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# A Method for Identification, Representation, and Assessment of Complex System Pathologies in Acquisition Programs

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## Abstract

Acquisition programs continue to struggle with increasing complexity. High degrees of emergence, interconnectedness, and uncertainty are the norm rather than exception. *The purpose of this research is to explore extension of ongoing research in complex system pathologies for acquisition programs*. Significant advances have been made in development of deeper understanding of the nature of pathologies (deviations from healthy system function) and their implications for performance of complex systems. Complex system pathologies represent “violations” of underlying system principles. These violations negatively affect system governance functions (control, oversight, accountability) resulting in degradation of system performance. Greater understanding of complex system pathologies offers insights to enhance complex system performance. This paper reports on the current state of development of a method to identify, represent, and assess systemic pathologies in complex systems. The method examined (M-Path Method) supports enhanced capabilities for pathology discovery, support for prioritization based on impact ranking, and provision of guidance for feasible strategic response across a spectrum of pathologies. Thus, the acquisition field and practitioners will benefit from results reporting on (1) acquisition field advancement through system science-based research into impediments to system performance, (2) providing a research-based method to improve acquisition program performance, and (3) reporting on successes and lessons learned from preliminary application of the method. The paper concludes with discussion of initial applications of the method, developmental areas, and guidance for acquisition practitioners.


## Introduction

There seems to be a high level of agreement that acquisition of major systems continues to experience difficulties in meeting expectations under increasingly complex circumstances. There are plentiful accounts of “failures” of the acquisition system to produce on schedule, on cost, and on technical performance systems. This sentiment is echoed in the near constant criticisms from oversight bodies (e.g., Government Accountability Office) suggesting that there is much room for improvement in the acquisition field. There have been numerous attempts to explain the factors contributing to acquisition failures (Berteau et al., 2011; Francis, 2008, 2009; Rascona, Barkakati, & Solis, 2008; Smith et al., 2016). Unfortunately, without resolution, the demonstrable failures in acquisition programs and calls for reform persist. For example, Cilli et al. (2015) examined recent Government Accountability Office assessments of major acquisition programs, concluding that while attempts were being made to improve, the difficulties remain. Irrespective of a lack of reform success, efforts at Acquisition System reform continue (Bucci & Maine, 2013) and recognize the need to streamline the system and craft a more agile and flexible Acquisition System. Regardless of noble efforts and attempts to “improve” the acquisition system, the realistic conclusion persist that reforms have not had the desired impact. Instead, the continuing outward appearance of the acquisition system is that of a monolithic system. This system has not demonstrated that it is well suited for the complexity, speed, uncertainty, and ambiguity that exist in warfighting needs and environments characteristic of the 21st century.

There has been a continuing legion of reports, critiques, and calls for reform in the acquisition system. In fact, Fox (2012) was quick to point out that the calls for defense acquisition reform have been levied for decades and have continued to persist despite the continuing calls for change. There have been multiple corresponding investigations attempting to identify and explain the underlying causes contributing to unsuccessful acquisition efforts (Berteau et al., 2011; Francis, 2008, 2009; Rascona et al., 2008; Smith et al., 2016). Yet, the criticisms of the acquisition system persist and seem to be resilient to any of the remedies suggested to reform. The present state appears to be a system that, in the best case, appears to be severely debilitated. And, in the worst case is outright dysfunctional and "broken." Programs that can be offered as exemplars of successful acquisition endeavors seem to be a rarity. There is a short supply of successful exemplars of acquisition excellence, judged against usability, budget, and delivery schedule performance that meets or exceeds expectations. Successful acquisition endeavors are frequently studied in hopes that they will answer the riddle as to why acquisition programs so often fail and what might be done to improve the chances for success of future programs (Boudreau, 2007; O'Rourke, 2014). Presently, there is no satisfactory, or widely held consensus as to the path forward, much less the feasibility of successfully embracing that path. Looking to other countries for benchmarking and innovation in the hope that their smaller acquisition portfolios might provide a different vantage is an option. However extensive reviews like that of Joiner and Tutty (2018) comparing Australia's and the United States' defense acquisition systems, show that the U.S. initiatives provided at scale appear to deal better with complexity and that therefore the complexity problem for allies is worse.

There is not consensus on directions necessary for acquisition system development and reform. Characterizing reports critical of defense acquisition, Cilli et al. (2015) suggested, "In general, these reports call for early, robust, and rigorous assessments of a broader range of alternatives across a thorough set of stakeholder value criteria to include life-cycle costs, schedule, and performance" (p. 587). Given the present state of acquisition, this appears laudable, and possibly even to some extent infeasible. In a most recent publication, the Section 809 Panel (focused on making the DoD's acquisition system bold, simple, and efficient) January 2018 report provided recommendations such as marketplace framework, commercial buying, earned value management, and establishing of "offices" among other recommendations. The incorporation of these "recommendations" has yet to be established, much less their impact. Based on the present "disagreeable" state of the acquisition system, we must ponder the question, *"Why after over 40 years of acquisition reform do the critical performance issues not only persist in this field but seem to be worsening?"* In examination of a response, we suggest that, given the vexing nature of acquisition system problems, coupled with our inability to provide satisfactory reform, a different vantage point might provide insights. To this end, acquisition failure has not been rigorously examined from a systems theoretic perspective to formulate "systemic deficiencies" in the design, execution, and development of acquisition as a true "system."

There is much to be gained in deeper application of a systems theory perspective of acquisition to provide a different vantage point. To foster this perspective, the purpose of this paper is to *explore extension of ongoing research in complex system pathologies for acquisition programs.* There have been significant advances made in the development of pathologies (aberrations from normal or healthy system conditions) as a key to deeper understanding sources of failure for complex systems (e.g., acquisition). For this exploration we have focused on achievement of four primary objectives, including: (1) identify a perspective and method for identification of pathologies in a complex system, (2) suggest implications for pathology analysis for acquisition program development, (3) present a demonstration of results from pathology identification and assessment for acquisition programs, and (4) suggest implications for further development and deployment of pathologies as potential sources to advance acquisition system development. To achieve these objectives, the paper is organized to first suggest a systems explanation for current difficulties being experienced in the acquisition system. Second, as a deeper systems elaboration of systemic sources of failure in complex systems, we elaborate the concept of system pathologies. This elaboration anchors the notion of complex system failure sources to violations of underlying systems principles fundamental to the design, execution, and development of all complex systems. Third, a method for the discovery and characterization of systems pathologies is developed. A short demonstration of the implications of the method for deployment in the acquisition system is presented. The paper closes by suggesting a direction for further development and elaboration of pathologies for complex systems in general, and implications for the acquisition system in particular.

## A Systems Perspective of Challenges in the Acquisition System

To begin a dialog on the systems formulation of acquisition difficulties, we posit six central themes (Figure 1), consistent with and extending several earlier works (Keating et al., 2017a, 2017b; Bradley, Katina, & Keating, 2016). These considerations provide a systemic frame of reference (views) for the modern landscape of defense acquisition. While these characteristics are endemic to modern systems in general, the particular emphasis of the Defense Acquisition System is intended to invite a different level of dialog, exploration, and "systemic" understanding.

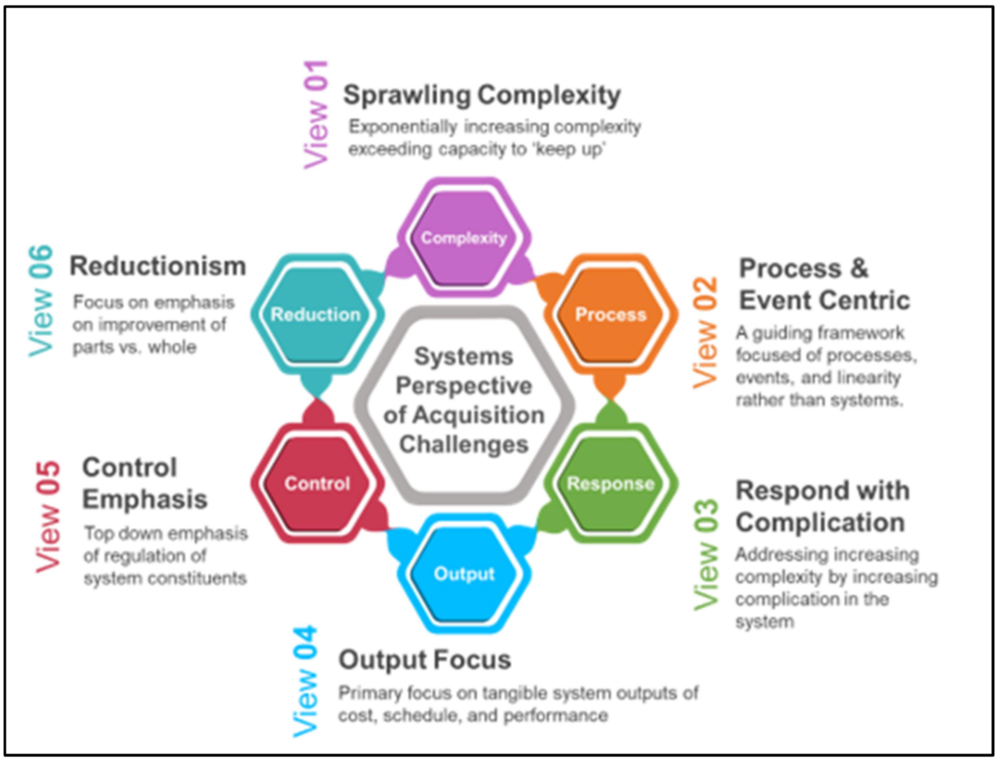


**Figure 1. Six Systems Perspectives (Views) for the Defense Acquisition Field**

1. *Sprawling Complexity Exceeds Capacity of the System to Absorb*. As the complexity of systems being acquired have increased exponentially, so too has the acquisition system which procures them. Such system elaborations are expected. However, lacking integrated, purposeful, and accountable management of increasing complexity, leaves the acquisition system behind and lacking capacity to "match" the complexity in the system(s) they are charged to acquire. For the Defense Acquisition System this suggests that the calls for reform, increased agility, boldness, simplicity, and efficiency, as

well as other such suggestions by numerous authors, are perhaps summed up in Kendall's (2014) congressional testimony stating, "Our system over time accumulated excessive levels of complex regulatory requirements that are imposed on our program managers and other acquisition professionals. … One thing I hope we can all agree on is the need to simplify and rationalize the bureaucratic burdens we place on our acquisition professionals" (p. 6). Similarly, Australia's First Principles Review (Peever et al., 2015) found, "Acquisition teams must comply with over 10,000 Defence Materiel Organisation specific policies and procedures which includes 35 policy and procedure artefacts totaling around 12,500 pages on procurement processes and controls" (p. 14). Despite these intricate processes, that review went on to find that acquisition had "great difficulty measuring and monitoring real performance" and that there was "a disconnect between customers and the purchaser as well as multiple and unnecessary handover points which increase complexity and risk."

2. *Process and Event Centric Focus*. The Defense Acquisition System is proclaimed to be a "system" without further qualification. However, facing the most rudimentary articulation for classification as a system (e.g., defined boundary, entities, transformation, outputs/outcomes, etc.), the Acquisition System falls short. In reality, the "Acquisition System" is a collection of elements for which the precise representation is not presented, operated, or evolved holistically as a system. The DoD 5000 reference to the Defense Acquisition Management System as both a "framework" as well as an "event-based process" supports this conclusion, as the "system" falls short of the notion of system from the most basic articulations of a system in the literature. The ramifications of a focus limited to process and event focus include missing development opportunities from a systems perspective (versus process or event perspective). The intent of pointing out this systems perspective is not to discredit defense acquisition. On the contrary, by inviting a more "systemic" perspective of the Acquisition System, the potential for future shifts in design, analysis, and development might become available.
3. *Response to Increasing Complexity Relegated to Increasing Complication.* The original intent of the Federal Acquisition Regulation (FAR) was quite straightforward, as it attempted to provide an efficient approach to the acquisition of material necessary to support government functions. However, since the introduction of the FAR, it has continued to elaborate in structure, volume, and become increasingly complicated (having many parts and pieces). New regulations, extended processes, and implementation of new controls have all acted to make the FAR much more complicated than the original document. As an example of this increasing complication, Federal Acquisition Regulation expanded from 1,953 pages at introduction in 1984 to 2,193 pages by 2014, with the DFAR supplement adding another 1,554 pages and each of the services initiating a host of their own "specialized" implementation guides, instructions, directives, and memorandums (Friar, 2015). This "explosion" has served to make the FAR more complicated, as deficiencies and calls for reform have continued, and arguably, escalated.
4. *Emphasis on an Output Versus Outcome Focus.* The Defense Acquisition System is clearly focused on achievement of outputs. Outputs are those tangible, verifiable, and objective elements that serve as products of a system and provide value consumed external to the system. Outcomes are the not

necessarily tangible effects of a system. These effects are more related to the fulfillment of purpose/need, not easily verifiable, subjective in nature, and primarily focused on meeting expectations for problem resolution. As such, outcomes exist as related, but removed in nature and scope, from outputs achieved from a system (Salado & Nilchiani, 2017). The “iron triangle” for acquisition programs has been, and remains, focused on the outputs of cost, schedule, and performance. It is hard to read a criticism of the current state of affairs for acquisition that is not targeted to one or more of these tangibly measurable (output) elements. However, we suggest that these indicators are “systemically” limited in their ability to capture the true indication of performance in acquisition. While these indicators (cost, schedule, performance) are necessary indicators of system performance, they alone do not provide sufficiency as a set of judgments of Acquisition System performance. For example, Cilli et al. (2015) point out the sunk costs of five programs between 2006 and 2011 in excess of $32 billion. While this “failure” is easily marked from the cost metric, it is disingenuous to capture the essence of program failures only on the cost dimension. Deficiencies that permitted those failures might be found beyond the cost, schedule, and technical performance triad. This invites consideration of a much wider view for examination of acquisition reform, beyond the simple cost, schedule, and performance triad.

5. *Global Control*. From a systems perspective, control is about providing constraint of a system only to the degree to which is necessary to assure continued performance (Keating et al. 2014). Excess constraint in a system (control) wastes resources and limits local autonomy (independence of decision, action, and interpretation). Thus, for acquisition, the less control invoked makes for a more cost-efficient system—since constraint is not free and escalates costs of a system. Acquisition programs aptly refer to these excessive controls with such terms as overregulation, bureaucracy, and excessive constraint without evidence of commensurate value added to the system. The near constant state of acquisition reform (Fox, 2012; Schwartz, 2014) supports the increasing elaboration of system controls in ways that do not necessarily enhance performance. This does not demean the improvements achieved, or those suggested (e.g., Panel 809 recommendations) in reform processes, but instead suggests that a different (systemic) viewpoint of control might shift the landscape for acquisition program design, execution, and development.
6. *Reductionism as a Driving Paradigm*. At the basic level reductionism is understanding systems by ever deepening “reduction” to more finite components whereby system performance is held in understanding component level behaviors. For acquisition, this frame of reference is evident in the development of the “acquisition system” as a fragmented assemblage of processes, procedures, regulations, and standards. It is not a large leap to surmise that the present acquisition system has emerged through a series of well-intentioned additions over time. One would be hard pressed to claim that the current acquisition system was either purpose built as a whole, or currently performs as a unity. In contrast to reductionism is holism, a central tenet of Systems Theory. Holism is focused the central notion that understanding of system performance or behavior is achieved by understanding the interactions among components, rather than the

components themselves. This shift in thinking paradigm lies at the center of a more holistic, versus reductionist, perspective of acquisition. Arguably, the acquisition system has been developed and evolved from a reductionist perspective. This has placed primary emphasis on the constituent element development (e.g., processes, laws, offices, procedures, regulations) as opposed to the interactions of those elements to understand system performance and drive reform.

This systems perspective for the Defense Acquisition System is intended to suggest that a different frame of reference might be helpful. Our intention is to invite a dialog to further exploration and understanding of the current system, while offering insights into issues in design, execution, and development of the system from an alternative frame of reference. For our purposes, the alternative frame of reference is focusing on understanding system difficulties through discovery of underlying pathologies (aberrations from "healthy" functioning of a system). To achieve our purpose, the remainder of the paper is organized around four primary objectives. First, in the following section, we provide a grounding perspective of "system pathology" in relationship to complex system dysfunctions. Second, we elaborate a method for discovery of system pathologies in complex systems. This method, the M-Path Method (Metasystem Pathologies Method), suggests that the source of system dysfunction might be found in the metasystem (higher level integrating functions) that ultimately produce system behavior/performance. Third, we examine a preliminary application of the explanation of acquisition difficulties based on the perspective provided by pathologies. Fourth, in the final section of the paper, we conclude with implications for further research, contributions, and application development of pathologies for a different set of insights to support Acquisition System development.

## Pathologies as a Source of Dysfunction in Complex Systems

Certainly, understanding of system performance, including acquisition, involves discovery of conditions that might act to limit that (i.e., acquisition system) performance. Previous research related to systems theory and systems theory-based methodologies offers insights that provide explanation for aberrant conditions affecting performance (Keating & Katina, 2012). These aberrant conditions have been labeled as pathologies, defined as "a circumstance, condition, factor, or pattern that acts to limit system performance, or lessen system viability <existence>, such that the likelihood of a system achieving performance expectations is reduced" (Keating & Katina, 2012, p. 214). Pathologies have a rich development and have been anchored in Systems Theory (the set of laws and principles that govern behavior of all complex systems) and Management Cybernetics (the science of system structural organization).

For grounding our present exploration, we introduce two key points related to the nature and role of pathologies in complex systems—pathologies and their relationship to Systems Theory. First, pathologies have been extensively developed for application to the design, execution and development (governance) of complex systems (Keating & Katina, 2012; Katina, 2015). Complex System Governance (CSG) provides a set of "coordinates" to locate the existence of a pathology. This location is identified to nine different functions essential to continued viability of a complex system. For succinctness, Table 1, drawn from the work of Katina (2016) presents a summary of the nine essential metasystem functions of a complex system. The "metasystem" acts to provide governance (design, oversight, accountability) of a complex system (following Keating & Bradley, 2015; Keating et al., 2017) through the following:

- **Control:** constraints necessary to ensure consistent performance and future system trajectory.
- **Communications:** flow and processing of information necessary to support consistent decision, action, and interpretation throughout the system.
- **Coordination:** providing for effective interaction to prevent unnecessary instabilities within and in relationship to entities external to the system.
- **Integration:** maintaining system unity through common goals, designed accountability, and maintaining balance between system and constituent interests.

**Table 1. Metasystem Functions for a Complex System**

| *Metasystem Function* | *Primary Role of the Function* |
|---|---|
| *Metasystem five (M5): Policy and identity* | 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. |
| *Metasystem Five Star (M5*): System context* | To monitor the system context (i.e., the circumstances, factors, conditions, or patterns that enable and constrain the system). |
| *Metasystem Five Prime (M5'): Strategic system monitoring* | To monitor measures for strategic system performance and identify variance requiring metasystem level response. Particular emphasis is on variability that may impact future system viability. Maintains system context. |
| *Metasystem Four (M4): System development* | 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. |
| *Metasystem Four Star (M4*): Learning and transformation* | To provide for identification and analysis of metasystem design errors (second order learning) and suggest design modifications and transformation planning for the system. |
| *Metasystem Four Prime (M4'): Environmental scanning* | To provide the design and execution of scanning for the system environment. Focus is on patterns, trends, threats, events, and opportunities for the system. |
| *Metasystem Three (M3): System operations* | To maintain operational performance control through the implementation of policy, resource allocation, and design for accountability. |
| *Metasystem Three Star (M3*): Operational performance* | To monitor measures for operational performance and identify variance in system performance requiring system level response. Particular emphasis is on variability and performance trends that may impact system viability. |
| *Metasystem Two (M2): Information and communications* | To enable system stability by designing and implementing architecture for information flow, coordination, transduction, and communications within and between the metasystem, the environment, and the systems being governed. |

A second essential and fundamental grounding for development of pathologies is their linkage to Systems Theory–based laws/principles. For our present purposes, the nature of 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. These system laws are always there, always on, non-negotiable, non-biased, and explain system performance. Acquisition practitioners must ask, “Do we understand systems laws and their impact on our system(s) design and performance?”
2. **All systems perform essential system functions that determine system performance.** These functions are performed by all systems, regardless of sector, size, or purpose. These functions define what must be achieved for maintaining viability of a system. Every system invokes a set of unique implementing mechanisms (means of achieving system functions) that

determine how system functions are accomplished. Mechanisms can be formal-informal, tacit-explicit, routine-sporadic, or limited-comprehensive in nature. These functions serve to produce system performance which is a function of previously discussed communication, control, integration, and coordination. Acquisition practitioners must ask, “Do we understand how our system performs essential system functions to produce performance and maintain viability?”

3. **Violations of systems laws/principles in design, execution, or development of a system 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. Acquisition practitioners must ask, “Do we understand problematic system performance in terms of violations of fundamental system laws?”
4. **System performance can be enhanced through development of essential system functions.** When system performance fails to meet expectations, deficiencies in governance functions can offer novel insights into the deeper sources of failure. Performance issues can be traced to governance function issues as well as violations of underlying system laws. Thus, system development can proceed in a more informed and purposeful mode. Acquisition practitioners must ask, “How might the roots of problematic performance be found in deeper system issues and violations of system laws, suggesting different development directions?”

Given this brief introduction to pathologies in complex systems, following the recent work of Katina (2016) and earlier work of Keating and Katina (2012) a set of 53 pathologies have been develop in relationship to the metasystem functions provided earlier (Table 2). These pathologies are organized around the nine metasystem functions and serve to identify aberrations to normal (healthy) functioning of a complex system (e.g., acquisition).

## Table 2. Pathologies Corresponding to Metasystem Functions

| *Metasystem Function* | *Corresponding Set of Pathologies* |
|---|---|
| Metasystem five (M5): Policy and identity | M5.1. Identity of system is ambiguous and does not effectively generate consistency system decision, action, and interpretation. |
| | M5.2. System vision, purpose, mission, or values remain unarticulated, or articulated but not embedded in the execution of the system. |
| | M5.3. Balance between short-term operational focus and long-term strategic focus is unexplored. |
| | M5.4. Strategic focus lacks sufficient clarity to direct consistent system development. |
| | M5.5. System identity is not routinely assessed, maintained, or questioned for continuing ability to guide consistency in system decision and action. |
| | M5.6. External system projection is not effectively performed. |
| Metasystem Five Star (M5*): System context | M5*.1. Incompatible metasystem context constraining system performance. |
| | M5*.2. Lack of articulation and representation of metasystem context. |
| | M5*.3. Lack of consideration of context in metasystem decisions and actions. |
| Metasystem Five Prime (M5'): Strategic system monitoring | M5'.1. Lack of strategic system monitoring. |
| | M5'.2. Inadequate processing of strategic monitoring results. |
| | M5'.3. Lack of strategic system performance indicators. |
| Metasystem Four (M4): System development | M4.1. Lack of forums to foster system development and transformation. |
| | M4.2. Inadequate interpretation and processing of results of environmental scanning—non-existent, sporadic, limited. |
| | M4.3. Ineffective processing and dissemination of environmental scanning results. |
| | M4.4. Long-range strategic development is sacrificed for management of day-to-day operations—limited time devoted to strategic analysis. |
| | M4.5. Strategic planning/thinking focuses on operational level planning and improvement. |
| Metasystem Four Star (M4*): Learning and transformation | M4*.1. Limited learning achieved related to environmental shifts. |
| | M4*.2. Integrated strategic transformation not conducted, limited, or ineffective. |
| | M4*.3. Lack of design for system learning—informal, non-existent, or ineffective. |
| | M4*.4. Absence of system representative models—present and future. |
| Metasystem Four Prime (M4'): Environmental scanning | M4'.1. Lack of effective scanning mechanisms. |
| | M4'.2. Inappropriate targeting/undirected environmental scanning. |
| | M4'.3. Scanning frequency not appropriate for rate of environmental shifts. |
| | M4'.4. System lacks enough control over variety generated by the environment. |
| | M4'.5. Lack of current model of system environment. |
| Metasystem Three (M3): System operations | M3.1. Imbalance between autonomy of productive elements and integration of whole system. |
| | M3.2. Shifts in resources without corresponding shifts in accountability/shifts in accountability without corresponding shifts in resources. |
| | M3.3. Mismatch between resource and productivity expectations. |
| | M3.4. Lack of clarity for responsibility, expectations, and accountability for performance. |
| | M3.5. Operational planning frequently pre-empted by emergent crises. |
| | M3.6. Inappropriate balance between short-term operational versus long-term strategic focus. |
| | M3.7. Lack of clarity of operational direction for productive entities (i.e., subsystems). |
| | M3.8. Difficulty in managing integration of system productive entities (i.e., subsystems). |
| | M3.9. Slow to anticipate, identify, and respond to environmental shifts. |
| Metasystem Three Star (M3*): Operational performance | M3*.1. Limited accessibility to data necessary to monitor performance. |
| | M3*.2. System-level operational performance indicators are absent, limited, or ineffective. |
| | M3*.3. Absence of monitoring for system and subsystem level performance. |
| | M3*.4. Lack of analysis for performance variability or emergent deviations from expected performance levels—the meaning of deviations. |
| | M3*.5. Performance auditing is non-existent, limited in nature, or restricted mainly to troubleshooting emergent issues. |

| | |
|---|---|
| | M3*.6. Periodic examination of system performance largely unorganized and informal in nature. |
| | M3*.7. Limited system learning based on performance assessments. |
| Metasystem Two (M2): Information and communications | M2.1. Unresolved coordination issues within the system. |
| | M2.2. Excess redundancies in system resulting in inconsistency and inefficient utilization of resources—including information. |
| | M2.3. System integration issues stemming from excessive entity isolation or fragmentation. |
| | M2.4. System conflict stemming from unilateral decisions and actions. |
| | M2.5. Excessive level of emergent crises—associated with information transmission, communication, and coordination within the system. |
| | M2.6. Weak or ineffective communications systems among system entities (i.e., subsystems). |
| | M2.7. Lack of standardized methods (i.e., procedures, tools, and techniques) for routine system level activities. |
| | M2.8. Overutilization of standardized methods (i.e., procedures, tools, and techniques) where they should be customized. |
| | M2.9. Overly ad-hoc system coordination versus purposeful design. |
| | M2.10. Difficulty in accomplishing cross-system functions requiring integration or standardization. |
| | M2.11. Introduction of uncoordinated system changes resulting in excessive oscillation. |

## A Method for Discovery of Pathologies in Complex Systems

Katina (2016a) has developed a method for deploying pathologies in complex systems, entitled the M-Path Method (Metasystem Pathology Method). This method extends previous research related to problem formulation (Katina & Keating, 2014; Katina, 2015; 2016a; 2016b) and complex system governance pathologies (Katina & Keating, 2014; Keating & Katina, 2012). With respect to application of the M-Path Method, there are three qualifications necessary. First, the pathologies are of a generalized form. Therefore, their manifestation in “different” complex systems may be evidenced by surface level “symptomatic” conditions. The pathologies are rooted in the underlying dysfunctions of a system that produce “observable” surface symptomatic conditions. Thus, pathologies are not directly observable, but rather are inferred from observable/demonstrable conditions in a system. Second, pathologies have a degree of existence. They are not binary reducible, and thus have a “degree of existence,” rather than a binary present/not present attribution. Third, pathologies represent “deficiencies” in the system design (structural organization of a system to achieve desired behavior/performance), execution (performance of the system design), or development (evolution of the design and design/execution interface). As such, pathologies produce real consequences related to system performance which can be measured across a range of possible impacts for a system. Given this essential grounding, we present the M-Path Method in five phases (Figure 2, adapted from Katina, 2016a).

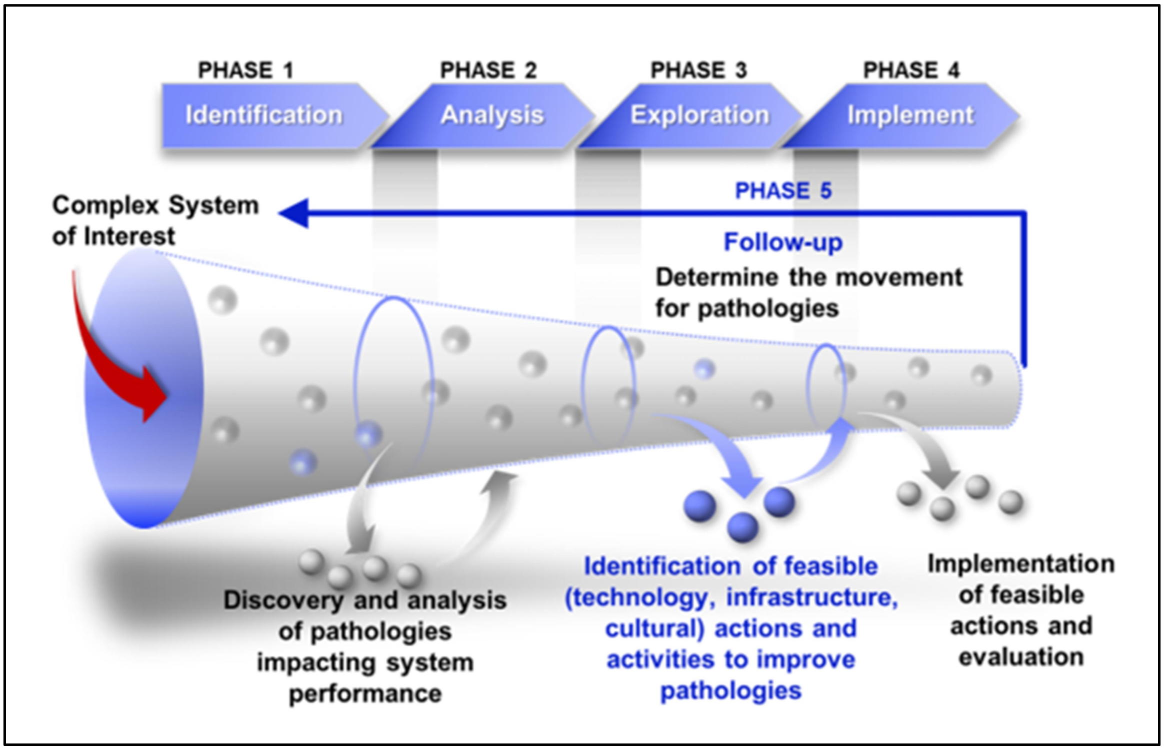


**Figure 2. Phases of the M-Path Method for Pathologies**

In essence, the M-Path Method is an approach that guides identification and assessment of specific pathologies that exist in a complex system. While not presented as complete or absolute, Table 2 was presented as the current state of pathology development for complex systems. This includes the 53 unique possible metasystem pathologies that can be assessed with respect to varying degrees of *existence, impact*, and *feasibility* to resolve. For conciseness we provide the following summary of the five phases of M-Path and their implications for pathology development.

**Phase 1: Identification** involves the identification and discovery of the degree to which the 53 pathologies exist for a given situation/system in focus. A determination is made with respect to the perceived existence and impact of pathologies. This determination is from the perspective of those practitioners who must design, operate, maintain, and develop the complex system.

This phase produces three essential pieces of information related to each of the pathologies: degree of existence, impact on system performance, and feasibility of addressing the pathology. *Degree of existence* is the level to which the pathology is deemed to be present—ranging from negligible to extreme. *Impact* is offers an assessment as to the degree to which the existence of the pathology is influential in affecting system performance. *Feasibility* captures the degree to which the pathology might be addressed (e.g., limited by technology, infrastructure, resources, safety, legality, authority, culture, etc.) with a reasonable confidence of success. Previous research has used a Web-based instrument (e.g., see Katina, 2016a) to capture this information. The data is represented in aggregate form (centroid of cluster for each pathology) and summary statistics (variance from cluster centroid). This provides input to a set of representations of the perspectives and their variability for the pathologies in a complex system of interest. Thus, support for further pathology analysis and exploration is supported by the process of "binning" pathologies based on levels of existence, their potential impact, and the feasibility of resolution.

**Phase 2: Analysis** examines the nature and implications of the unique landscape of pathologies for the system being examined. This phase is targeted to exploration of the specific implications each pathology holds for the particular system of interest. Pathologies do not have the same relevance, impact, or feasibility for resolution in a complex system.

The first phase only identifies the presence and impact of the 53 metasystem pathologies. The second phase involves an examination of nature and implications of the unique landscape of pathologies for the system interest. Driven by the kind of tools used in data collection of Phase I, the analyst collects and synthetizes the data into meaningful representations for further exploration of the pathologies. Invariably, this phase provides a deeper reflection on the pathologies identified from Phase 1. The following caveats apply to this phase:

- This analysis should *enumerate metasystem pathologies using measures of existence and impact,* and permit dialog concerning different notional evidence and support for the capture of the centroid of the pathology.
- The analysis should also indicate *variability in measures of degree and impact* as suggested by participants—in this case as taken from survey data. It is expected that each participant will not provide the same measure for the same pathology. This variability provides insights that might be further examined in Phase 3.
- The analysis should provide articulation of the *interpretation of feasibility* to address the pathologies identified by participants. This permits an explicit capture of the tacit nature of the pathology to be confronted and addressed, without a call for justification or loss of anonymity in the assessment.

**Phase 3: Exploration** guides an investigation into the meaning and system development implications for identified pathologies. An important preparatory aspect of this phase is the search for additional sources of data, anecdotes, and other supporting examples supportive of the classifications for the pathologies. This phase also maps existing initiatives and their expected potential contribution to identified pathologies. The result of this phase is a strategy and corresponding feasible actions designed to positively influence pathologies. Performance of this phase is critical to begin to make the pathology exploration actionable.

The results of Phase 2 are made available to system owners in preparation for further guided investigation into the meaning of the identified pathologies as well as their implications for system development. This phase involves a two-way dialogue between system owners and the analysts involving the general meaning of pathologies and exploration of the meaning in context for the system of interest. This dialogue is instrumental for articulating and/or voicing system of interest development implications in response to the discovered pathologies. Care must also be taken so as to provide support for the classification of pathologies along existence, impact, and feasibility. This might require gathering additional data, anecdotes, or supporting/refuting attributions for pathologies. It is during this phase that the existing initiatives (development activities underway in the organization) must be mapped against pathologies. This mapping enables discovery of strengths and weaknesses in system development in relationship to the existing pathologies. The results of this phase include a prioritized enumeration of pathologies based on feasibility. Feasibility is an indicator of the anticipated success should the pathologies be engaged for resolution. Ultimately, the output includes a set of strategies and corresponding actions designed to impact the identified pathologies.

**Phase 4: Implement** deploys selected responsive strategies and corresponding actions to address pathologies and provide for integrated system development. As with any system implementation, the response to pathologies will involve the potential for emergent conditions. Care must be taken to ensure that the implementation actions/strategies are monitored for their impact on the pathologies targeted for resolution.

The purpose of this phase is to ensure that selected responsive strategies are effectively deployed. Activities are based on what is decided in the previous phase. For example, this might include "develop and install a coordinated process for assessment of strategic monitoring" in response to metasystem pathology M5'.2. {Inadequate processing of strategic monitoring results} as identified in Table 2. Identifying this as an issue starts in Phase 1 by the initial identification and assessment of the suspected existence, impact and feasibility for resolution. Phase 2 continues to provide a more detailed examination and analysis of the pathology to identify sources and confirm existence of the pathology and veracity of attributions concerning the pathology. Phase 3 continues with a detailed examination to develop new initiatives while understanding and integrating current initiatives in relationship to the pathology. Phase 4 focuses on the planning for implementation of the responsive strategies and corresponding actions to address the pathology situation. An additional aspect of this phase is to set time expectations with respect to strategy/action deployments as well as definition of the expected contributions to address the pathology (reduction of existence, reduction of impact, or shifting feasibility to address).

**Phase 5: Follow-up** is focused on the examination of the impact for strategy and action execution in response to pathologies. While direct cause-effect is not possible, conclusions concerning the application of pathology responses should be examined for further implications.

This final phase is focused on examination of the effects of the strategies and actions undertaken to address pathologies. An established timeline, coupled with predetermined contribution expectations, can serve as a place-maker for a re-evaluation of the system by fulfilling two primary purposes: (1) to measure the effects of the strategies/actions as implemented in Phase 4 and (2) identification of new pathologies. Such efforts serve the role of continuous system development. This is essential since the system of interest is operating within a dynamic and most likely turbulent environment. Moreover, the deployment strategies might lose effectiveness over time, new pathologies might emerge, and new technologies might shift the landscape of pathologies along existence, impact, and feasibility dimensions. Therefore, navigating through the M-Path Method is truly continuous with each phase complementing and interrelated to the previous phases.

The application of pathologies for acquisition represents a new and novel perspective for understanding the nature of deficiencies in the acquisition system. A cursory look at the most recently recommended reforms (e.g., Panel 809 report), suggests that (1) while the reforms might be beneficial, they have been constructed and presented in independent actions, (2) the nature of targeting the recommendations does not suggest that the acquisition system is truly being addressed as an integrated system, and (3) without a direct linkage to systems based pathologies, several of the recommendations could be identified as addressing one or more pathologies.

## Using System Pathologies: An Application Perspective for Acquisition

The CSG paradigm, and corresponding systems pathologies, has been written from first principles. This has been largely on a clean sheet, especially with respect to the current breakdown of disciplines in capability management in areas like defense acquisition. Those with experience working all aspects of such bureaucracies will know that they largely are beholden to four disciplines, and their corresponding systems, which are also societal memberships: project management, engineering, finance, and contractual law. It is possible, and often necessary, to be members of, and competent in, multiple disciplines. However, it is extremely difficult to be an effective change agent or foster a reform movement operating to shift a bureaucracy with all four disciplines simultaneously satisfied. In fact, the existence and propagation of pathologies in a system are just as likely to occur at the interfaces of these memberships, as to location within a specific membership. Bureaucracies like defense acquisition have largely operated on a project model to implement capability changes for the last 40 years, giving what appears superficially to be an ascendancy to project management, whereas engineering is responsible for developing, checking, certifying, verifying, validating, reviewing, gating and so forth—in short, the handbrake mechanisms. This portrayal explains why acquisition policies are so amorphous and unwieldy (Keating et al., 2017b), and acquisition reviews have called for common-sense changes (Peever et al., 2015; Patanakul et al., 2016; Fowler et al., 2017; Kendall, 2017; Keating et al., 2017b). CSG, and the associated M-Path Method is clearly a means to achieve simpler “due process” and thus governance without the need to revert to intuition. However, such approaches face a politically-charged battle involving the four disciplines.

Thus, the first challenge in implementing CSG and discovery of pathologies is one of recognition of the need for deeper exploration of familiar terrain from a vantage point that is not familiar. The issue for project management (PM) or systems engineering (SE) becomes if you begin with, “you do not understand,” then the bureaucracy will not understand CSG or the value of engaging M-Path for discovery of deeper systemic issues. The complex systems in CSG speaks of SE, yet governance in modern projects, while it adheres to SE gating, is primarily run by the P3O model of portfolio, program, and project management offices; that is, the PM discipline (PMI, 2003). Even then, while the P3O model usually is drawn as a hierarchy, the portfolio and program management offices are relative new-comers, ironically put in for better project governance, and thus projects have usually remained as pre-eminently powerful instantiations of funded futures for the chief executives of operations. This is often reflected in the portfolio and program officers being under-resourced and performing mostly administrative coordination. It is an easy step to understand the increasing complexity introduced by a model such as P3O, and the inherent pathologies stemming from a lack of purposeful design corresponding to the increased complexity. Also, the management hierarchies above acquisition projects have often remained in place with program and portfolio offices as add-ons—intensifying emergent “pathologies” where there is already a battle for control across projects. Arguably, the first P3O attempts at good governance of projects is still in relative infancy and being championed largely by the PM discipline, albeit with encouragement from the other disciplines. The inclusion of CSG, and the corresponding system pathologies perspective, could cynically be seen as a too-late version of P3O brought by the SE discipline. Thus, the risk-value-resource value proposition of engaging such an endeavor likely would be met with skepticism, particularly where there is a lack of understanding, desire, or intensity to move from a fragmented status quo. This status quo would be an ignorant view of the elegance and potential efficacy of the fresh thinking which cuts across both disciplines and offers a new and novel set of eyes to a fragmented, and admitted status quo delineated by existing and emergent problems—thus far resistant to resolution by existing paradigms, methodologies, or status quo thinking. However, the axiom that "culture eats strategy for breakfast every day" has to factor into how to get CSG and pathologies thinking into use. CSG pathology thinking offers nine new metasystem functions that are not beholden to either PM or SE, yet both disciplines would claim to perform these metasystem functions already. The key of course is to establish a structured dialogue on how efficiently and effectively they are done. This is particularly the case in the examination of status quo acquisition issues against the CSG metasystem and corresponding pathologies. Here the nine standardized dimensional metrics of CSG have a distinct advantage over current P3O governance measures, as they are directly linked to systemic deficiencies attributable to underlying violations of systems theory principles.

Another issue of resistance to CSG and pathologies incorporation is branding. For the terms "CSG paradigm" and "System Pathologies" to be embraced and sustained, there needs to be a simplistic power to attract and retain converts. Yet each word of CSG, metasystem, and pathology is, if anything, anathematic to simplistic power—complex, systems, governance, metasystem, pathology—are like five bullets capable of killing the best intentions and noble notions to improve systems. So, if CSG and the M-Path Method are to achieve implementation, especially in bureaucracies and not the utopia of a Silicon Valley start-up, they might need to be, unfortunately, deployed first from a Machiavellian perspective. Most importantly, CSG is unlikely to succeed if it does not leverage extant P3O management efforts towards good governance—the absence of already accepted approaches misses the opportunity to approach the unfamiliar from a familiar point. What is sacrificed in inappropriate assumptions might be made up in being able to continue the conversation. The remainder of this section outlines a suggested implementation approach aligning to these significant cultural barriers.

In pursuit of our goal, the next task is to target where within the P3O construct to fit the CSG paradigm and focus on pathologies. As CSG aims to govern systems for viability through the identification and reduction of pathologies (as threats to viability), CSG is more logically aligned with program management. Projects by definition are meant to be unique and to open and close, whereas acquisition programs are intended, designed, and focused to sustain operational capability. That both CSG and program management use biological adjectives like evolutionary acquisition, system viability, and pathologies indicates a healthy alignment.

If CSG is to constructively leverage the extant governance of program management, then the 53 pathologies developed in CSG around the nine metasystem dimensions are key. This is necessary to avoid introduction of CSG as an independent and mutually exclusive approach in competition to existing development methods. Currently, program management offices, where they seek improvement, usually do so for standardization and accreditation and through project management institutes. These institutes wield considerable influence and provide recognition predominantly within the PM domain of acquisition bureaucracies, in part equalizing established recognition within engineering disciplines. The PM institutes have been working on standards and metrics for P3O, with some proposals looking foundationally at aggregating assessment of realized benefits across a portfolio/program while others set generic standards. The most commonly used PM metrics focus on organizational maturity, developed from the four basic process improvement phases of standardize, measure, control, and continuously improve, but with program and portfolio governance added, as shown in Figure 3.

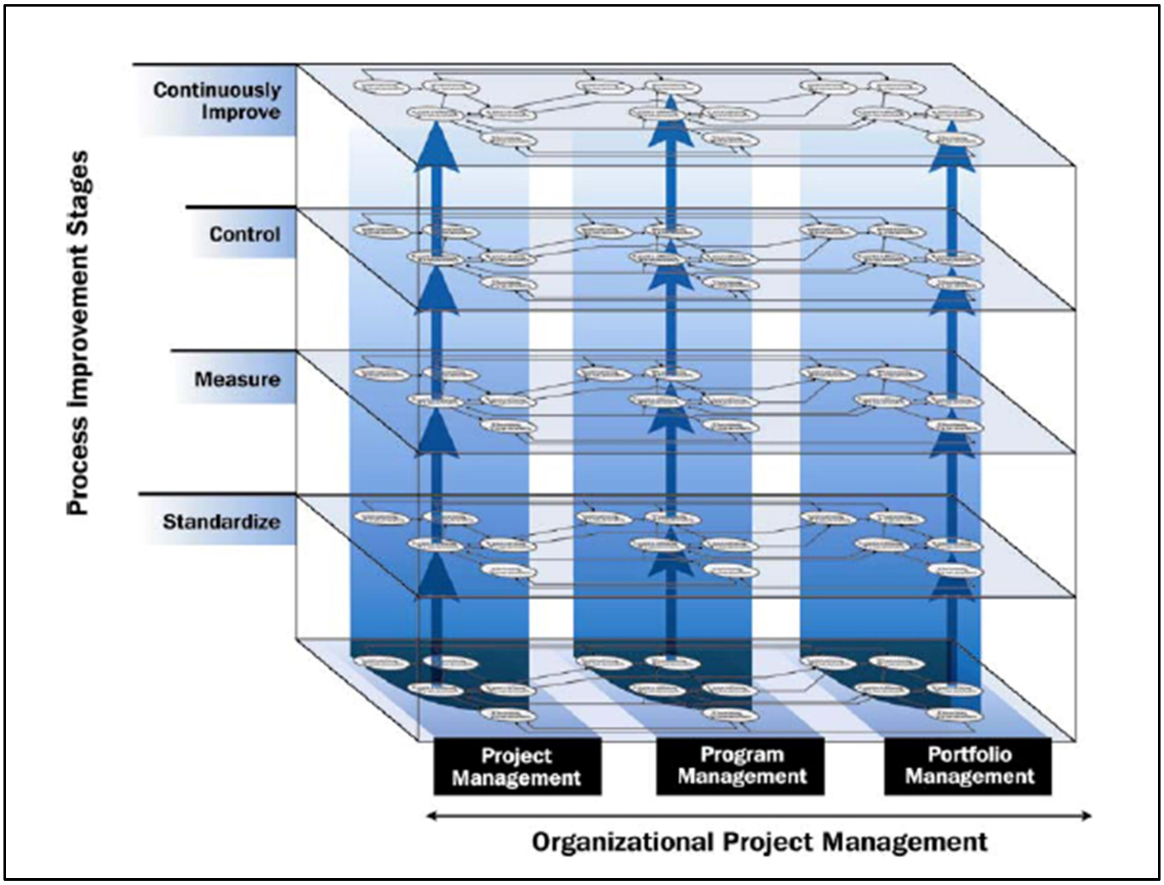


**Figure 3. Common PM Metrics**
(PMI, 2003, p. 28)

The maturity model metrics assess how the organization's processes compare to the model, usually as part of organizational accreditation for program or portfolio management. Scales are usually aggregated across project divisions and typically range up to five, where a three would be having defined project management processes and some measures of project achievement and feedback control, while a five would involve continuous and documented process improvement linked to better project achievements. Clearly, the CSG pathologies offer a substantially improved method to diagnosis program and portfolio governance, and if used correctly, ought to offer targeted process improvement, aligned with the first principles of CSG based in Systems Theory. Thus, P3O assessments offer a means for CSG pathologies to be adopted by accretion and improvement, analogous with how many manufacturing and some service industries use the six-sigma techniques without wholesale adoption and overt branding (Evans & Lindsay, 2014; Stamatis, 2016).

Adopting the CSG pathologies may be challenging for the PM disciplines alone, since as documented earlier, many governance elements remain relatively weak. A logical way to help achieve their use is to coopt the engineering domain, who, to be brutally honest, constructed most of the bureaucratic policies that beset acquisition as a check on projects delivering inadequate equipment. Much of the engineering hierarchy are skeptical at the vagueness of P3O project reviews and certainly of the traffic-lights and scoring of program office maturity. Putting the elegance and robustness of CSG pathologies into reviews of how program offices are structured and perform ought to gain engineering support. Thus, the PM discipline would lead the organizational reform, but using a robust model and CSG pathologies so the SE discipline can improve acquisition processes in a sound way. Put simply, CSG is not challenging the existence of PMOs, but is, rather, giving them better tools and techniques to refine the acquisition processes for more timely and effective governance.

A feature of CSG and the corresponding pathologies with potential to be a powerful change agent in PMO reviews, is the use of standardized assessment questionnaires. These questionnaires, taken by staff, can measure not only how effective the present state of governance is, but also how effective governance ought to be given the program objectives. This effectiveness can be examined in detail through the nine CSG meta-functional dimensions and their corresponding pathologies. In educational environments this is often referred to as the "actual" and "preferred" and is about the "fit" of an environment for an individual (Caplan & Harrison, 1993; Su, Murdock, & Rounds, 2015). Effort is therefore directed to where most P3O staff see governance is most deficient and it ought to lead to a satisficing level of necessary governance rather than constant pressure for utopia of an open five-point scale. Such a model is shown in the nine-point spider chart in Figure 4, where the actual web and preferred web show where there is the least fit and where effort in one dimension where governance exceeds assessed demand (e.g., capacity exceeding demand for the uncertainty dimension) can be traded off in another dimension where governance capacity falls below assessed demand (e.g., the complexity dimension; Jaradat, Keating, & Bradley, 2017). Such assessment of organizational governance and existence of pathologies depends on surveying the full spectrum of P3O; that is, both the governed and governing for 360-degree coverage of the system.

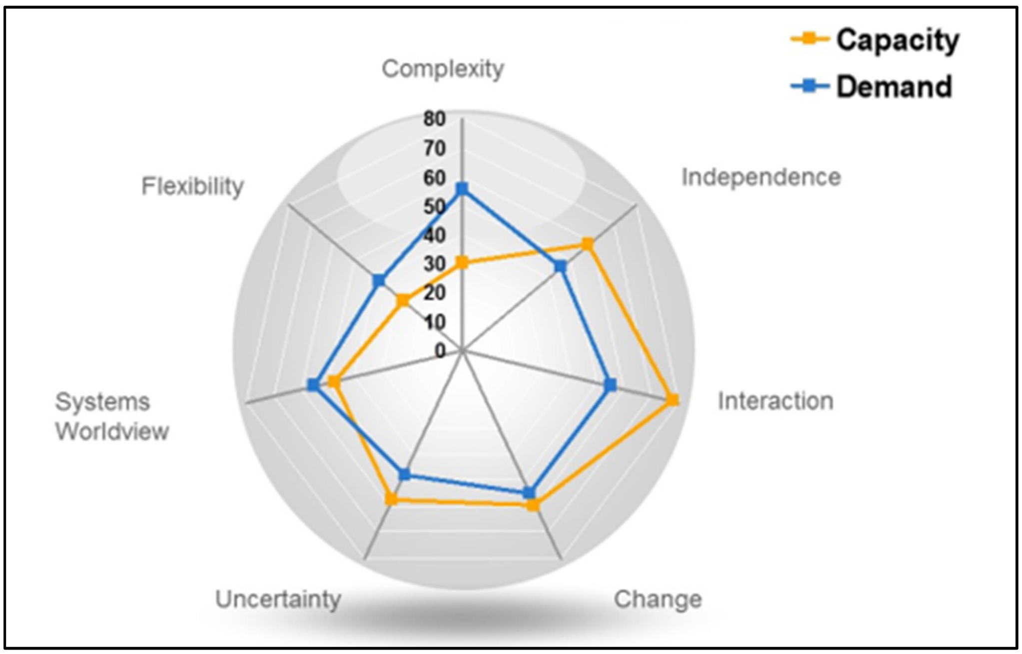


**Figure 4. Complexity—Systems Capacity Versus Environmental Demand**

Therefore, with that background, a general process of adopting the CSG paradigm and the constituent pathologies intent in industry, defense or other government acquisition department would be as follows:

1. With support from senior Systems Engineers, the portfolio of acquisition selects a program or series of program offices to undergo the CSG self-assessments of extant governance under the oversight of that program(s). The assessments are to compare the efficacy of CSG dimensions and pathologies against any existing program maturity improvement processes and metrics.
2. Each PMO doing entry-level CSG examines the preferred versus actual governance ratings of their P3O staffs to identify areas of expectation mismatch.
3. The associated pathologies, for areas of mismatch, are then workshopped with a representative sample of surveyed staff and affected process specialists to identify improvements which are then implemented.
4. After a suitable period of process embedding, the CSG self-assessments are repeated to examine if the mismatch(s) have been redressed and what, if any, further improvements are needed.

This approach has assumed a level of P3O management exists and has some form of self-assessment already focused on governance that can be leveraged. Where P3O management does not exist in name, it should exist in function and even if the self-assessment is ad hoc and not independent of general management, there exists a basis from which to acknowledge and begin. The M-Path Method is easily modifiable to fit to the approach proposed above.

## Conclusions, Implications, and Directions of Pathologies for Acquisition

In conclusion, we examine two interrelated facets for further development of CSG and the corresponding M-Path Method for both practice and research for acquisition. The application of the current state of CSG and M-Path for the acquisition field holds promise in several areas.

Ultimately, CSG and the M-Path Method to discover deficiencies in the performance of CSG functions, offers significant contributions to help practitioners address some of the most vexing current, as well as future, system problems they must confront. CSG is not suggested as a panacea for all problems facing the acquisition system and programs. Instead, CSG is advocated as an emerging field with significant opportunity to provide value in the following areas (Figure 5):

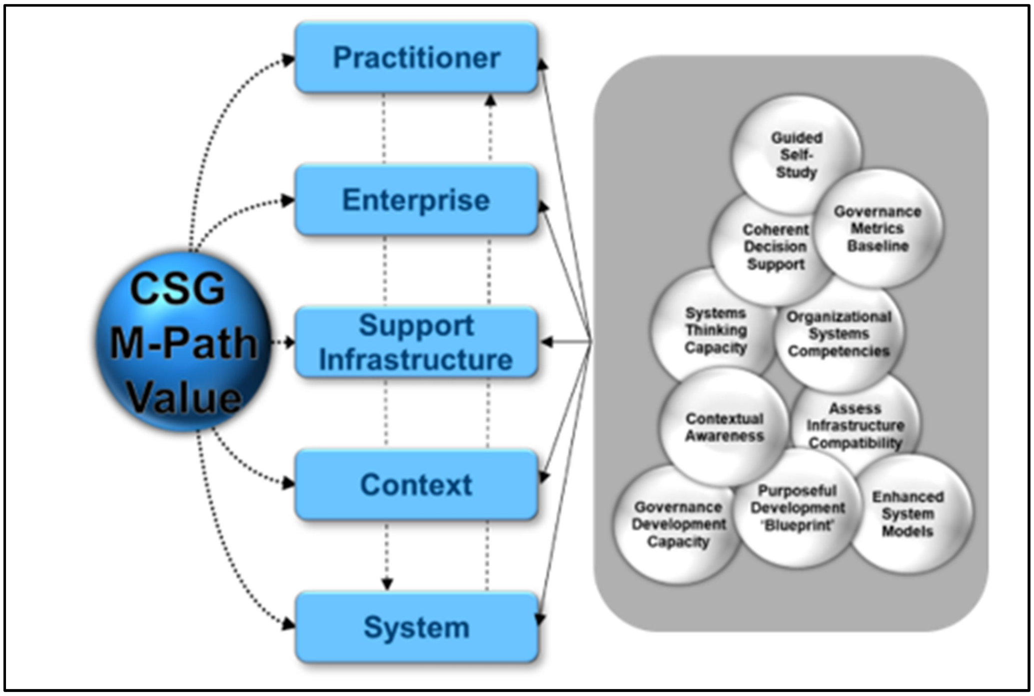


**Figure 5. CSG M-Path Method Value Adding Across Multiple Levels**

- **Rigorous Guided "Self-Study"** into CSG can provide significant insights into how the system (program, project, portfolio) actually functions. Although enterprises and their systems function routinely and successfully on a daily basis, as a matter of course practitioners are not particularly skilled, nor do they engage in deep reflection as to why, how, and what they do from a systems point of view. The gains to be made by reflective self-examination, from a systemic point of view, can reveal insights far beyond traditional methods of examination (e.g., Strategic Planning, SWOT analysis, Maturity Modeling, etc.). Thus, practitioners can examine a different level of analysis through "self-study" and experience insights in a "safe-to-fail" setting. Additionally, self-study might suggest the level of education/training that might be necessary for individuals and the organization to increase individual capacity and organizational competence necessary to engage in higher levels of systems thinking.
- **Coherent Decision Support** can be achieved by the big picture view of the governance landscape. This includes identification of highest leverage strategic impact areas and their interrelationship to the larger CSG performance gaps (through pathologies assessment). Thus, decisions for resource allocation can be better targeted. This allows steering away from activities that are simply intriguing without demonstrating the highest substantial benefit to the larger systemic governance concerns (e.g., pathologies high in existence, impact, and feasibility). In light of CSG development priorities, low contribution efforts can be eliminated, or resources shifted appropriately.
- **Governance Metrics Baseline** can be established to identify the present state of CSG functions as indicated by the pathologies. The set of unique indicators developed for a specific system of interest can provide a baseline that can be used to longitudinally establish the continuous progression of

governance improvement. In effect, the degree of improvement stemming from initiatives undertaken to improve CSG can be established. Therefore, the state and shifts in governance can be purposefully and actively planned, deployed, monitored, and adjusted as necessary.

- **Systems Thinking Capacity** of individual practitioners to engage in the level of systems thinking necessary to more effectively deal with the entire range of complex system problems can be enhanced through CSG application. These problems are a byproduct of modern acquisition enterprises and their systems. Effectiveness is achieved through development and propagation of CSG language, methods, and tools to assist practitioners in their efforts to design, analyze, execute, and evolve complex systems and their associated problems (Jaradat, 2015).
- **Organizational Systems Competencies** at the system (project, program, portfolio) level for dealing with complex systems and their derivative problems can be enhanced. This involves generation of knowledge, development of skills, and fostering abilities beyond the individual level to embrace problems holistically. For CSG, holism suggests competency development that expands beyond narrow technology centric infusions and the limiting cost-schedule-technical performance paradigm. Instead, enhanced competencies that span the entire range of sociotechnical considerations endemic to complex systems are an outcome from CSG engagement to identify, analyze, and address pathologies.
- **Enhanced Contextual Awareness** is a direct byproduct from the examination of system pathologies. Context exist as the circumstances, factors, conditions, or patterns that serve to enable or constrain performance of system functions. Thus, the wider consideration of system impediments provided by the M-Path Method can open the aperture of consideration of aspects for development of the system.
- **Assess Infrastructure Compatibility** necessary to support systems-based endeavors. This compatibility is necessary to formulate contextually consistent (feasible) approaches to problems, create conditions necessary for governance system stability, and produce coherent decisions, actions, and interpretations at the individual and organizational levels. The most exceptional system solutions, absent compatible supporting infrastructure, are destined to outright fail in the worst-case scenario and underachieve in the best-case scenario.
- **Governance Development Capacity** can be determined to help establish the feasibility of initiatives that can be undertaken with a higher probability of successful achievement. This does not minimize the degree of CSG discovered inadequacies that might exist in a system. However, it does take into account the current sophistication in system governance, the limiting/enabling context, and the individual systems thinking capacity that will influence what can be reasonably taken on with confidence of success. Minimally, consideration of feasibility for addressing M-Path Method generated issues can provide new insights into past successes/failures as well as cautions for impending future endeavors.
- **Enhanced System Models** generated through CSG M-Path Method deployment efforts can provide insights into the structural relationships, context, and systemic deficiencies that exist for governance of a system of

interest. These insights can accrue regardless of whether or not specific actions to address issues are initiated. The models can be constructed without system modification. Therefore, alternative decisions, actions, and interpretations can be selectively engaged based on consideration of insights and understanding generated through modeling efforts.

- **Purposeful Development Blueprint** development can provide focus for targeted advancement of the CSG functions. This accrues through resolution of priority M-Path derived issues in performance of system functions necessary to maintain system viability. While all viable (existing) systems perform the CSG functions and have pathologies, it is rare that they are purposefully articulated, examined, or addressed in a comprehensive fashion. Purposeful CSG development to resolve M-Path Method identified pathologies can produce a blueprint against which development can be achieved by design, rather than serendipity. This includes establishment of the set of "dashboard indicators" for CSG performance. These performance indicators exist beyond more traditional measures of system/organizational performance.

Ultimately, the CSG M-Path Method seeks to increase the probability of achieving desirable system performance (viability, growth, etc.) in the flux of a turbulent environment.

Further development of CSG pathologies for acquisition systems is focused on four critical challenges:

1. *Increasing Ease of Engagement*. CSG and corresponding pathologies are not easily understood, applied, or accessible for practitioners and the systems they manage. If CSG and pathologies are to become more mainstream there must be an increased emphasis on making the technologies (methods, tools, techniques, applications) accessible to practitioners. Accessibility must include the ease of engagement of pathologies, including (1) reduction of perceived risk for practitioners and systems subject to a thorough external analysis of design, execution, and development effectiveness, (2) efficiency in application resource demands, including time as well as cost, (3) emphasis on demonstrable value that can accrue from engagement in a CSG pathologies endeavor, and (4) potential linkage to ongoing or historical system development initiatives. Only by addressing these four areas can the probability of adoption of CSG pathologies be increased.
2. *Products-Insight-Action Triad*. Additional emphasis of CSG must focus on what tangible products (e.g., pathologies representation mappings) can serve as tangible artifacts of engagement in CSG activities. Absent tangible products, CSG is left at a conceptual level and is not likely to achieve full impact potential. Additionally, emphasis on the development of insights stemming from products will require processes that serve to guide exploration and interpretation of meanings generated from the CSG products. Finally, CSG pathologies insights must be made actionable to redesign, modify, and evolve governance for the system of interest. Irrespective of the intellectual grounding and products from CSG pathology applications, without corresponding actionable results, there is little possibility to make sustainable system improvements.
3. *System Ownership and CSG Accountability Acceptance*. Every system has owners who are ultimately responsible for the design of the system (functions), execution of the system (performance of functions to produce

results), and development of the system (to adapt to changing internal/external circumstances and address pathologies). Short of active engagement of “system owner” responsibilities and acceptance of accountability for CSG functions, there is little possibility to achieve the aims of CSG. Even though ownership might be agreed upon, the CSG responsibilities (e.g., pathology elimination) inherent in that ownership must be embraced. Without this mindset for CSG, the feasibility of effective engagement is minimal.

4. *Requisite Systems Capacity*. CSG pathologies are based in a strong underlying conceptual basis anchored in Systems Theory. Lacking a sufficient grounding, mindset, and acceptance of the “systemic” perspective, it is not likely that CSG pathologies will be effectively engaged or understood. Thus, care must to taken to ensure that an appropriate level of systems thinking capacity exist to adequately engage in CSG pathology related endeavors. Lacking the requisite systems capacity is likely to produce unsatisfactory results from CSG pathologies related efforts.

The acquisition field and practitioners are being called upon to deal with increasingly complex systems and the corresponding issues in their development. The emerging research in CSG and system pathology (e.g., see Troncale, 2013) pathologies can offer a new and novel way of framing acquisition issues across multiple levels, including projects, programs, and portfolios. CSG enables the design, execution, and evolution of critical metasystem functions necessary to maintain system viability. The identification of system pathologies provides a basis for a different level of thinking, corresponding decision, and alternative responsive actions. It is from this vantage point that we suggest engaging acquisition systems and their issues from a more systemic perspective creates possibilities for acquisition reform that, although desired, has yet to be realized.

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