field currently pursues research that engages a close correlation between science, research, and application domains. However, there is much to gain by pursuit of CSG for acquisition development that explicitly couples science, technology, and applications by design from an integrated systems perspective (Figure 6).

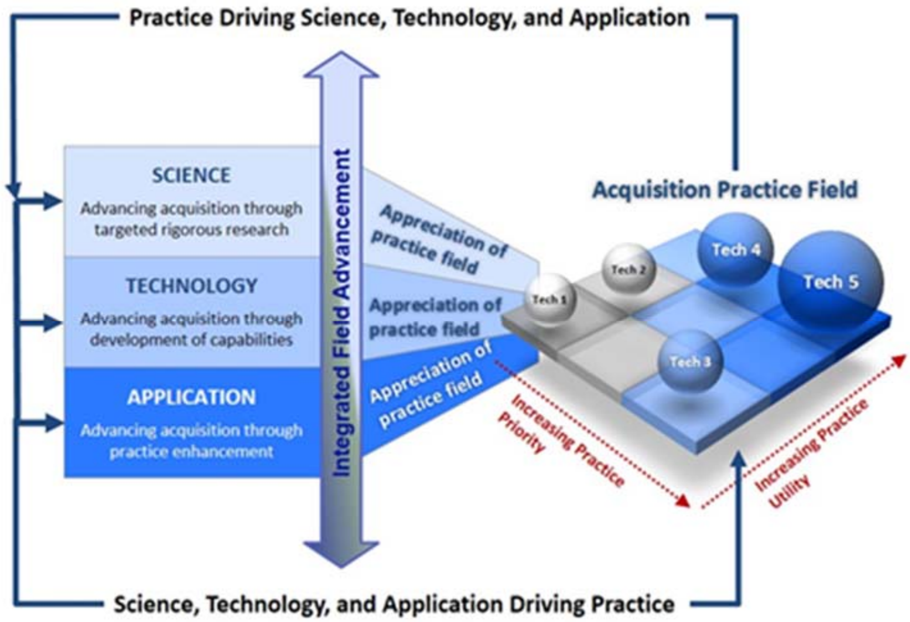

Figure 6. Integrated Development of Science, Technology, and Application for Enhanced Acquisition

The acquisition community is in a position to advance the field by inclusion of CSG in a way that will (1) steer the research agenda for the science and derivative technology developments related to Acquisition System Governance, (2) influence practitioner capabilities through development of science-based technologies to support acquisition governance practices, and (3) provide leadership to pioneer integration of the CSG emerging field to enhance acquisition capabilities and practice.

The major opportunities and impacts of engaging CSG for acquisition are summarized in the following three points:

1. Prod*uce Research Driven Acquisition Governance Technologies to Enhance Practitioner Capabilities and Effectiveness*—Ultimately, Acquisition Governance research can have a substantial impact on the performance of this vital function for government acquisition enterprises. Technologies to leverage scarce resources, provide decision and policy support, and establish effective oversight are hallmarks of effective governance. While emphasis on acquisition reforms targeted to issues of cost, quality, and schedule are necessary, that emphasis alone is not sufficient to provide "holistic" development of acquisition. We argue that it is also a "necessary" condition to emphasize the development of enhanced governance capabilities to truly advance the acquisition field.
2. *Enhance the Capabilities of Acquisition Practitioners*—The acquisition system itself should not be the sole focus of more advanced acquisition governance development. The practitioner and program levels should also be a focus for development. It is shortsighted to develop new governance technologies if the implementing practitioners do not have the compatible "systems thinking" mindset to deploy them consistent with their underlying systems essence. In

effect, governance development should also target enhancing the capacity of practitioners and programs to think more systemically.

3. *Research that Advances Acquisition System Governance*—This emphasis can generate the theory, methods, and deeper understanding of the phenomena associated with acquisition for Government Enterprises. The integration of CSG into the acquisition landscape brings a new perspective, corresponding language, and systems theoretic grounding to acquisition. Unfortunately, the current emphasis too often engages research that directs acquisition to development of systems and technologies that are predominantly outwardly focused—systems, technologies, and products that are acquired through the acquisition system for consumption external to the acquisition system that provided them. This is an essential role for acquisition. However, there is also a corresponding necessity to engage development of systems, capabilities, and technologies that are *inwardly focused* on achieving enhanced effectiveness for the acquisition system, community, and practitioners. We call this emphasis a self-reflexive effort to do "acquisition of acquisition" systems, capabilities, and technologies. In essence, CSG for Acquisition Governance is targeted to realization of this shortcoming in acquisition development. This can be achieved by producing science-based technologies to enhance acquisition practice for consumption by the professionals responsible for the effective design, operation, maintenance, and evolution of the acquisition system.

CSG for acquisition is not offered or pursued as a universal remedy for issues that plague acquisition programs and challenge practitioners. However, we are confident that it will permit practitioners to more effectively deal with the challenges of governance they face on a daily basis in acquisition. CSG integration to acquisition is not intended to replace, relegate, or subjugate the role of the acquisition practitioner. Analysis, interpretation, decision, and action have always been, and will always remain, the purview of acquisition management professionals. What CSG offers to the acquisition field is enhanced capabilities for acquisition professionals responsible for governance of acquisition systems and programs. CSG research seeks to support acquisition practitioners by development and testing of science based technologies and applications that amplify their effectiveness.

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