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# A Systems Theory Based Examination of Failure in Acquisition System Reform

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## Abstract

The defense acquisition system has been the source of intense scrutiny and calls for reform for over four decades. This research is to examine the contributions of Systems Theory to enhance prospects related to acquisition reform. Systems Theory offers a set of principles, laws, and concepts that explain the behavior of complex systems. Although the acquisition system and constituent programs have been critiqued and examined from multiple perspectives, they have never been the subject of exploration from Systems Theory. Recent advances in Systems Theory have identified 83 different potential system pathologies that can result in degraded system performance or outright failure. System pathologies have been previously defined (Keating & Katina, 2012) as "a circumstance, condition, factor, or pattern that acts to limit system performance, or lessen system viability, such that the likelihood of a system achieving performance expectations is reduced." Following a brief introduction to Systems Theory, this paper reports on efforts to (1) briefly examine the current state of the defense acquisition system and programs, focused on successes, failures, major reform themes, and critical challenges for moving forward; (2) mapping of systems pathologies to provide a different "Systems Theory" based perspective of acquisition system reform as well as acquisition system development; and (3) suggest implications for acquisition system development based on contributions from Systems Theory. The paper concludes with future research directions for Systems Theory contributions to the acquisition field and reform efforts.

## Introduction

The defense acquisition system has remained under continual scrutiny since its inception. Failures in acquisition have been as numerous as are the attempts to explain those disappointments (Berteau, Levy, Ben-Ari, & Moore, 2011; Francis, 2008, 2009; Rascona, Barkakati, & Solis, 2008). Unfortunately, problems in acquisition continue to exist, and arguably are increasing in frequency and severity. Arguably, the defense acquisition system falls short on the traditional essential attributes that are used to delineate a "system." These attributes, following decades of systems literature (Kramer & de Smit, 1977; Beer, 1978; Sykttner, 1996; Clemson, 1984; von Bertalanffy, 1968) include minimal characteristics of *boundary* (specifying what is included and excluded from the system), *environment* (all that exist external to the system boundary), *input* (matter, energy, resources, information crossing the boundary), *transformation* (processing of inputs to produce something of value), *outputs* (products of value consumed external to the system), and *feedback* (support for regulatory adjustment to make corrections necessary to maintain stability). The Defense Acquisition Management System has been referred to by the DoD 5000 as both a "framework" and an "event-based process." Processes and events, while they can be aspects of a system, fall short in the most fundamental characteristics for classification as a system.

Our point is not to criticize defense acquisition, or to challenge different formulations of defense acquisition as a "system." However, simply calling something a "system" does not make it a system, except in the very loose interpretations of the term. In fact, the mischaracterization may preclude discoveries and insights that might accrue from the more formal appreciation of, and accountability for, making attributions. Instead, our objective is to suggest that a more rigorous formulation and classification as a "system" may yield new insights into familiar unresolved acquisition system reform issues.

In previous work (Keating et al., 2017) related to acquisition system difficulties, there have been several "systemic" inconsistencies identified, coupled with the suggestion that a reformulation of issues from a stronger Systems Theory base might deepen understanding.

Among these “systemic formulations” were included (1) *Sprawling Complexity*—exponentially increasing complexity that exceeds the present capacity to sufficiently absorb to limit negative impacts, (2) *Process and Event Centric Orientation*—emphasis on the critical processes and milestones as the central focus for execution and development, (3) *Complication as a Response Strategy*—increasing the regulation and proliferation of controls to address increasing system complexity, (4) *Output versus Outcome Emphasis*—focus on the output based cost, schedule, and technical performance aspects of systems as primary versus the outcome based problem/need fulfillment aspects of systems, and (5) *Achievement of Control Through Excess Regulation*—emphasizing control of complexity by additional regulation by ad hoc and fragmented additions versus purposeful “systemic” design for control. While Systems Theory is not being offered as a panacea to this situation, nevertheless it does offer an alternative viewpoint from which the dialog might be shifted.

Systems Theory is a somewhat polarizing term, without a substantially agreed-upon definition. In fact, following the work of Adams et al. (2014), Table 1 depicts several definitions for Systems Theory.

**Table 1. Definitions for Systems Theory**

| Definition | Source |
|---|---|
| The formal correspondence of general principles, irrespective of the kinds of relations or forces between the components, lead to the conception of a “General Systems Theory” as a new scientific doctrine, concerned with the principles which apply to systems in general. | Von Bertalanffy (1950) |
| General systems theory is the skeleton of science in the sense that it aims to provide a framework or structure of systems on which to hang flesh and blood of particular disciplines and particular subject matters in an orderly and coherent corpus of knowledge. | Boulding (1956) |
| A new way of looking at the world in which individual phenomena are viewed as interrelated rather than isolated, and complexity has become a subject of interest. | Klir (1972) |
| General Systems Theory and the Systems Approach grapple with the issue of “simplicity” and “complexity” by which the relationships among systems and subsystems are decided. The problems of “optimization” and “suboptimization” are central to explaining the fruitless efforts of systems designers who reach for the “summum bonum” while settling for a “second best.” | van Gigch (1974) |
| Systems theory is a unified group of specific propositions which are brought together to aid in understanding systems, thereby invoking improved explanatory power and interpretation. It is precisely this group of propositions that enables thinking and action with respect to systems. | Adams et al. (2014); Whitney et al. (2015) |

Interestingly, the extension of Systems Theory into the domain of system acquisition is noticeably absent in the literature. While not totally unexpected, it is somewhat surprising that a field so heavily steeped in the acquisition of complex systems has somehow not routinely incorporated the most fundamental aspects of Systems Theory into the field. Given the scarcity of Systems Theory in acquisition, we suggest that there are three major contributions that Systems Theory can make related to a new and novel perspective of acquisition reform (Figure 1). The incorporation of Systems Theory might provide new insights and contributions into the past “failures,” “present” challenges, and “future” trajectory for acquisition reform.

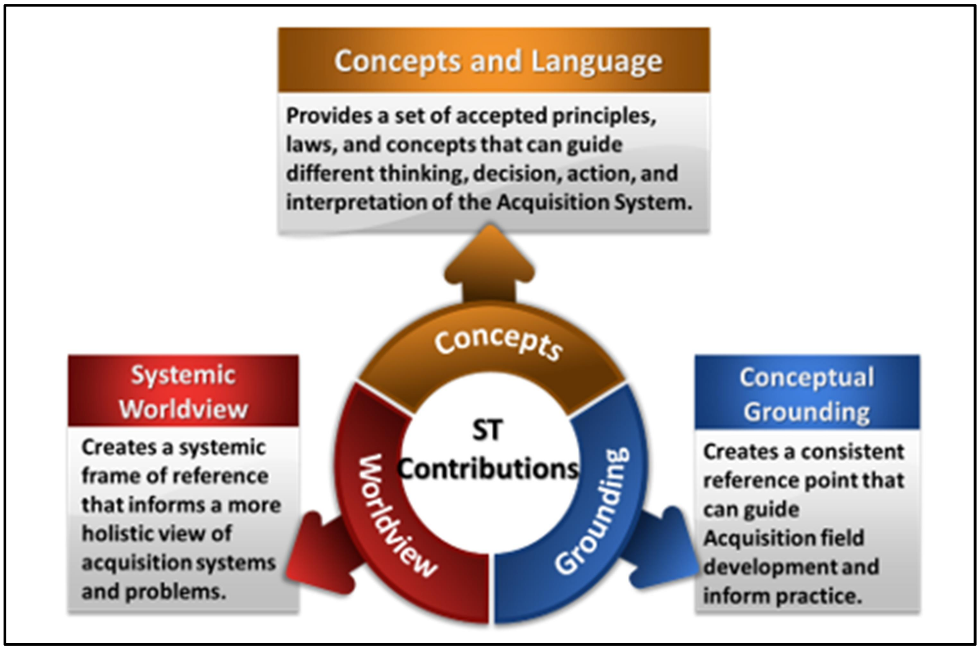


**Figure 1. Contributions of Systems Theory for Acquisition**

1. ***Concepts and language*** of Systems Theory can provide a basis to drive different thinking, decision, action, and interpretation related to understanding and explaining acquisition system difficulties. We think through language, and if we are to engage in a different orientation for potential breakthrough in acquisition reform, Systems Theory provides a conceptual foundation that has been largely absent from acquisition system development.
2. ***Conceptual grounding*** provided by Systems Theory offers acquisition system development and practice a theoretical grounding that appears to be absent in the field. The strong theoretical basis of Systems Theory can offer a rigorous theoretical grounding for the acquisition field and provide the basis for a stable and sustainable foundation. This can provide the acquisition field with a consistent reference point against which system development and reform can be anchored.
3. ***Systemic worldview*** provided by Systems Theory is consistent with the complex domain facing the acquisition system and practitioners. The systemic worldview is consistent with the complexity, ambiguity, contextually bound, and holistic nature of acquisition. This worldview can support thinking, decision, action, and interpretation that may provide potential new and novel insights to "move the equation" for acquisition reform.

This paper is focused on providing an alternative paradigm, Systems Theory, for viewing failure in acquisition system reform. This does not diminish the work, efforts, or results achieved by the individuals and entities engaged in trying to improve the acquisition system. On the contrary, our intention is to invite a dialog to further explore and understand the contributions that an alternative paradigm (Systems Theory) might provide to move the acquisition reform dialog in new and fruitful directions. To achieve our purpose, the remainder of the paper is organized around four primary objectives. First, we provide an overview of the state of acquisition reform, focused on highlighting several failure modes that delineate the system. In the section following, we elaborate a Systems Theory perspective through the introduction of pathologies (aberrations from healthy system functioning) as violations of underlying system propositions (concepts, laws, principles). After that, in the section titled Systems Theory Implications for Acquisition System Reform, we suggest implications of pathologies in relationship to acquisition system reform. The final section concludes the paper with implications for further research and development of Systems Theory as an alternative and insightful paradigm to better understand, and potentially shift the trajectory, related to failures in defense acquisition system reform.

## State of Defense Acquisition System Reform

The state of the acquisition system is generally not considered to be strong. However, like many other topics in government, that assessment is not an entirely fair or straightforward answer to an extremely complicated question. The importance of the acquisition of weapon systems and other materials and supplies to equip the nation's armed forces cannot be overstated. If the Armed forces did not have the tools they need to fight, their existence would be threatened and so too would the existence of the nation itself. However, this acquisition is a function of government and not a function of industry, and therefore subject to the rules and regulations governing government. In his last report on the performance of the acquisition system, Under Secretary Kendall (2016) suggested that there were only four major steps to insuring success in acquisition. "(1) set reasonable requirements, (2) put professionals in charge, (3) give them the resources that they need, and (4) provide strong incentives for success." Kendall does, however, go on to say that the current system is much more complicated than this and, in many cases, does not allow basic good management to be the only factor in the development of systems.

These following sections focus on review of the current state of the acquisition system and provide some of the history of how the system was developed and the contracts that make the system operate in the ways that it does.

### *The Acquisition System*

The acquisition system, as defined by the federal government, consists of many different parts and is not exactly the same in all parts of the government. The most complex version of the federal acquisition system is the Department of Defense (DoD) acquisition system. Since complexity is critical to issues with the acquisition system, we will concentrate on the defense acquisition system.

The defense acquisition system is actually three different systems that are linked together. These systems are (1) the acquisition system, which creates the systems and delivers them to the warfighter, (2) the requirements system (JSIDS), which generates the requirements from which the acquisition systems develops products, and (3) the Planning, Programing, Budgeting, and Execution (PPBE) process, which is the way the Department of Defense (DoD) asks for and gets the money it needs from Congress.

So, in reality there are three very complex processes that make up the DoD acquisition process. One of the most well-known attempts to document of complexity of the acquisition system is captured in the wall chart illustration of the DoD acquisition system (Figure 2), which is basically a flow chart of all three systems put in a single place. It does look complicated because the process is complicated. The processes level of complexity comes from several major sources. The first driver of complexity of the systems is the complexity of the programs (e.g., a Navy aircraft carrier is considered the most complex system ever designed). The second driver of complexity is the need to integrate defense systems into a very complex existing system with many interphases and relationships already in place. The next driver of complexity is the very harsh environment that defense systems must operate in; this drives complex and lengthy testing protocols. Also, complexity is driven do to all of the government rules and regulations that must be followed by the participants in the acquisition processes. Additionally, complexity is driven from the fact that many different stockholders, including many for profit companies, are trying to influence the processes in their favor. Finally, complexity is driven from a last major factor adding complexity to the system—the buildup of rules, processes, and reviews built into the system from each new leader and from generation after generation of Congress.

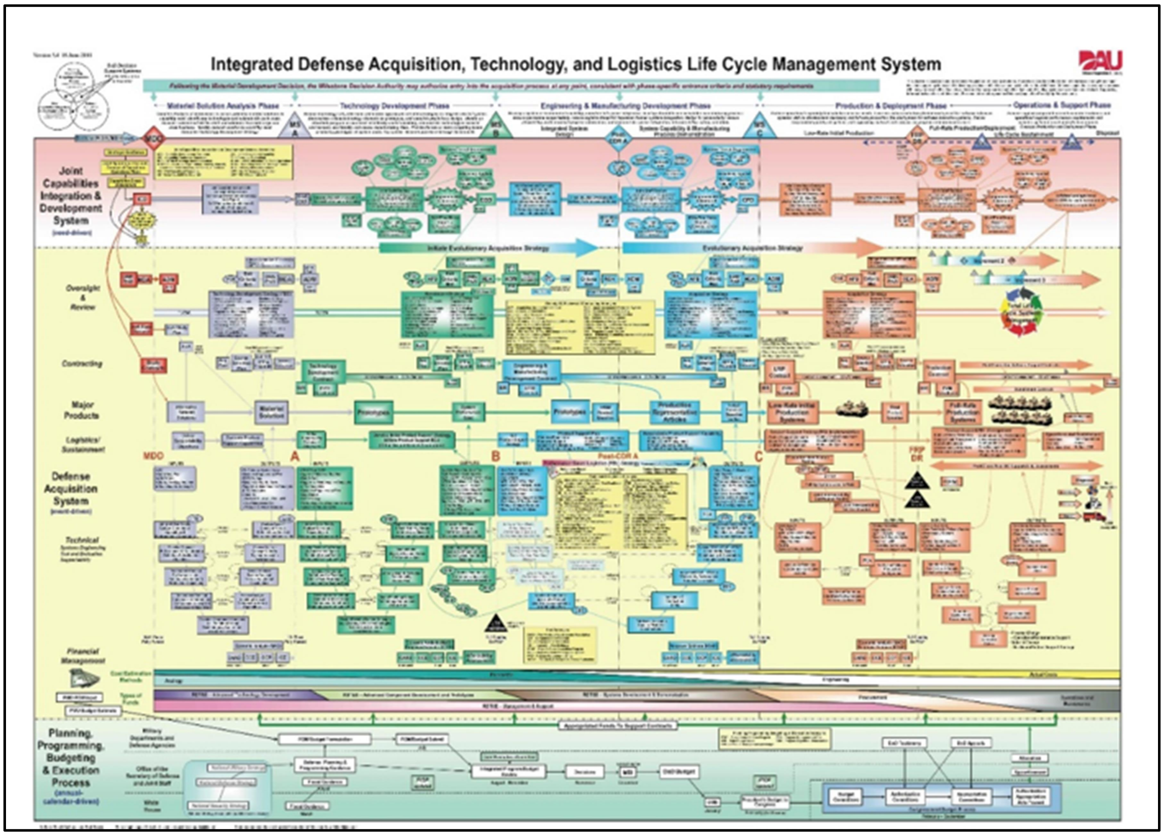


**Figure 2. The Department of Defense Acquisition Chart (Wall Chart)**

***Success and Failure in the Acquisition System and Programs***

Overall the defense acquisition system and the programs and products (plans, ships, weapons, etc.) that it produces can be evaluated as both a great success (delivering a wide range of very capable, very lethal systems) and also great failure (many programs overrunning cost and schedule, some to the point of cancellation). There have been many studies into the failures of the acquisition system. Some of the best documented failures include the following:

1. ***The Future Combat System (FCS)***—First introduced in 1999 by Army Chief of Staff Eric Shinseki, FCS was supposed to be a family of networked, manned, and unmanned vehicles and aircraft for the 21st century battlefield. With the Warfighter Information Network–Tactical (WIN-T) intended to support the FCS, it was supposed to be a wholesale re-envisioning of the ground force. However, the terror attacks of Sept. 11, 2001, short-circuited a 15-year operational pause that the military was hoping for to implement the

program. Spiral development and shifting requirements by the Army also resulted in costs ballooning by 25%. Finally, after $19,000,000,000 already spent and the program in the System Design and Demonstration phase, Secretary Gates cancelled the program in 2009.

2. ***The RAH66 Comanche***—22 years, $6,900,000,000 spent and zero helicopters. Originally conceived at the height of the Cold War, it was supposed to become the next generation of armed reconnaissance air support for the Army, replacing the Huey, Cobra, and Kiowa helicopters in the process. A textbook case in technology being superseded by current events, the Comanche also faced serious concerns over its ability to simply get off the ground when fully loaded. The program was cancelled in 2004 with two prototypes now on display.

**Figure 3. RAH66 Comanche Helicopter**

3. ***The XM2001 Crusader***—Intended to be the Army's next-generation mobile gun system, the Crusader (see Figure 4) was conceived in the early 1990s as a powerful new self-propelled howitzer (SPH). While it was designed to be lighter and faster than the existing M109A6 Paladin SPH, it was too similar to the existing, upgraded inventory. A system designed for a Cold War army, it was not widely supported by the Army Staff as it no longer aligned with the new operational concept. Ironically, many of the Crusader technologies were incorporated in the FCS family of XM1203 Non-Line of Sight (NLOS) cannons, which were subsequently cancelled as well.

**Figure 4. XM2001 Crusader Mobile Gun System**

4. ***CG(X)***—Known as the Next-Generation Cruiser in the early 1990s, it was part of the Navy's Surface Combatant for the 21st century program (see Figure 5). However, budget cuts resulted in the program being split up in 2001 with the destroyer variant being renamed the DD(X) and then the Zumwalt-class of destroyers. While the DD(X) is a case study in and of itself, the CG(X) actually looked like it might increase its allocation of ships before being abruptly cancelled in 2010. Deemed too similar in capability to the existing, upgraded Arleigh Burke-class of destroyers, the ship was never built, but not before spending more than $200,000,000 in development costs.

**Figure 5. CG(X) Next Generation Cruiser**

Equally, there are many success stories to be told in defense acquisition, including the following:

1. ***MC-12W Aircraft***—The U.S. Air Force needed more Intelligence, Surveillance, and Reconnaissance capability and so launched the Project Liberty program. The result was the low-cost MC-12W aircraft, which flew its first combat mission in June 2009, just eight months after receiving funds. It has since flown thousands of successful missions in Afghanistan and Iraq.
2. ***Harvest Hawk***—The U.S. Marine Corps needed a boost in close air support capabilities. In October 2010, just 18 months after announcing the program, the Harvest Hawk was in the fight. This inexpensive, reversible mod to a KC-130 not only puts steel on difficult targets, but also gets eyes on previously unseen locales.
3. ***Virginia-Class Submarine***—The U.S. Navy began the Virginia-class submarine program after terminating the unaffordable Seawolf program (see Figure 6). The USS *New Hampshire*, first of the Block II Virginias, came in eight months early and $54 million under budget, and that's on top of the $300 million cost savings which were already achieved on the Block II design.

**Figure 6. Virginia-Class Submarine**

### *Themes of Acquisition System Reform*

oday's defense acquisition system is a product of decades of reform initiatives, legislation, reports, and government commissions. Major reform efforts began in earnest in the 1960s with Secretary of Defense Robert McNamara. His main reform efforts centralized control within the Office of the Secretary of Defense (OSD) and created the Planning, Programming, and Budgeting System for resource allocation. Throughout the latter half of the 20th century, each administration left its own mark on defense acquisition, focusing primarily on the acquisition process itself, as well as DoD management. However, many of the reforms recycled various schemes to shift decision-making authority from the services to the OSD, realign oversight and accountability responsibilities, and alter the process (adding and removing milestones, phases, and so forth). Despite these initiatives, cost and schedule growth continue.

The Pentagon has wrestled with reforming defense acquisition procedures for over 40 years and, during that period, over 120 defense acquisition reform actions and policies have been implemented. Of these, the 1986 Congress of the Goldwater-Nichols Defense Reorganization Bill has been one of the most wide-ranging and had the largest impact. This landmark legislation was intended to add both significant discipline and accountability to the defense acquisition process and focus the management and oversight of defense research development test and evaluation, which now consumes over $600 billion annually and continues to grow.

One of the major actions in the legislation was the establishment of the position of under secretary of defense for acquisition, or USD(A), to vest in one person the overall oversight responsibility of the defense research development test and evaluation process of the numerous systems in various stages of development and fielding. The hope was that this position would enable the defense secretary to have a single line of command, one office responsible for overseeing and streamlining the activities of the hundreds of large Acquisition Category I defense programs, such as ships and missile defense, all the way down to the smaller Acquisition Category IV programs, like small arms and body armor. But development times and costs went up, not down. A few years later, recognizing that injecting research and development breakthroughs was vital to retaining weapon superiority, the job was expanded to under secretary of defense for acquisition and technology, or USD(A&T), to assure that this cross-pollination was taking place efficiently. Again, development timelines and costs both increased The latest reorganization effort (splitting the function of the under secretary for acquisition, technology, and logistics into two), mandated by the FY17 NDAA (National Defense Authorization Act) will undo one of the major changes made by the Goldwater-Nichols Act of 1986, which codified the acquisition chain of command and was based largely on the recommendations of the 1985 Packard Commission. On the positive side, the creation of the new under secretary for research and engineering comes at a time when the DoD is working to regain its technological advantage, notably through its pursuit of a third offset strategy to renew and perhaps advance the competitive advantage of the United States and its military allies. This change should increase the emphasis on these efforts. On the negative side, this new organization may introduce an element of confusion and competition into the decision-making process by not having a single end-to-end process owner. Although acquisition reform continues, no reform processes or approaches have yet to overcome the challenges of complexities of the defense acquisition system.

### *Critical Issues and Challenges for Acquisition System Reform*

Many issues and challenges remain for the acquisition system and for acquisition reform efforts. The next generation of acquisition reform will need to address many of the same issues as earlier reform efforts. However, given the many failures in parts acquisition reform, the answers and approaches need to be very different to meet the needs of an ever-more-quickly-changing world. The first priority of the next generation of acquisition reform will continue to be the need for speed. Whether the acquisition is a software development that takes two years and needs to take three months, or a new airplane that takes 15 years and needs to take four years to develop, we must find ways to make the acquisition system faster. The next major area that cannot be avoided is the need to somehow address the requirements process, to make it faster, more flexible, and more responsive to changes in technology and the future needs of the warfighters.

In order to make a faster and more flexible acquisition system work, we also need to find ways of delegating authority and accountability that empower key individuals to do their best work and deliver products in ways that will continue to be significant successes. Lastly, reform efforts will also need to address major congressional actions required to change many of the legal roadblocks that create problems in the defense acquisition system, including but not limited to, funding management and added levels of review and oversight.

In the following section, a path forward is forged through articulation of deep systemic issues (pathologies) affecting acquisition systems. While this is not posed as "the answer" to acquisition system woes, Systems Theory does offer a substantial departure from other attempts at modification of an unwieldy system.

## Systems Theory Pathologies Perspective for Acquisition System Reform

For our present purposes, the nature of system pathologies in complex systems can be captured in the following critical points and their suggested relevance to acquisition practitioners and system development:

1. ***All systems are subject to the laws of systems***—Just as there are laws governing the nature of matter and energy (e.g., physics law of gravity), so too are our systems subject to laws (principles, laws, concepts defining the behavior, and performance of complex systems). These system laws are always there, always on, non-negotiable, non-biased, and explain system performance.
2. ***Violations of systems laws carry consequences***—Irrespective of noble intentions, ignorance, or willful disregard, violation of system laws carries real consequences for system performance. In the best case, violations degrade performance. In the worst case, violations can escalate to cause catastrophic consequences or even eventual system collapse.
3. ***Violations of systems laws generate associated pathologies***—Pathologies are circumstances, conditions, factors, or patterns that act to limit system performance, or lessen system viability, such that the likelihood of a system achieving performance expectations is reduced. When system performance fails to meet expectations, violations of systems laws are always in question.

In the examination of failures in the acquisition system, programs, and projects, violations of Systems Theory (manifest as system pathologies) should be considered as potential sources contributing to failures and dysfunctions. Following the systems pathology research (Katina, 2015a, 2015b, 2016a, 2016b, 2017; Katina & Keating, 2014, 2016) based in violations of systems propositions, the following summary table (Table 2) is provided. Three notes are necessary to guide interpretation of the table. First, we have referred to the principles, laws, and concepts simply under the banner of "propositions," following the nomenclature of Adams et al. (2014) so as not to overburden the presentation with the finer distinction between principle, law, and concept. In the end, they all inform our understanding and explanation of systems behavior/performance and their violation jeopardizes system performance. Second, we have presented the set of pathologies from a pragmatic perspective, attempting to remain free from a barrage of scholastic verbiage. While some depth will naturally be sacrificed in this delivery, our intent is to make the principles more approachable to meet our present objectives. A more thorough and "scholarly" deep accounting of the principles can be found in other composite works (Adams et al., 2014; Clemson, 1984; Hammond, 2002; Katina, 2015b, 2016b, 2017; Katina & Keating, 2016; Lespier et al., 2015; McDermott & Alejandro, 2017; Skyttner, 2005; Troncale, 1977;

Warfield, 1999; Whitney et al., 2015). Third, the principles are intended to provoke consideration related to the design, execution, and development of systems (e.g., acquisition). The role of the propositions is analogous to the use of "illities" (e.g., reliability, usability, affordability) in their system design role of informing design considerations, performance tradeoffs, and guiding development. Similarly, the systems propositions serve to inform complex system design, explain sources of performance variation, and support more enlightened inquiry to potentially drive system development from a different perspective.

Table 2 presents a set of Systems Theory derived propositions, a concise statement of their violation producing system errors, and speculation of applicability for Acquisition System Reform (ASR) and the Acquisition System (Acq Sys). The ASR and Acq Sys implications are speculative and anecdotal at best. However, lacking more rigorous explication, they broadly suggest that inclusion of Systems Theory (propositions) in Acquisition System Reform and Acquisition System development might better inform future acquisition system design, execution, development, and reform.

**Table 2. Summary of Systems Theory Propositions (Principles, Laws, Concepts)**

| System Proposition | Concise Statement of Proposition Producing Errors (Pathologies) | Acquisition System (Acq Sys) Reform (ASR) Implication |
|---|---|---|
| *Complementarity* | A situation in which an entity ignores other perspectives/models that are not entirely compatible with the established-predominate perspectives of elements such as missions, goals and objectives. An entity in this case mistakenly assumes that there is only one "right" perspective. | ASR can benefit by inclusion of multiple "new" perspectives provided by Systems Theory. |
| *Diminishing returns* | Mistakenly assuming that continually increasing resources (e.g., number of staff) will have a corresponding increase in the productivity or performance of the system as a whole | Expecting more of the same approaches to ASR to be fruitful can be shortsighted. |
| *Requisite hierarchy* | There is insufficient regulatory capacity (levels of organization) to provide sufficient control of a system necessary to match that required by the environment. | Fragmented ASR system structure impacts efficient regulatory capacity. |
| *Requisite knowledge* | Sufficient knowledge is either not available, accessible, or actionable to provide sufficient regulatory capacity necessary to sustain consistency in system thinking, decision, action, and interpretation in response to environmental turbulence and internal system flux. | ASR is hindered by the knowledge system that appears somewhat incongruent to needs. |
| *Requisite parsimony* | System failure due to exceeding human capacity to simultaneously focus on multiple complex tasks. This number is limited to seven plus or minus two. | Acquisition System and workforce are stretched beyond capacity to respond. |
| *Requisite saliency* | System productivity is reduced due to having undifferentiated importance of system priorities—resulting in inconsistencies in priorities, decisions, actions, and interpretations. | Criticality in priorities for ASR do not appear to be congruent across entities. |
| *Requisite variety* | Regulatory capacity of the system fails to match that required to provide stability and sustain consistent performance in the midst of environmental turbulence and internal flux. | ASR environment complexity far exceeds regulatory response capacity. |
| *Adaptation* | Inability of internal structures of a system to change at a pace necessary to match that required in response to external disturbances to preserve system performance | ASR must address a system outpaced by the rate of external change. |
| *Autonomy* | Excessive limitations or lack of balance concerning the degree of freedom and independence of decision, action, and interpretation for constituents in a system | Increasing centralization of Acq Sys control/regulation diminishing local autonomy. |
| *Balancing system* | Inappropriate system balance in *Design* (ranging from self- | Acq Sys appears to be |

| System Proposition | Concise Statement of Proposition Producing Errors (Pathologies) | Acquisition System (Acq Sys) Reform (ASR) Implication |
| --- | --- | --- |
| *tensions* | organizing to purposeful), *Change* (ranging from stable to unstable) and *Control* (ranging from autonomy to integration) | fragmented, unstable, and overly complex (regulated). |
| *Basis of stability* | Failure to provide sufficient resources or energy to move a system past a threshold to a new stable state, resulting in an inevitable return to the former stable state (maintain status quo) | ASR has not generated sufficient movement to significantly shift status quo. |
| *Buffering* | Lack of sufficient surplus resources, to provide for system stability beyond immediate needs, when confronted with unexpected increases in demand (threatening continued stability) | Exceeding cost, schedule, and performance targets questions sufficient buffer. |
| *Circular causality* | System failures due to nonlinearities that cannot be reduced to simplistic cause effect relationships, requiring consideration of multiple, and perhaps ill understood, causal relationships | ASR response appears to be piecemeal fixes largely self-organized and ill understood. |
| *Consequent production* | A system is only capable of producing what it produces, nothing more and nothing less—this does not necessarily match what was designed, intended, or desired. | Limited ASR focus on underlying system producing undesirable behavior. |
| *Cybernetic stability* | A system has an insufficient number of external connections necessary to provide stability and ease of adaptation to changing circumstances. | Ability of Acq Sys to adapt to volatile change appears inadequate. |
| *Darkness in a situation* | Knowledge/understanding of a system is always incomplete, fallible, and emergent over time with increasing experience gained through operation of a system. | ASR has been attempted with apparent limited and fallible system knowledge. |
| *Dialectism* | Inappropriate inquiry balance for detection and correction of error in a system between first order (staying within design) or second order (adjusting system design) learning emphasis | ASR modifications seem to skew to the first order versus second order inquiry and learning. |
| *Emergence* | Failure to compensate in system design or execution for occurrence of behaviors or performance in a system that could not be predicted in terms of timing, nature, or impact | Emergence in acquisition does not appear compatible with Acq Sys design. |
| *Environmental-modification* | Limitation in integrated design, strategies, and actions to deliberately and proactively attempt to influence the environment | Acq System appears to be reactive to env turbulence. |
| *Equifinality* | Failure to recognize that from different initial starting points, the same end state can be attained through different pathways and means—not just a singular path/design to achieve desirable states | Detail Acq event-process mapping appears to be rigid in the pathway to completion. |
| *Equivocation* | Inefficient communication channels not providing the intended signal (information/message) from one point (entity) to the next, resulting in lack of clarity, excessive noise, or misinterpretation | Anecdotal observation suggests that ASR lacks clarity of communication. |
| *Eudemony* | Overemphasis on a preferred set of affairs and motives (e.g., financial profitability) of a system above all other measures, sacrificing balance with other potentially meaningful measures | Acq Sys near exclusive focus on cost, schedule, and performance are limiting. |
| *Events of low probability* | Focus on events of a system without distinction as to their probability of occurrence, attempting to control for all scenarios and thus potentially jeopardizing fundamental system objectives | There is not sufficient knowledge to speculate on this proposition. |
| *Feedback* | Inadequacies in system scanning to identify fluctuations requiring adjustments to maintain system stability | Not apparent that ASR has been formulated as a system. |
| *Flatness* | Reduction of system stability by an inappropriate balance in the distribution of system control—generating an imbalance between administrative and productive functions | ASR does not appear to be under central control or development oversight. |

| System Proposition | Concise Statement of Proposition Producing Errors (Pathologies) | Acquisition System (Acq Sys) Reform (ASR) Implication |
|---|---|---|
| *Frame of reference* | The lack of consistent standards by which a system can be judged or existence of a common vantage point from which a system can be viewed | Acq Sys regulatory standards do not appear to present a common frame of reference. |
| *Hierarchy* | Lack of sufficient structure of a system (levels of organization) to provide sufficient regulatory capacity necessary to control a system to maintain stability | Acq Sys does not appear to have regulatory capacity sufficient for stability. |
| *High-flux* | The rate of arrival of correct resources in response to system failure is insufficient to provide continuing stability in response to a correctable perturbation. | There is not sufficient knowledge to speculate on this proposition. |
| *Holism* | Focus on individual system entities as the source of system performance, as opposed to performance stemming from interaction of those entities to produce what individually they cannot | The Acq Sys exists as a fragmented aggregate set of entities and standards. |
| *Homeorhesis* | System lacking mechanisms that provide ability to return it to a pre-set path or trajectory following an environmental disturbance | Other than generalities, ASR trajectory is not clear. |
| *Homeostasis* | System lacking ability to maintain essential variables, within limits necessary to maintain stability, in response to external disturbances | Arguably, the Acq Sys has not been in a stable state. |
| *Internal elaboration* | Excessive tendency of a system to increase interconnections, constraints, and controls (regulations) over time in ways that make them increasingly complicated and complex | ASR must deal with the sprawling complexity and complication of the system. |
| *Iteration* | Failure to move through repetition cycles in system development allowing quick error identification and increasingly deep understanding | ASR has not be explicitly developed or performed in an iterative fashion. |
| *Least effort* | Selection of high resistance (resources, constraints) paths to maintain system performance where less resistance paths could provide the same results with less expenditure of energy | ASR is engaging with high resistance for maintenance of the status quo as preferable. |
| *Maximum power* | Limitations in ability to increase intake capacity and transformation rate necessary to realize system productivity potential. Failure to keep up with demand. | There is not sufficient knowledge to speculate on this proposition. |
| *Minimal critical specification* | Introducing system constraints beyond those minimally necessary to maintain system performance—overconstraining system entities, wasting resources, and not improving performance | The Acq Sys appears to be overregulated to the detriment of performance. |
| *Multifinality* | Failure in realizing that from the same initial starting point radically different end states are possible—assuming approaches based on prior experiences will yield similar results is flawed. | There is not sufficient knowledge to speculate on this proposition. |
| *Omnivory* | Inability of a system's internal structure to be modified to accommodate a more diverse set of input resources to increase stability | There is not sufficient knowledge to speculate on this proposition. |
| *Organizational closure* | Incongruence in the essence of a system that provides coherence in system identity—providing consistency and unity in thinking, decision, actions, and interpretations for system related matters | The identity of the Acq Sys and ASR appear to lack clarity. |
| *Over-specialization* | An excessive degree of specialization such that a system lacks the ability to change and adapt to shifting circumstances and conditions | The Acq Sys appears slow to adapt to increasing change and rates of change. |
| *Pareto* | Expenditures of system resources to enhance productivity are not directed proportionally to those offering the greatest contribution for improvement. | There is not sufficient knowledge to speculate on this proposition. |
| *Patchiness* | Limited system design capacity to accommodate a diversity of resources from the environment, without needing to be | There is not sufficient knowledge to speculate on |

| System Proposition | Concise Statement of Proposition Producing Errors (Pathologies) | Acquisition System (Acq Sys) Reform (ASR) Implication |
|---|---|---|
| | structurally modified to accept different types of resources | this proposition. |
| *Polystability* | Failure to appreciate that stability of system entities does not imply stability can be directly translated to stability of the larger system | ASR should consider the constituent Acq systems. |
| *Redundancy of potential command* | Limitations in subsystem authority and independence to make decisions and take action on behalf of the system, limiting speed of response to identified opportunities, novelties, trends, and treats from the environment | Consolidation of decision authority limits autonomy and decision efficiency in the Acq Sys. |
| *Redundancy of resources* | Failure to provide redundant critical resources beyond those identified as necessary under ideal conditions—this optimal efficiency perspective assumes unforeseen circumstances will not occur. | There is not sufficient knowledge to speculate on this proposition. |
| *Relaxation time* | Introduction of too many simultaneous changes rendering a system incapable of processing or assimilating the changes and resulting in continual instability | ASR is being undertaken with multiple, and not necessarily integrated, efforts. |
| *Resilience* | Following a disturbance, lack of capability of a system to withstand the disturbance, either operating at a degraded level or outright failing to return to operation | The ability of the Acq Sys to withstand disturbances and function is speculative. |
| *Robustness* | Inability of a system to withstand a wide range of environmental disturbances without the necessity for system modifications | Constant flux in ASR suggests lack of robustness. |
| *Safe environment* | A system not acting to create a level of stability in the environment to reduce disturbances that might have a detrimental impact on system performance | The Acq Sys environment is not explicitly mapped, modeled, or understood. |
| *Satisficing* | Attempting to resolve issues by seeking the optimal (best) solution as opposed to a less resource-intensive solution that will work | There is not sufficient knowledge to speculate on this proposition. |
| *Self-system* | Failing to gain efficiencies by increasing autonomy of system entities to make decisions and initiate actions more their local level and require less energy (resources) to maintain | The Acq Sys does not appear to provide high levels of autonomy for decisions. |
| *Separability* | Failure to account for designs that permit such tight coupling of subsystems that small variations can spiral out of control to cause major negative consequences | The Acq Sys is tightly coupled making escalation of failures possible. |
| *Steady state* | Failure to account for overall system steady state being dependent on the continuing steady state of constituent subsystems—if a subsystem moves out of steady state, so too does the overall system. | There is not sufficient knowledge to speculate on this proposition. |
| *Suboptimization* | A focus on optimization of subsystems results in sacrifice of (optimal) performance of the larger system—all subsystems and the overall system cannot be simultaneously optimized. | ASR would benefit by representation as a system with defined subsystems. |
| *Subsidiarity* | Elevation of a local system issues/conflicts for resolution by a higher level (authority) system, when the resolution could be accomplished locally in harmony with higher level system objectives | ASR would benefit from close examination of decision authority level. |
| *System context* | Addressing a system independent of the context (unique circumstances, factors, trends, patterns) within which the system exists | The Acq Sys appears to be designed and regulated as a context free system. |
| *First cybernetic control* | System lacking ability to compare behavior/performance, or to make corresponding adjustments, based on continuous monitoring against a set standard | The narrow focus on cost, schedule, and performance is limiting in design for control. |
| *Red Queen* | System failure due to the inability to compete with other systems in the same environment—continually falling behind other systems by failing to make minimal improves to “just keep up” | There is not sufficient knowledge to speculate on this proposition. |
| *Second cybernetic* | Communications fail to provide regulatory capacity | ASR should consider |

| System Proposition | Concise Statement of Proposition Producing Errors (Pathologies) | Acquisition System (Acq Sys) Reform (ASR) Implication |
|---|---|---|
| *control* | necessary to address disturbances that impede system performance. | communications capacity. |
| *Third cybernetic control* | Attempting to make modifications (tinkering) to a system that is in control—a system cannot be brought into control if it has not first gone out of control. | ASR is attacked piecemeal with limited modifications for a problem system. |
| *Transcendence* | Failure to recognize that understanding might lie beyond rational, scientific, or determinate explanation—sometimes requiring explanation be taken on “faith” as belief without question | ASR lack of consideration of limitations in holistic knowledge is problematic. |
| *Ultra-stability* | Design sufficiency to fend off anticipated disturbances, but lacking the ability to fend off unknown disturbances without changing internal structures | The Acq Sys design ability to deal with emergent disturbances is questionable. |
| *Undifferentiated coding* | Failing to value knowledge or understanding that which cannot be attributed to direct observation of results and objective human sensing | ASR focus on “intangible” indicators would provide more holistic perspective. |
| *Unity* | Lack of an integrated system purpose or having an identity that establishes system uniqueness and serves to easily distinguish the system from other systems | Identity for ASR or Acq Sys could be more explicit, clear, and subject to development. |
| *Viability* | Failure to keep key system parameters in control and maintained within their set limits—questionable balance between autonomy and integration and between stability and adaptation | ASR might consider examination parameters and limits for Acq Sys viability. |
| *Gödel’s incompleteness* | Operating on a system as though the frame of reference is consistent and complete—when in actuality it is not free from assumptions, infallible, or necessarily complete | ASR frame of reference does not appear as explicit. |
| *Information redundancy* | Insufficient reduction of probability for communication errors in a system due to a lack of “redundant” means used to transmit the communication | There is not sufficient knowledge to speculate on this proposition. |
| *Morphogenesis* | System failure to maintain stability following creation of a new and radically different structure | There is not sufficient knowledge to speculate on this proposition. |
| *Morphostasis* | Reduction of stability of a system by resisting change in favor of a preference for maintaining the existing status quo | The Acq Sys appears to have an emphasis on maintaining the status quo unthreatened. |
| *Pareto optimality* | Undertaking an activity to improve one aspect of a system with the mistaken belief that there will be no adverse effects on other aspects of the system | ASR appears as a well-intentioned set of disjointed activities tangentially related. |
| *Purposive behaviorism* | The purpose of the system is unguided and primarily based on intended, desired, or designed results as opposed to what the system produces. | Acq Sys purpose is not examined beyond stated intentions. |
| *Recursiveness* | Incorrectly assuming that a system exist independent and mutually exclusive of all other systems—in reality a system exists within a larger system and is comprised of (lower level) systems | There is not sufficient knowledge to speculate on this proposition. |
| *Reification* | Failure due to treatment of an abstract system (e.g., representation) as though it exists as a concrete reality | Much of the Acq Sys exists as incomplete representations. |
| *Channel capacity* | Inability of a communication channel to transmit different messages without being modified—design insufficiency to account for noise such that a message is not understood as intended | There is not sufficient knowledge to speculate on this proposition. |
| *Genesis of structure* | Failure to initiate and maintain forming structure through communications (flow of information among elements) necessary for continued system viability (existence) | The Acq Sys appears to be largely self-organizing directed by higher |

| System Proposition | Concise Statement of Proposition Producing Errors (Pathologies) | Acquisition System (Acq Sys) Reform (ASR) Implication |
|---|---|---|
| | | authorities. |
| *Synchronicity* | Phenomena about a system appears to be meaningfully related but is ignored since its explanation is impossible in terms of cause-effect relationships and therefore not deemed meaningful. | ASR might focus on examination beyond simple cause-effect relationships. |
| *Communication* | Failure due to receiver(s) of information unable to receive information as intended by the sender—where the receiver does not understand the meaning and is not influenced as intended by the sender | There is not sufficient knowledge to speculate on this proposition. |
| *Control* | Inadequacy in the means necessary to provide regulatory capacity required to preserve identity of a system, permitting adaptation a maintenance of viability (continued existence) | Acq Sys regulatory capacity is in question as is clarity of system identity. |
| *Dynamic equilibrium* | Failure to maintain stability stemming from insufficient adjustment based on environmental shifts requiring system adjustments in response to maintain an equilibrium state | Acq Sys equilibrium appears questionable in response to environmental shifts. |
| *Punctuated equilibrium* | Failure to take into account that a system may experience long periods of stasis (relative calmness) that are interrupted by sudden bursts of change that were not expected and possibly catastrophic | ASR has gone through periods of fundamental change and periods of stasis. |
| *Sociotechnicality* | Failure due to misplacing preference, favoring either “technical” or “social” aspects of a system—when in actuality every complex system has both aspects and may shift their importance over time | ASR should focus on the social as well as technical aspects of the Acq Sys. |
| *System boundary* | Improperly establishing the demarcation between a system and its environment—without clear delineation of separation causing confusion as to what is to be included/excluded from the system | ASR should delineate the multiple system boundaries that denote the Acq Sys. |
| *System environment* | Lack of clarity for what lies outside the system and potential treatment of things outside of control/influence of the system as though they are within control boundaries of the system | The nature and articulation of the Acq Sys environment appear underdeveloped. |

The presentation of this set of Systems Theory principles must be acknowledged for several considerations. First, this listing, although it is born from a wide breadth of existing literature of systems, cannot make the claim of being either absolute or complete. Second, the principles create the impetus for a different level of thinking, decision, action, and interpretation in creating conditions for improvement in fields (e.g., acquisition) struggling with increasingly complex systems and their problems. Third, the principles only create the conditions for different understanding of the acquisition system, and as such offer explanatory power as well as predictive power as to the future prospects for acquisition reform. We now shift our discussion to deeper examination of the implications of Systems Theory for acquisition system reform.

## Systems Theory Implications for Acquisition System Reform

As we have seen from our present development, the acquisition literature is replete with calls for reform, improvement, and modification. However, a closer look at the acquisition literature suggests that the emphasis has been focused on the more tangible level of processes, tools, methods, and "new" structural ways of attempting to improve future prospects for meeting cost, schedule, and technical performance expectations. In a recent review of literature for acquisition system development, Keating et al. (2017) examined a distribution of the literature over an 11-year period for 151 journal articles across five major classification categories (Figure 7), including the following:

- ***Tools***—Implements used to support accomplishment of a specific task or purpose
- ***Methods***—Systematic approaches that are performed to achieve an objective
- ***Models***—Representations that capture attributes against which comparisons can be made
- ***Methodologies***—Generalized frameworks that guide applications for the field
- ***Conceptual***—Fundamental underlying philosophical, theoretical, and axiomatic foundations that serve as a basis for the field

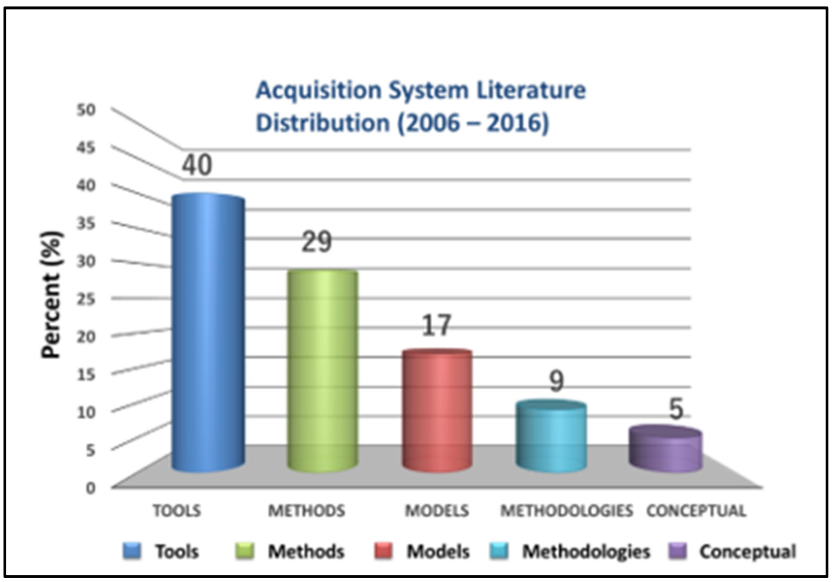


**Figure 7. Literature Distribution for Defense Acquisition System**

There are four primary conclusions based on this work: (1) There appears to be a heavy inclination toward the "practice" side of the acquisition system literature (Tools, Methods, Models) as fully 127 articles (84%) fit into these categories, (2) there was a noticeable absence of literature steeped in Systems Theory based domains, (3) a meager 14 articles (9%) address methodological aspects of defense acquisition, and (4) there was a noticeable scarcity of conceptual/theoretical articles (8 articles, 5%) where Systems Theory would be captured (although there were no Systems Theory based works).

In consideration of the present work in relationship to acquisition system development, five primary implications are offered:

1. *Acquisition system reform has proceeded without inclusion of Systems Theory*—this is not totally unexpected. Acquisition has developed as a practice based field. Notwithstanding the absence of System Theory, there is also a recognizable absence of consistent grounding in any theoretical basis. Therefore, the conclusion is offered that suggests an emphasis on a stronger theoretical linkage, which may include Systems Theory, might be beneficial for acquisition system reform.
2. *Systems Theory offers a different perspective and inquiry framework for examination of acquisition system reform*—Systems Theory places emphasis on understanding system design, execution, and development from the perspective of a well-grounded, mature, body of knowledge. Systems Theory provides a language, given as the set of propositions, which serves to explain the behavior/performance of complex systems while providing some predictive power.
3. *Acquisition system development breakthrough might be supported by focusing on the underdeveloped "conceptual" emphasis*—the scarcity of literature targeted to the conceptual (philosophical, theoretical, axiomatic) aspects of the acquisition system, suggests that this might be an area with substantial promise for enhancing acquisition system reform. As the preponderance of work has eluded this area, there might be significant breakthroughs to reform dilemmas.
4. *Focus on Systems Theory (propositions) violation might provide new and novel insights for acquisition system reform*—since the Systems Theory propositions have not been previously deployed in the development of the acquisition system, there is potential for new and insightful thinking. This might offer a shift in trajectory of acquisition system reform that has not yet been achieved.
5. *Acquisition Systems Theory*—a scan of comprehensive scholarly literature databases for "Acquisition Systems Theory" produced not a single article. This is consistent with finding that the conceptual (theoretical, philosophical, axiomatic) limited literature in the body of knowledge for the acquisition field. This suggests that there might be opportunity to "change the conversation" of acquisition system reform by the inclusion of theoretical development.

Systems Theory has broad-ranging implications for acquisition system reform. By any reasonable acknowledgement, acquisition system reform has met with difficulties. Nevertheless, as we have articulated, this has not prevented the success of multiple programs under the acquisition system. In looking for new and novel paths forward for the acquisition field, Systems Theory has been introduced as a body of knowledge with potential to elevate the acquisition field. We now turn to closing this work with an examination of conclusions and research directions.

## Conclusions and Research Directions

In this paper, we have laid a foundation for the nature and role of Systems Theory in advancing present efforts related to acquisition system reform. Systems Theory has been presented as a potential contribution to better understand acquisition system reform. Additionally, Systems Theory might advance the acquisition field by introducing a new and novel language (to acquisition). This language can provide the basis for a different level of corresponding thinking, decision, action, and interpretation for acquisition system reform. In conclusion for this effort, three primary points are offered:

1. *Systems Theory as a Basis for Insights*—Systems Theory was presented as a set of propositions (laws, principles, concepts) that have been organized as an informing body of knowledge for the field. The set of propositions are applicable across systems, including the acquisition system. They serve to explain, and provide predictive power, for the behavior/performance of complex systems. As such, Systems Theory can provide explanatory analysis and insights to the acquisition system that have been elusive.
2. *Acquisition System Reform*—Systems Theory offers an enhanced perspective for acquisition system reform. It is interesting that the acquisition field has been relatively free from inclusions of Systems Theory. Even a rudimentary examination of Systems Theory provides a different perspective on acquisition. Perhaps acquisition system reform, continually being criticized for falling short of expectations, would benefit by the deeper examination from Systems Theory.
3. *Explaining Success and Failure*—The acquisition literature/programs are replete with both successes and failures. However, there has never been a thorough examination of the nature of success (and failure) from the perspective of Systems Theory. While Systems Theory has not been offered as a panacea to advance the acquisition system reform, it is portrayed as a new and novel approach to better understand critical issues in acquisition system development.
4. *Foundation for New Generation of Supporting Tools*—Bringing Systems Theory to life to support acquisition system reform requires movement beyond the conceptual (philosophical, theoretical, axiomatic) level. New Systems Theory based methods, tools, and techniques can be developed and tailored to the acquisition field to support practitioners faced with increasingly complex systems and problems.

Based on current explorations in Systems Theory application to acquisition system reform, several developmental avenues are suggested. While not offered as a complete set, these developmental directions will provide the foundation for a coherent (making sense for the acquisition field) and congruent (fit to address acquisition system reform) contribution to acquisition system development. These areas include *Systems Theory for Acquisition, Methods Development,* and *Applications* (Figure 8).

*Systems Theory* provides a knowledge base to explain the behavior/performance of complex systems. However, there is a noticeable absence of Systems Theory application to acquisition system reform. Although we do not know the reason for this absence, there are significant opportunities to expand acquisition system reform horizons through Systems Theory. While the essence of Systems Theory is not in question, there needs to be examination as to the direct application to acquisition field systems. We might certainly expect to make modifications in how the language is adjusted based on nuances of the acquisition field.

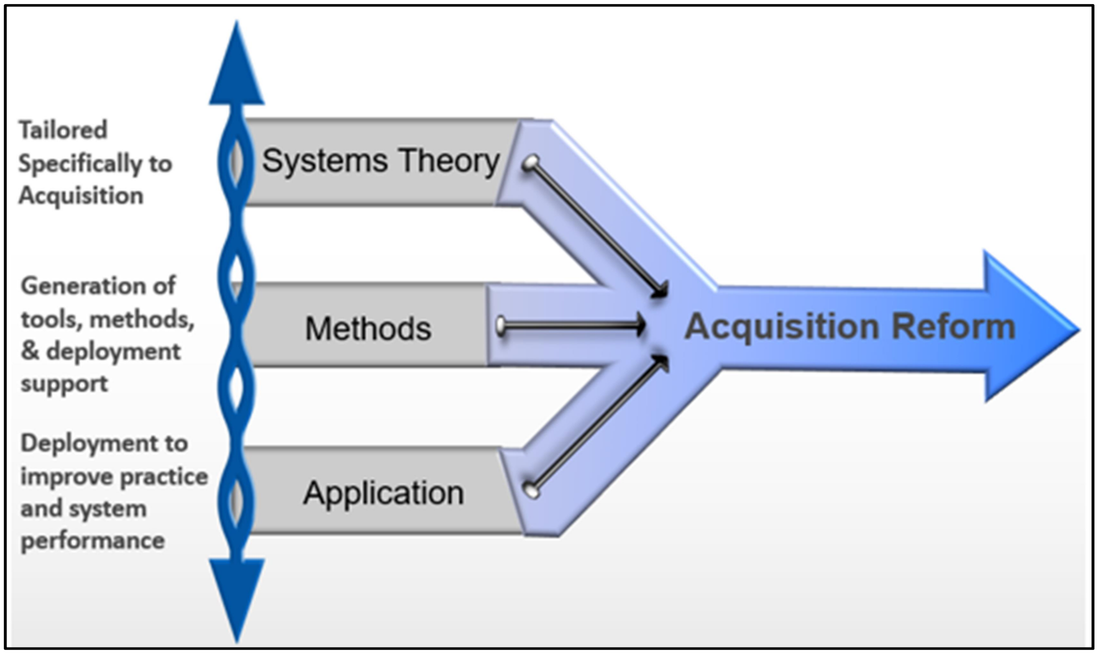


**Figure 8. Simultaneous Development of System Theory, Methods, and Applications**

*Methods* involves engineering of the science-based artifacts (tools, techniques, methods) to support enhanced capabilities that promote improved acquisition practice. Thus, *methods* finds its basis in Systems Theory and bridges the world of Systems Theory to the world of application through engineering of methods. Finally, *application* is focused on the deployment of methods-based capabilities to enhance acquisition practice. In the case of acquisition, this implies enabling practitioners with more sophisticated (Systems Theory based) methods to perform in their roles as acquisition professionals.

The path forward for application of Systems Theory for the acquisition field and practitioners is not without challenges. However, we have shown the promise that Systems Theory holds for acquisition system reform. There are no guarantees for the utility that will accrue for the application of Systems Theory to acquisition system reform. However, this exploration provides a level of confidence in knowing that Systems Theory offers a new, novel, and insightful perspective for engaging acquisition reform.

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