# Complex System Governance

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**Abstract** This chapter examines the definition, nature, and role of complex system governance (CSG). We begin by introducing the need and utility for the CSG field. Next, we address five primary elements for elucidation of CSG. First, the context for CSG is examined. This is achieved by exploring the underpinnings of CSG and acknowledgment of the conceptual foundations upon which the field is grounded. Second, the nature and definition of CSG are explored. This examination includes the underlying philosophical, conceptual, and practical utility foundations for the emerging field. Particular emphasis is placed on the underlying CSG paradigm and supporting systems worldview upon which it is based. Third, the applicability of CSG to the design, execution, and development of governance functions is explored. This exploration is conducted through the examination of several vignettes and scenarios that serve to demonstrate the utility and contributions offered by CSG. As part of this exploration, advantages, limitations, and challenges brought by CSG to practitioners and the practices for governing complex systems are suggested. Fourth, the implications of CSG development to enhance practice are examined. Specific suggestions of the utility and contributions that CSG can make to both practices and practitioners who must navigate complex systems and their problems are explored. The chapter closes with some concluding thoughts and several exercises that serve to underscore central concepts from the chapter.

**Keywords** Complex systems · Systems thinking · Systems development · Management cybernetics

## 1 Introduction

The problems facing practitioners in modern systems appear to be intractable given the apparent ineffectiveness of the responses provided to address them. These problems continue to proliferate into all aspects of human endeavor and the systems

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designed to orchestrate those endeavors. They are not the privilege, or curse, of any particular field or sector (energy, utilities, health care, transportation, commerce, defense, security, services), as none are immune to the effects of this problem domain. Problems stemming from this domain do not have a precise cause-effect relationship that would make understanding and resolution easy. In fact, they are more likely products of a 'circular causality', where the precise singular determination of cause is doubtful [28, 35] Instead, these problems are consistent with the notion of [1] 'messes' (interrelated sets of problems that are not well formulated, understood, or easily resolved) and Rittel and Webber's [32] 'wicked problems' (problems that are intractable with current levels of thinking, decision, action, and interpretation). This problem domain is likely to continue and perhaps accelerate, as we continue to grapple with twenty-first-century complex systems and their problems.

Arguably, complex systems and their associated problems have been in existence long before the twenty-first century. However, the landscape for modern systems has changed appreciably into a much more 'complex problem space'. This problem space is marked by difficulties encountered across the holistic range of technical, organizational, managerial, human, social, information, political, and policy issues. The different aspects of this 'new normal' complex problem space have been previously established [17, 19, 20, 23] as being characterized by conditions identified in Fig. 1.


**Fig. 1** Challenges for practitioners in the complex system problem domain

While this problem listing is not exhaustive, it illustrates two important points. First, the issues emanating from the complex system domain continue without consistent resolution methods. Thus, there is certainly room for new thinking and derivative approaches to address this domain. Second, the challenges identified are not likely to recede in the future. In essence, this domain represents the 'new normal' for the practitioners dealing with complex systems.

The problems emanating from this domain appear to be intractable. In any cursory look at present systems and their problems, it is easily concluded that we have not, and are not, mounting an effective solution. Given the current level of ineffectiveness in dealing with complex system problems that have proliferated into all aspects of human endeavor, CSG has been introduced. It is in the domain presented above that CSG is being postured to impact practitioner capabilities to more effectively address growing concerns. CSG is primarily based in general systems theory [2, 8, 33, 34] and management cybernetics [4–6] and has been built upon their philosophical, theoretical, and methodological underpinnings. At this point in our development, we introduce CSG as it has been previously defined as the design, execution, and evolution of the metasystem functions necessary to provide control, communication, coordination, and integration of a complex system. This chapter will focus on the elucidation of CSG as a response to the problem domain identified in Fig. 1.

In many cases, our systems have developed over time through processes of accretion or self-organization. Accretion is a process whereby elements are added in a piecemeal fashion until the whole system appears fragmented and no longer makes sense. Self-organization involves letting system structure and resulting behavior develop with minimal design oversight. This can produce results that may or may not be consistent with expectations or desirable performance. The result of either of these system development processes, accretion or self-organization, can and often do result in systems that fail to meet performance expectations. In effect, system development is not purposeful, resulting in a condition we refer to as 'system drift'. Just as a powerless ship drifts along its intended course subject to uncontrollable currents, so too can our systems experience drift resulting from development by accretion or self-organization. System drift symbolizes a system that is subject to the unintended consequences that accrue in the absence of a purposefully executed design. In the end, system drift describes a condition all too familiar to practitioners who must navigate systems through the increasingly complex environment, while confronting seemingly intractable issues on a daily basis. CSG is a coherent response to system drift.

CSG is one of many systems-based approaches [16] designed to better deal with complexity and what we referred to earlier as 'system drift'. System drift denotes systems that, irrespective of the noblest intentions, have either which is never been properly designed or whose execution continually fails to meet desired performance expectations. In short, these 'drifting' systems fall short of delivering minimal value expected, much less producing high performance. We do not need to look far to see examples of drifting systems. In fact, it would be a rare day that we would not be impacted by systems in drift. Consider the following examples: (1) launching of a new Enterprise Resource Planning initiative that collapses due to emergent incompatibilities with existing systems, (2) a costly crisis from discovery of non-compliance to a regulatory requirement that has been in existence for several years but never identified, or (3) introduction of a new purchasing policy that achieves intended reductions in supplier costs but increases overall costs due to resulting schedule delays. Unfortunately, the impacts of system drift are not limited to increased costs. These drifting systems have considerable associated human cost. These human costs are borne by those that must suffer through these drifting systems by compensating for their ineffectiveness. CSG supports thinking, decision, and action to proactively and purposefully address system drift. Ultimately, CSG is intended to reduce the high human costs characteristic of these systems in drift.

Systems-based approaches, such as CSG, and the systems thinking upon which they are founded, are certainly not 'new' in trying to address what we described as system drift. The foundations of systems thinking have been traced as far back as the ancient Chinese work The I Ching (translated as Book of Change dated prior to 400 B.C.) that noted the dynamic nature of changing relationships among elements. Additionally, the central philosophical tenet of systems thinking, holism, can be traced back to the writings of Aristotle, who suggested that 'the whole is more than the sum of its parts'. Thus, approaches based in systems thinking and 'holism' are not new and have historically represented a significant step toward dealing with system drift. However, what is new in bringing CSG-applied research to the problem domain is the fusion of general systems theory and management cybernetics to provide practitioners with perspective, supporting methods, and tools to confront drifting systems. This practitioner-focused CSG research seeks to increase capabilities for better understanding, decision, and action in dealing with complex systems and their associated problems. In essence, CSG seeks to increase effectiveness in dealing with system drift.

CSG is focused on providing practitioners with perspective, methods, and tools to better understand and deal with complexities they must routinely confront. In essence, CSG helps avoid system drift through purposeful design, similar to a ship changing heading or speed to compensate for the effects of wind or current. Figure 2 below depicts five critical realities that practitioners responsible for modern complex systems must face. The ability to effectively respond to these realities will separate the high-performance systems from the 'also ran' systems in the future. We might hope that this situation would only be a temporary aberration from normal. Unfortunately, these conditions are not likely to subside in the near or distant future. Instead, they are more likely to intensify. Practitioners responsible for systems must adjust to thrive in this 'new normal' reality. Those who do not shift the level of decision, action, and understanding in response, in the best case scenario, will likely be experiencing system drift firsthand. In the worst case scenario, they are likely to experience outright failure and system collapse.

Effectiveness in dealing with these problem domains beckons for individuals and organizations capable of engaging in a different level of thinking, decision, and action to produce alternative paths forward. As one response, CSG is proposed as an emerging field to enable practitioners to build capabilities to better diagnose and effectively respond to deeper level systemic issues that impede system performance.

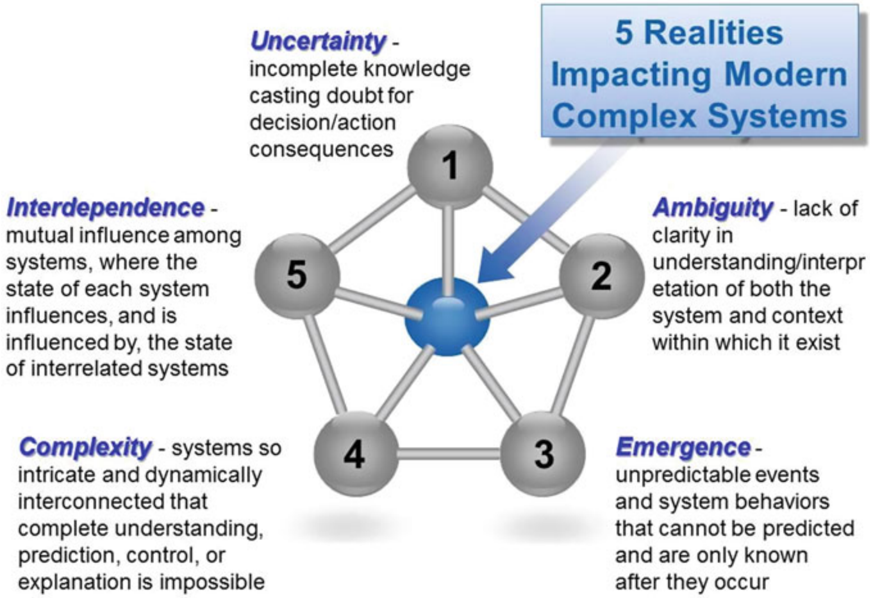


**Fig. 2** Realities for practitioners in modern complex systems

Thus, CSG seeks to identify and 'design through' fundamental system issues such as those identified in Fig. 1.

***A Complex System Governance Vignette—Water Utilities.***

*The water utilities industry provides an excellent demonstration of the pervasive nature of the complex system problem domain. Multiple sources indicate a challenge for water utilities as the industry tries to navigate the twenty-first century [3, 12, 31]. Among these recognized challenges are economic and financial uncertainty, resilience of operations, aging infrastructure, new and emerging contaminants in water supplies, an aging workforce and requirements for new skills in a future workforce, uncertainties in water resource demands and adequacy of current supplies, instantaneous access to information and public perceptions of performance, proliferation of information and advanced technologies, regulatory changes, the uncertainty of climate impacts, and the scarcity in resources as demands for efficiency increase. These conditions are not going to resolve or reside in the near future. It is also evident that the thinking and approaches to address these issues will not rest in those that have brought the industry to the present state. Instead, there is a clarion call that different thinking and approaches will be necessary even to maintain industry performance much less improve performance. Time continues to run short as industry crises loom eerily on the horizon. The water industry does not stand alone in these challenges. We only need to look to other industries, enterprises, and sectors facing similar circumstances (e.g., energy, transportation, health care, education, defense, security, infrastructure, etc.).*

Unfortunately, these issues exist at deep tacit levels and appear only as symptomatic at the surface. Thus, efforts to address the problems at the surface level, although providing temporary 'fixes', continually fail to resolve the deeper fundamental system issues. This deeper fundamental system-level resolution is necessary to preclude recurrence of the symptomatic issue in another superficial form. Continual treatment of symptomatic conditions contributes to 'system drift' by focusing on temporary correction of deficiencies at a superficial level. Unfortunately, this correction behavior is endemic to modern systems, fostering 'system superheroes'. These 'system superheroes' are recognizable as individuals who resolve surface symptoms (crises) through brute force and knowing how to navigate problematic systems. However, this behavior for error correction fails to address underlying systemic inadequacies, instead opting to reactively focus on apparent resolution that only serves to mask deeper systemic inadequacies. This is not to disparage the hard work and noble efforts of practitioners who become skilled at compensating for poorly designed and executed systems (system superheroes). On the contrary, we seek to draw attention to the liabilities of dependence of 'system superheroes' to resolve 'crises' invoked by faulty systems. We should ask three important questions of systems that operate in the 'system superhero' reactive problem resolution mode. First, is the existence of 'system superhero' behavior masking more fundamental deficiencies in the underlying system? Second, is reliance on 'system superheros' unsustainable, creating conditions for an eventual system collapse? And third, what happens when the 'system superhero's get overwhelmed, tired, retire, or just leave? While CSG cannot claim to eliminate the existence of system superheroes, it does provide an opportunity to address underlying systemic deficiencies that this behavior masks. And perhaps, if not making them obsolete, at least reducing reliance on superheros for system performance.

CSG is certainly not portrayed as a 'panacea' to singularly guarantee success with the present and future twenty-first-century problems facing organizations and their systems. However, CSG does offer a compelling argument as an approach to generate alternative thinking, decision, and action to address system problems. In addition, CSG can foster enhanced collaboration and partnerships across a system. This includes supporting: (1) a 'total systems view' based in a holistic perspective, (2) effective communication with multiple stakeholders through more explicit system understanding and system representations, (3) development of systems-based leadership skills that enhance capabilities for dealing with increasingly complex systems, and (4) increasing the likelihood of achieving expected performance. Again, while CSG is not a singular remedy to produce better-performing systems, it does provide a solid complementary set of methods, tools, and thinking to enhance practice.

The reminder of this chapter is organized as follows: Sect. 2 explores the context for CSG. This provides a brief background into the initial formulation of CSG to explain the particular genesis and contributing fields that inform CSG. Section 3 provides a detailed definition and development of CSG. This provides an articulation of the precise definition of CSG and the essential context necessary to grasp the essence of an emerging field. In Sect. 4, the applicability of CSG to modern complex systems and their problems is examined, where the emphasis is placed in the particular role that CSG might play in addressing a class of problems that appears intractable given present paradigms and approaches. Section 5 explores the implications that

CSG holds for addressing present and future complex systems and their problems. The implications for practitioners are also examined, with the intent to demonstrate the potential this field holds for advancing capabilities for dealing with complex system problems. Finally, the chapter concludes several exercises to consolidate thinking.

## 2 The Context for Complex System Governance

In this section, we examine the foundations for CSG, including the background of the initial formulation. Our examination is focused on development of the three primary fields informing the development of CSG. CSG lies at the intersection of three fields, including *general systems theory, management cybernetics,* and *governance* (Fig. 3). In broad terms, general systems theory provides the set of propositions (laws, principles, concepts) that defines the behavior and performance of all complex systems. For CSG, [general] systems theory provides the basis for integration and coordination. Management cybernetics (the science of effective system organization) complements general systems theory by identifying the essential functions performed by all complex systems to remain viable (continue to exist). Governance is concerned with the providing for direction, oversight, and accountability for system(s). Each of

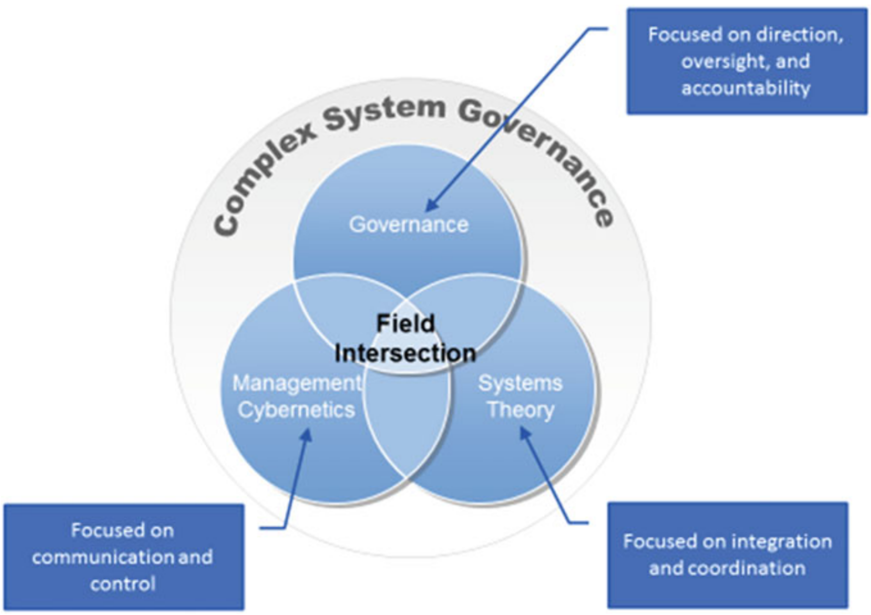


**Fig. 3** CSG at the intersection of three fields

these fields will be examined for their unique contributions as the conceptual basis for CSG.

## 2.1 Contributions of General Systems Theory to CSG

*General systems theory* cannot be depicted by a common definition that is accepted by a preponderance of those scholars and practitioners for which the field has significance. In fact, the foundations of systems thinking, upon which general systems theory and CSG have been built, can be traced as far back as the ancient Chinese work *The I Ching* (translated as Book of Change dated prior to 400 B.C.). From the earliest beginnings of mankind, the struggle with increasingly complex and troublesome systems and the continually evolving general systems theory has endured. The early Chinese work noted the dynamic nature of changing relationships among elements—a condition that has not changed in well over two thousand years since it emerged. Additionally, the central philosophical tenet of systems thinking, *holism*, can be traced back to the writings of Aristotle, who suggested that 'the whole is more than the sum of its parts'. The more recent depictions of general systems theory are frequently attributed to Anatol Rapoport, Norbert Wiener, Karl Ludwig von Bertalanffy, and Ross Ashby [27, 30], having emerged in the 1940s in response to the inabilities of 'reductionist' approaches to adequately account for behavior of more complex systems. Reductionism depicts a particular intellectual stance rooted in the knowledge that is objective and understandable from the behavior of the parts, relationships that can be precisely and repeatably defined, and a close coupling with the tenets of the scientific method [8, 14]. In contrast, *holism emerged* as the driving foundation of general systems theory suggesting that knowledge is subjective and observer dependent, understanding of behavior is found in the relationships among parts, and that behavior in (complex) systems is not necessarily capable of being completely understood or repeatable [9]. They kept re-discovering the Aristotelian dictum of the whole being greater than the sun of its parts in biology, psychology, sociology, and physics [8, 29]. This sets in motion a different level of thinking, based in understanding systems behavior/performance not being explained from traditional reductionist thinking.

The genesis of general systems theory is thus found in pursuit of the goal to find a common platform of understanding the behavior/performance for all systems and thus provide a basis for a common frame of reference for universally applicable models, principles, and laws that help explain 'system' phenomena [7, 15, 29, 30]. Thus, general systems theory has always been targeted to discovery and understanding of 'universally' applicable propositions that govern the behavior, function, and performance of all systems, be they natural or manmade.

General systems theory provides a strong theoretical grounding for complex system governance. General systems theory has been identified as a set of axioms and associated propositions (principles, concepts, and laws) that seek to describe the behavior of systems, either natural or manmade [2, 38]. A full development of general systems theory is beyond the scope of this chapter. However, following the development of Whiteny et al. [38] and adapted from the earlier work of Keating [20], general systems theory is provided as a set of seven systems axioms and their implications for CSG:

1. *Centrality Axiom:* Central to all systems are emergence and hierarchy and communication and control. This implies that there should be consideration for flexibility in design for uncertainty, minimal constraint on constituents within a system, and the flow of information by design.
2. *Contextual Axiom:* Meaning in systems is derived from the circumstances and factors that surround them. This implies the necessity to account for influence of system context and the holistic consideration of the range of socio-technical-political aspects of the domain within which a system is embedded.
3. *Goal Axiom:* Systems achieve specific goals through purposeful behavior using pathways and means. This implies that there must be clarity in system purpose as well as the pathways, strategies, and resources necessary to achieve those purposes.
4. *Operational Axiom:* Systems must be addressed in situ, where the system is exhibiting purposeful behavior. This implies that system performance must be monitored and balanced to alleviate variability and provide for integration of constituent elements in their operational setting.
5. *Viability Axiom:* Key parameters in a system must be controlled to ensure continued existence. This implies that external perturbations and internal flux must be managed to maintain viability consistent with the continuing identity of the system.
6. *Design Axiom*: Purposeful imbalance of resources and relationships. This implies that there must be responsive system reconfiguration through trade-offs consistent with the identity of the system. Also that, there is a rebalancing of constituent autonomy with system-level integration considerations as well as resource allocation balancing.
7. *Information Axiom:* Systems create, process, transfer, and modify information. This implies that information necessary to support consistency in decision, action, and interpretation on behalf of the system must be by purposeful design. Also, sufficient redundancy in information must be available to ensure continuity of the system.

In effect, general systems theory provides a theoretical grounding for CSG such that integration and coordination necessary to ensure continuation of a system can be achieved.

## 2.2 Contributions of the Governance Field to CSG

*Governance* provides a critical set of grounding insights for CSG. There is an abundance of perspectives on governance stemming from the literature. However, tailoring this work for CSG, the following developments based on the work of Calida [10] and subsequently Calida and Keating [11], provides discovery of the multitude of perspectives that permeates the governance field. We offer three that are influential in providing a grounding perspective of governance for CSG:

1. *Process-centric:* collective decision making processes that are based in formal, consensus seeking, and deliberative execution in nature. The aim is to provide effective processes that enable the act(s) of governance to be performed.
2. *Structure-centric:* emphasis on the formulation and execution of structures that preserve order/continuity and steer the system in desired directions. The aim is to install sufficient structure that provides and maintains the trajectory of a system toward desired ends.
3. *Policy-centric:* emphasis on the formulation of policies that act to inculcate the principles, norms, rules, and behaviors that produce sufficient regularity in performance. The aim is to invoke policies with sufficient capacity to direct/control aspects essential to achieve/maintain system performance.

In addition, it is important in the development of CSG to make a distinction between 'governance' and 'management' perspectives. Based on the work of Keating [22], Table 1 identifies the management–governance critical distinctions.

Based on this spectrum of governance perspectives suggested by Calida [10], we can draw several important themes, which serve to inform a systems perspective of governance from the literature. For CSG, we suggest that governance embodies continuous achievement of: (1) *Direction:* sustaining a coherent identity and vision that support consistent decision, action, interpretation, and strategic priorities, (2) *Oversight Design:* providing control and integration of the system and corresponding initiatives, and (3) *Accountability:* ensuring efficient resource utilization, performance monitoring, and exploration of aberrant conditions.

## *2.3 Contributions of Management Cybernetics to CSG*

*Management cybernetics* has been described by its founder as the science of effective organization [4]. Management cybernetics provides a critical contribution to the emerging paradigm of complex system governance. Beer [4, 6] introduced the concept of the 'metasystem' as a set of functions that must be performed by any viable (continuing to exist) system. The metasystem acts to provide the integration and coordination necessary to ensure that a system continues to produce the products or services that allow it to meet performance levels necessary to continue to operate (exist). Failure of any of the metasystem functions would jeopardize the overall system. Beer's formulation of the metasystem provides five essential functions for continued system viability. These functions are summarized below:

1. *Coordination function:* provides for system stability by preventing unnecessary oscillations within the set of systems being integrated by the metasystem.

**Table 1** Differences between management and governance

| Characteristic | Management | Governance | Implications for CSG |
|---|---|---|---|
| *Emphasis* | Outputs (tangible, objective, short term) | Outcomes (less tangible, subjective, long term) | Determination of governance 'goodness' is not simple or straightforward |
| *Central questions of concern* | What? And How? | Why? | Governance exists at a higher logical level of performance—emphasizing purpose |
| *Focus* | Near-term demonstrable results | Long-term future focused trajectory | The focus of governance is expansive, entertaining long view questions of strategic rather than operational significance |
| *Determinants of success* | Easily defined, measured, and tracked | Difficult to define and measure | While governance measures might be developed, they necessarily lack precision |
| *Time horizon* | Short term | Long term | The nature of governance invokes a much longer time horizon |
| *Action-response proximity* | Close separation between action and system response | Tenuous separation and relationship between action and response | Instabilities in understanding, knowledge, and magnitude create separation between action-response certainty |
| *Uncertainty* | Local uncertainty concerns | Global uncertainty concerns | Governance has a more global level of uncertainty and its resolution |
| *Stability and emergence* | Local proximity stability, local-level emergence | Global proximity stability, global-level emergence | Global focus of governance questions assumptions of long range or time stabilities |

Promotes operational system performance by ensuring sufficient integration within the system. Acts to harmonize the system such that the system acts in unison. Without the coordination function, the system would be subject to unnecessary turbulence, decreasing both efficiency as well as effectiveness.

2. *Operational control function:* maintains operational performance on a day-to-day basis. Provides for the execution of policy, distribution of resources, and accountability within the system. Governance must provide a focus that allows near-term achievement to be balanced with longer term system shifts necessary to maintain viability.
3. *Audit and accountability:* provides monitoring of the system to identify aberrations and invoke necessary explorations to determine the source of the aberrant behavior or unexpected variance. Essential to understanding the nature of variance and focus actions to resolve variance.

4. *Development function:* scans and captures information from the environment and assesses that information for strategic implications and system- level impacts. Models the future and strategic evolution of the system. Critical to governance since the early indicators of strategic system threat are identified and interpreted.
5. *Policy function:* provides for the strategic decisions and direction that maintain the identity of the system. Monitors and maintains a balance between the inherent tension between the long-term external focus and the short-term internal focus of the system. For governance, this function is essential to ensure that the system maintains itself on a trajectory consistent with the desirable future.

In development of CSG, management cybernetics brings three important contributions. First, the strong grounding in cybernetics provides a strong theoretical foundation for CSG. Cybernetics, at a most basic level, is concerned with communication and control—in effect deriving from the Greek notion of 'steering'. This is consistent with the function of governance as providing the direction and monitoring the movement of the system along that trajectory. With respect to control, taking a cybernetic viewpoint allows inclusion of the more expansive perspective of control. This perspective is consistent with providing the highest degree of autonomy within a system, while preserving integration necessary to maintain system performance. Second, the work of Beer [4, 6] provides a model (viable system model) which includes functions (metasystem) consistent with achievement of governance for a system. This reference model, identified by the functions above, provides CSG with an established frame of reference upon which to build. The management cybernetics foundation provides a strong systemic/cybernetic set of underpinnings, is logically consistent with CSG articulation from a systems perspective, and offers a field which has withstood several decades of scrutiny. Since its development in the 1970s, management cybernetics has been successfully applied for over five decades. It has maintained a sustainable footing, even with the arrival and departure of a multitude of other methods or approaches that have ceased to exist in any formidable fashion.

***A CSG Vignette—No Way Out of the Crisis Mode.***

*The mantra is frequently heard in the corporate halls, 'all we do is continually deal with crises, moving from one fire to the next.' One executive, tired of the continual 'firefighting mode', decided to examine their system from a 'governance' perspective. This entailed structured accounting for the design, execution, and development of the system. The discovery from an introspective examination suggested that while people were working harder, they were masking system deficiencies that created inefficiencies, inconsistencies, and a seeming endless engagement in the 'status quo' operation in continual crisis mode. Engaging in a protracted 'CSG study' of their system focused on identification and assessment of critical systemic issues (governance) in the design and execution of their system. The result of the 'guided' self-study identified and prioritized multiple design issues based on their impact on system performance. For example, one design issue was the near absence of coordinated efforts with respect to scanning the environment for trends, patterns, and shifts. This absence precluded early identification, analysis, and response planning—prior to the inevitable crises that would eventually erupt upon their 'too late' discovery. The stage was set to establish and integrate appropriate mechanisms for more effective environmental scanning.*

## 3 Defining Complex System Governance

In this section, we examine the nature and definition of CSG. We begin with introduction and amplification of a definition of CSG. This is followed by examination of the systems-based paradigm that captures the essence of CSG. We close this section by the examination of five fundamental aspects that capture the essence of CSG.

### *3.1 Defining CSG*

There is a growing body of knowledge related to CSG. The essence of CSG lies in the current state of the definition captured as the '*design, execution, and evolution of the metasystem functions necessary to provide control, communication, coordination, and integration of a complex system*' [24]. This depiction of CSG allows for several points of emphasis.

First, *design* accentuates the necessity to purposely and proactively engage in the creation of the governance system. While this seems as though it should be a taken for granted proposition, we suggest that truly purposeful, holistic, and comprehensive design of governing systems represents the rare case. While we might argue the merits of this conclusion, at this point, it suffices to say that based on the current level of performance and issues propagating all manner and form of our 'manmade' complex systems, the anecdotal evidence suggests that what we are doing with respect to our systems is not working.

Irrespective of purposeful/purposeless design, *execution* embodies the notion that a design without deployment offers little more than good intention. Execution is where a design meets the harsh realities of the 'real world' which is fraught with complexity and emergent conditions that are sure to test the most thoughtful designs. We should note that the need to adjust a system during execution is not indicative of poor design, but rather recognition that all designs are flawed. They must be flawed because they are abstractions of real-world complexity that can be neither totally captured nor completely understood.

The term *evolution* recognizes that systems as well as their environments are in constant flux. Therefore, governance must also be able to flex (evolve) in response to internal and external changes impacting the system. *Evolution* by its very nature suggests that the emphasis is on long-term sustainability, notwithstanding the need to operate a system in real time. In effect, governance must be capable of absorbing, processing, and responding to external turbulence and internal system flux to ensure the system remains viable (continues to exist). Viability must be maintained in both the short-term operational sense that delineates current system existence as well as the long-term evolutionary sense that positions the system for the future.

The CSG definition with the articulation of *design, execution, and evolution* focuses attention on the second part of the definition, *metasystem* as the set of functions that produces governance for a complex system. Nine (9) interrelated functions serve to capture the essence of CSG [24, 25]. These functions find their basis in and offer an extension of Beer's metasystem concept in the viable system model [4–6]. The metasystem for CSG is the set of 9 interrelated functions that acts to provide governance for a complex system. These functions include:

- ***Metasystem Five (M5)—Policy and Identity—***focused on overall steering and trajectory for the system. Maintains identity and balance between current and future focus.
- ***Metasystem Five Star (M5*)—System Context—***focused on the specific context within which the metasystem is embedded. Context is the set of circumstances, factors, conditions, or patterns that enables or constrains execution of the system.
- ***Metasystem Five Prime (M5')—Strategic System Monitoring—***focused on oversight of the system performance indicators at a strategic level, identifying performance that exceeds or fails to meet established expectations.
- ***Metasystem Four (M4)—System Development—***maintains the models of the current and future system, concentrating on the long-range development of the system to ensure future viability.
- ***Metasystem Four Star (M4*)—Learning and Transformation—***focused on facilitation of learning based on correction of design errors in the metasystem functions and planning for transformation of the metasystem.
- ***Metasystem Four Prime (M4')—Environmental Scanning—***designs, deploys, and monitors sensing of the environment for trends, patterns, or events with implications for both present and future system viability.
- ***Metasystem Three (M3)—System Operations—***focused on the day-to-day execution of the metasystem to ensure that the overall system maintains established operational performance levels.
- ***Metasystem Three Star (M3*)—Operational Performance—***monitors system performance to identify and assess aberrant conditions, exceeded thresholds, or anomalies.
- ***Metasystem Two (M2)—Information and Communications—***designs, establishes, and maintains the flow of information and consistent interpretation of exchanges (through communication channels) necessary to execute metasystem functions.

The means for executing the set of 9 interrelated CSG functions providing governance is found in the *metasystem communication channels* that provide for the flow of information between system entities as they perform functions. These channels support the flow of information for decision and action as well as produce consistency in interpretation for exchanges within the metasystem and between the metasystem and external entities. The ten CSG communication channels are adapted from the work of Beer [4–6] and extensions of Keating and Morin [26]. Table 2 below provides a concise listing of the communication channels, their primary CSG metasystem function responsibility, and the particular role they play in CSG metasystem execution.

The final part of the definition of CSG is focused on the elements of *control, communication, coordination, and integration*. These terms, and their basis, emanate from management cybernetics (communication, control) and general systems theory

**Table 2** Communication channels of the metasystem for CSG

| Communications channel and responsibility | CSG metasystem role |
|---|---|
| Command (Metasystem 5) | • Provides non-negotiable direction to the metasystem and governed systems<br>• Primarily flows from the Metasystem 5 and disseminated throughout the system |
| Resource bargain/accountability (Metasystem 3) | • Determines and allocates the resources (manpower, material, money, methods, time, information, support) to governed systems<br>• Defines performance levels (productivity), responsibilities, and accountability for governed systems<br>Primarily an interface between Metasystem 3 to the governed systems |
| Operations (Metasystem 3) | • Provides for the routine interface concerned with near-term operational focus<br>• Concentrated on providing direction for system production of value (products, services, processes, information) consumed external to the system<br>• Primarily an interface between Metasystem 3 and governed systems |
| Coordination(Metasystem 2) | • Provides for metasystem and governed systems balance and stability<br>• Ensures design and achievement (through execution) of design: (1) sharing of information within the system necessary to coordinate activities and (2) ensures decisions and actions necessary to prevent disturbances are shared within the metasystem and governed systems<br>• Primarily a channel designed and executed by Metasystem 2 |
| Audit (Metasystem 3*) | Provides routine and sporadic feedback concerning operational performance<br>• Investigation and reporting on problematic performance issues within the system<br>• Primarily a Metasystem 3* channel for communicating between Metasystem 3, the governed systems, and the metasystem concerning performance issues |
| Algedonic (Metasystem 5) | • Provides a 'bypass' of all channels when the integrity of the system is threatened<br>• Compels instant alert to crisis or potentially catastrophic situations for the system<br>• Directed to Metasystem 5 from anywhere in the metasystem or governed systems |

(continued)

**Table 2** (continued)

| Communications channel and responsibility | CSG metasystem role |
|---|---|
| Environmental scanning(Metasystem 4') | • Provides design for sensing to monitor critical aspects of the external environment<br>• Identifies environmental patterns, activities, or events with system implications<br>• Provided for access throughout the metasystemMetasystem as well as governed systemsSystem by MetasystemMetasystem 4' |
| Dialog (Metasystem 5') | • Provides for examination of system decisions, actions, and interpretations for consistency with system purpose and identity<br>• Directed to MetasystemMetasystem 5' from anywhere in the metasystem or governed systems |
| Learning(Metasystem 4*) | • Provides detection and correction of error within the metasystem as well as governed systems, focused on system design issues as opposed to execution issues<br>• Directed to MetasystemMetasystem 4* from anywhere in the metasystemMetasystem or governed systems |
| Informing (Metasystem 2) | • Provides for flow and access to routine information within the metasystem or between the metasystem and governed systems<br>• Access provided to entire metasystem and governed systems<br>• Primarily designed by Metasystem 2 for utilization by all metasystem functions as well as governed systems |

(coordination, integration). Here are the extended perspectives for each of these elements provided by CSG:

- *Control: c*onstraints necessary to ensure consistent performance and future system trajectory. In our formulation of control, we look to a more informed system view for guidance. This view suggests that control is not a pejorative term, to be scorned as a form of domination over a particular venue, activity, or entity. On the contrary, in the systems view we take, control is essential to ensure that the system stays on the trajectory that will provide future viability in response to changing conditions and circumstances. This is achieved by providing the greatest degree of autonomy (freedom and independence of decision, action, and interpretation) possible while still maintaining the system at desired levels of performance and behavior. In effect, this suggests that over-constraint of a system wastes resources (constraint is not free), limits system initiative/creativity, and diverts important emphases of a metasystem unnecessarily to lower levels of the system (inefficiency). However, underconstraint may sacrifice system level performance by providing excessive autonomy at the expense of integration necessary to maintain system level performance.

- *Communication: f*low and processing of information necessary to support consistent decision, action, and interpretation across the system. Communication is essential to governance and operation of the metasystem. Communications include not only the exchange of information, but also the interpretative schemas that permeate the system. These interpretative schemas are necessary to provide coherence in making, understanding, and interpreting the myriad of exchanges in a system. Communications may range from formal to informal, explicit to tacit, and patterned to emergent. There is not an optimal configuration for communication in a system, and the arrangements are certainly subject to shifts over time and emergent patterns. However, from a complex system governance perspective, communications are something that would be better off not left to chance self-organization. Instead, purposeful design and evolution of communications within a system are more likely to produce and maintain desirable results.
- *Coordination: p*roviding for effective interaction among different entities within the system, and external to the system, to prevent unnecessary fluctuations. Certainly, coordination is an essential aspect to ensure that a system provides sufficient interaction among different elements to maintain consistency. Quite possibly, the most important aspect of coordination is the damping of unnecessary fluctuations as the system operates. In effect, this implies that there must be sufficient standardization to provide routine interface as well as a sufficiently robust design to absorb emergent conditions that could not have been known in advance. While original work in management cybernetics focused on coordination as an internal function, we should also consider the necessity for coordination external to the system.
- *Integration:* design for system unity with common goals, accountability, and balance between individual constituent autonomy and system level interests. The primary focus of integration is to insure that the system achieves desirable levels of performance while (1) providing the maximum level of autonomy to constituents, (2) invoking the minimal constraint necessary for the system to function as a unity in achieving the intended purpose, and (3) strategically shifting the balance point between autonomy and integration based on changes in contextual factors and system performance levels. Integration is not achieved through serendipity, but rather by active design and continuous evolution.

The definition of CSG is incomplete without recognition of the underlying paradigm within which it is embedded. We now turn our attention to examine this paradigm and its importance to the deeper understanding and development of CSG.

***A Complex System Governance Vignette—Where is the Metasystem?***

*Our systems continually act to disappoint by producing behavior, performance, and outcomes that are inconsistent with our intentions. An exemplar of this can be found in the case of an urban university, seeking to better understand their 'system' for bringing new students into the university system. Engaging in examination of the 'system' used for bringing on new students, several discoveries came to the forefront. Among these were the realization that the 'system' for* *student entry was not designed, executed, maintained, or developed as a system at all. Instead, what was purported to be a system was a loose 'aggregate' of different processes, elements, and components. This aggregate had developed over time, without the benefit of a higher-level view concerning 'how it actually fits together' and made sense to effectively guide student entry. What was discovered was that there were individual units (e.g., finance, admissions, housing) that individually functioned very well. However, from a metasystem viewpoint, the individual units failed to function together. This was evidenced by the many problems that spanned multiple units and required their integrated efforts to address. Unfortunately, lacking a design or understanding as to how the 'metasystem' functioned, each issue that required multiple units for resolution generated inconsistent performance, emergent crises, and high human costs (frustration for administrators as well as students who had to navigate the system). The active examination from the 'lenses of the CSG metasystem helped to identify system design deficiencies and understand their source in systems principles/laws violated). Thus, a different path forward was made visible. A new decision, action, and performance interpretation space was opened to the system designers.*

## *3.2 The CSG Paradigm*

CSG is developing and exists in the early stages of emergence at the intersection of the governance, general systems theory, and management cybernetics fields as shown in Fig. 3. As such, it has the advantages of being tied to three fields with substantial substance, acceptance, and longevity. On the contrary, this intersection also invokes the criticisms and limitations of the fields as well as the potential for incompatibilities of the fields. Potential incompatibilities might exist across philosophical, theoretical, or methodological lines. This does not diminish the pursuit of CSG as an integrated field, but rather establishes a set of cautionary considerations in movement forward.

In the light of this caution, we have produced a succinct paradigm for CSG. This paradigm is related but distinct from each of the informing fields. As such, the paradigm exists as the particular way of thinking (worldview), which defines the grounding essence of the field. At this early stage, we would hesitate to suggest that CSG could be either considered a field or possessed a generally accepted paradigm. Instead, we have deliberately chosen to suggest an emerging paradigm for CSG—rooted in the governance, general systems theory, and management cybernetics, we have previously articulated. Although this does not preclude discovery or inclusion of other works or bodies of knowledge, it does offer a tenable starting point for further exploration. CSG could proceed absent a defining paradigm. However, this would be shortsighted, particularly given the CSG emphasis on enhancing the prospects for long term, sustainable systems, and solutions to their problems.

A paradigm offers a particular way of thinking (worldview). For CSG, we offer the following articulation of the paradigm:

*From a systems theoretic foundation, a set of functions is enacted by mechanisms that invoke metasystem governance to produce the communication, control, coordination, and integration essential to continued system viability.*

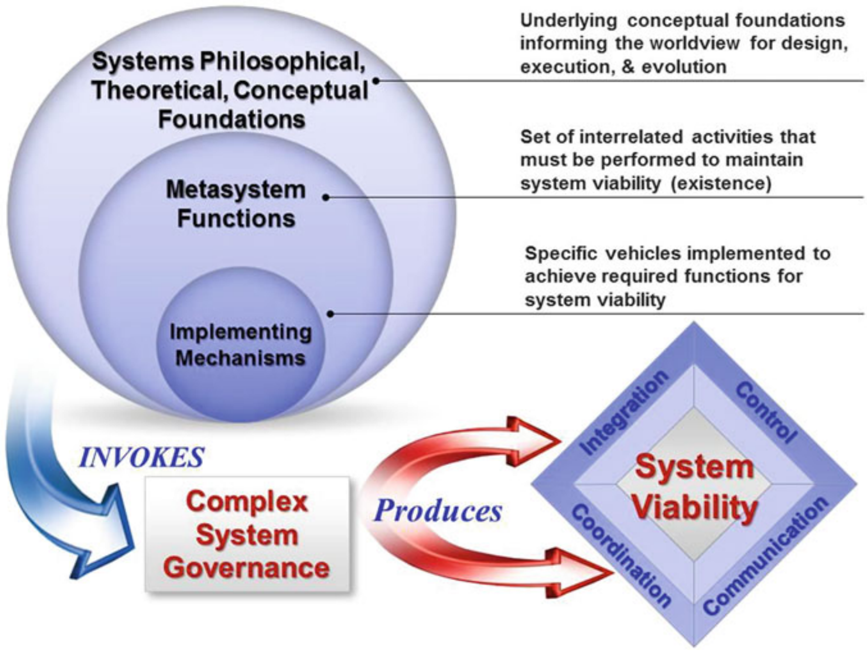


**Fig. 4** Emerging paradigm for metasystem governance

Figure 4 below provides a pictorial representation of the emerging paradigm for CSG. It should be noted that the set of (metasystem) functions referred to in the paradigm as well as their development do not operate in isolation from one another. On the contrary, the functions themselves form an inseparable unity. The paradigm includes the relationship of three primary elements that serve as a triad for CSG. The first element consists of the *systems philosophical, theoretical, and conceptual foundations*. This foundation is rooted primarily in the general systems theory field, although foundational concepts from management cybernetics and governance are not excluded. The second element stems from the *metasystem functions* (specified above) that exist within the systems theoretic foundations and are subject to the laws, principles, and concepts that constitute general systems theory. *Implementing mechanisms* are the final element of the CSG triad, complementing conceptual foundations and metasystem functions. Implementing mechanisms are the ’vehicles’ through which the metasystem functions are performed.

Conceptual foundations help to explain and understand ‘why’ systems behave and perform as they do, based on the laws and principles of general systems theory and management cybernetics. These laws and principles are immutable and cannot be negotiated away. The consequences for violation of the laws are real and will impact system viability. The metasystem functions identify ‘what’ must be achieved to ensure continued system viability. All systems must perform these functions at a minimal level to maintain viability. However, viability is not a 'guarantee' of performance excellence. On the contrary, viability only assures that the system continues to exist. There are degrees of viability, the minimal of which is existence. Implementing mechanisms are the specific vehicles (e.g., processes, procedures, activities, practices, plans, artifacts, values/beliefs, customs, more) that implement metasystem governance functions for a specific system of interest. These mechanisms may be explicit/tacit, formal/informal, routine/non-routine, effective/ineffective, or rational/irrational. However, all mechanisms can be articulated in relation to the metasystem governance functions they support.

## *3.3 Five Fundamentals that Capture the Essence of CSG*

The essence of CSG can be captured in five fundamental points that serve to provide a succinct depiction of a very detailed approach to the design, execution, and development of complex systems.

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, non-negotiable, unbiased, and explain system performance. *Practitioners must ask, 'do we understand systems laws and their impact on our system(s) design and performance?'*
2. ***All systems perform essential governance functions that determine system performance.*** Nine system governance functions are performed by all systems, regardless of sector, size, or purpose. These functions define 'what' must be achieved for governance of a system. Every system invokes a set of *unique implementing mechanisms* (means of achieving governance functions) that determines 'how' governance functions are accomplished. Mechanisms can be formal-informal, tacit-explicit, routine-sporadic, or limited-comprehensive in nature. CSG produces system performance which is a function of previously discussed *communication, control, integration, and coordination. Practitioners must ask, 'do we understand how our system performs essential governance functions to produce performance?'*
3. ***Governance functions can experience pathologies (deviations from 'healthy' system conditions) in performance of functions.*** There is no perfect system in execution. Regardless of the nobility of a system design, execution includes too many variabilities to 'guarantee' complete or absolute realization of design intentions. The effectiveness of governance is evident in the efficacy of identification, assessment, response, and evaluation to inevitable pathologies. Governance provides the degree of resilience and robustness to withstand and persevere in the middle of external turbulence and internal system flux. Good systems deal with pathologies as they occur—great systems continually design out pathologies before they escalate into crises. *Practitioners must ask, 'do*

*we purposefully design and redesign our system to address and preclude pathologies?'*

4. ***Violations of systems laws in performance of governance functions 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, violation can escalate to cause catastrophic consequences or even eventual system collapse. *Practitioners must ask, 'do we understand problematic system performance in terms of violations of fundamental system laws?'*
5. ***System performance can be enhanced through development of governance 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. *Practitioners must ask, 'how might the roots of problematic performance be found in deeper system governance issues and violations of system laws, suggesting development directions?'*

## 4 Applicability of CSG

Organizations and practitioners must deal with increasingly complex systems and their inevitable problems. In essence, the complex system problem domain represents the *'new normal'* for the practitioners who must contend with complex systems and their associated problems. As a summary of this domain, following earlier work [17], we suggest that the domain is marked by the following characteristics:

- ***Uncertainty***—incomplete knowledge casting doubt for decision/action consequences as well as the appropriate approach(es) to proceed
- ***Ambiguity***—lack of clarity in understanding/interpretation of the system, environment, boundary conditions, context (circumstances, factors, conditions) within which it exists, and the nature of problems stemming from system operation
- ***Emergence***—occurrence of events and system behaviors that result from interactions, cannot be predicted, and are only known after they occur
- ***Complexity***—systems so intricate and dynamically interconnected that complete understanding, knowledge, prediction, control, or explanation is impossible
- ***Interdependence***—mutual influence among systems, where the state of each system influences, and is influenced by, the state of other interrelated systems

Complex systems, their associated problems, and the conditions that mark their problem domain are not going away. Practitioners (designers, owners, operators, performers) facing this domain are left in a precarious position. They must mount an effective response to develop systems and resolve problems within this domain, without the luxury of waiting for more effective support that lies 'just' beyond the horizon. CSG has applicability for practitioners who are interested in engaging complex systems at a different level of thinking.

At first glance, this reality is somewhat 'off-putting'. However, a closer examination of three questions is helpful for better understanding this current state of affairs in relation to the development of CSG in response.

***How did our present day systems come to this reality?*** In many cases, our 'systems' have not been conceived, designed, or in fact executed as systems. Think of a problematic system—chances are it is like most of 'our systems', having come about through one of two primary means, *ad hoc* or *self-organized* design. An *ad hoc* system evolves by adding pieces and parts over time to respond to new requirements, never really being designed or evolved as an integrated whole. A fragmented 'system' emerges for which individual 'pieces' in the hodgepodge might make sense, but as a whole, the system becomes incomprehensible. Eventually, well-intended individual pieces detract from one another and degrade overall system performance. Examples of ad hoc systems are everywhere. Take for instance, a maintenance system intended to provide integrated and efficient maintenance operations across multiple entities and products. Over time, new maintenance programs, which all individually make sense and provide value, are added. However, although they individually might make great sense, collectively as a system, they comprise a 'hodgepodge' of fragmented pieces. This fragmented collection can actually detract from the primary purpose of the larger system intended to effectively integrate maintenance across the larger organization.

A second means of system development is *self-organization*, where the structure and functions of a system are permitted to develop 'on their own' without imposition of external constraints. This approach works great, as long as the system continues to produce expected behavior and desired performance levels. In effect, with *self-organized* system design, 'you get what you get', which may or may not continue to meet expectations given the present and future system realities. System design by *self-organization* might be great for low-stakes endeavors (e.g., a dinner party). However, for high-stakes complex systems, such as the maintenance system, exclusive reliance on self-organization is a recipe for disastrous system performance.

The third means of development is by *purposeful design.* This development involves the rigorous examination of a system through a set of systemic lenses. Although there are other systems- based approaches for applicability in system development, CSG is offered as a rigorously grounded systems-based approach to see underlying systemic issues and generate potential alternative paths forward.

***If the situation of our systems is so 'dire', how do they continue to operate?*** Quite simply, systems continue to operate—in spite of poor designs—through 'brute force' execution. Without getting into an elaborate systems explanation, brute force can be recognized by such compensating activities as: (1) requiring excessive resources to overcome seemingly endless emerging issues, (2) simply living with the high cost (including human costs) of poorly designed/executed systems, or (3) reliance on *'system superheros 'to* sufficiently Band-Aid poor system designs to keep things working. Everyone has experienced system *superheroes* or might even be/have been one! *System superheroes* know 'how to get things done', 'can cut through the garbage', or 'know how to navigate the dark spaces of the system'. They are not bad people, however, system superheros frequently mask poorly designed and executed systems. And let us face it, even *superheroes* get tired, retire, or move on. In effect, it is 'us' who have let poor system designs evolve as they have and 'us' who have become so adept at accepting and 'compensating' for their poor performance—sometimes with incredible nimbleness. In effect, we frequently suffer and compensate for our poorly designed systems with execution that continues to mask system inadequacies.

***Why is CSG not in the mainstream of system development approaches?*** CSG is an emerging field, with associated methods, applications, and technologies rapidly being developed for deployment. However, even though CSG might seem to 'make sense', engagement at any level of CSG development is not a casual decision. Underperforming systems do not appear overnight. They have gone through an evolutionary development (generally, *ad hoc* or *self-organized* as previously mentioned) and become entrenched in structure, strategies, support systems/processes, and even the identity of an organization (system). In essence, they have a large momentum based in the status quo. Thus, CSG exploration, analysis, and redesign can represent a 'sea change' to the 'status quo' within which a system exists. In other words, CSG is hard work, can be resource intensive, and can potentially discover fundamental system issues that may not be 'feasible' or 'palatable' to address given current circumstances. This does not diminish the value of CSG, but rather serves to establish more realistic expectations for CSG, or any approach that seeks to challenge entrenched systems, regardless of potential payoff.

CSG is not a 'silver bullet' or 'magic elixir' promising to cure all ills of modern systems. It requires hard work and commitment, but the payoff can be substantial. What is the payoff? Imagine having to navigate to a destination in the dark, without a map, having questionable directions, and no local knowledge of 'bad spots' to avoid. The result is very likely the 'trip from hell'. CSG provides practitioners with the equivalent of a real-time guide—providing directions, identifying impediments along the way, and tailoring the route to the capabilities of the vehicle (system) and practitioners making the trip. CSG is an invitation to generate a different experience in navigating complex systems and their problems. In effect, a *governance positioning system (GPS)* to provide directions to the future via more effective and compatible routes.

CSG has been developed as an alternative to *ad hoc* or *self-organized* system design, execution, and evolution. The CSG alternative is one of *'purposefully designed'* systems or p-systems. P-systems are focused on active design, execution, and evolution of governance functions in ways that are consistent with the laws (principles) of systems.

***A Complex System Governance Vignette—Where is the Owner's Manual for this System?***

We have all been in the situation where we are driving a rental car and cannot seem to find where a particular control is located and operates (e.g., heat, windshield wipers, gas tank release, trip mileage control, cruise control, radio, resetting clock). Since we do not 'own' the vehicle, there is a certain 'acceptance' of the annoyance, unless we breakdown and go to the owner's manual in the glovebox to learn how the function we desire is performed. However, for the vehicle we 'own', we have an owner's manual that provides guidance to make the intricate system adjustments we desire (e.g., Bluetooth settings). We would not purchase a complex vehicle without also receiving the owner's manual that tells us critical things about our car (system) such as maintenance intervals, troubleshooting problems, meaning of indicators, and performance of essential functions. Suggesting that a car is nowhere near the complexity we find in a modern organization, *why do we not have an integrated owner's manual that specifies the design, execution, and development for our organization (system)?* In many ways, we have pieces and parts—for example, processes, policies, and procedures provide some indicators of system execution. However, at the 'metasystem' level for governance, it is the rare case that we find an owner's manual equivalent for governance of an enterprise.

CSG is a system(s)-based approach to enable practitioners to better deal with complex systems and their problems.

CSG can provide value across several levels (Fig. 5), including:

- ***Practitioner:*** enhanced capacity of individual practitioners to engage in the level of systems thinking necessary to more effectively deal with the issues related to design, execution, and evolution of complex systems and their problems.
- ***Enterprise:*** provide competency development (knowledge, skills, abilities) for targeted entities (units, staff teams, departments) across the enterprise to better engage complex systems and problems.

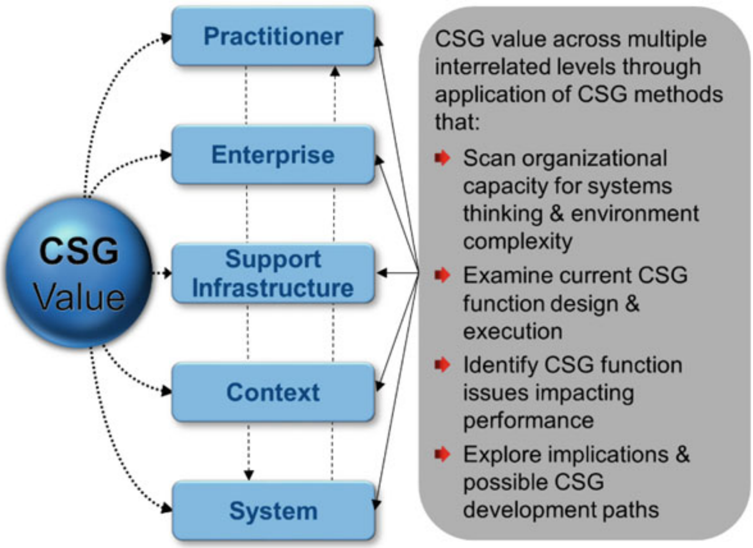


**Fig. 5** Value-added at multiple levels from CSG

- ***Support Infrastructure:*** examination and development of support infrastructure (processes, technologies, systems) for compatibility with system governance design, execution, and development.
- ***Context:*** identification and development consideration for unique circumstances, factors, and conditions that influence (constrain or enable) achievement of system governance functions and system performance (e.g., stakeholders, regulatory requirements, staff, leadership style).
- ***System:*** providing identification of impediments to system performance rooted in specific deficiencies in design, execution, and development of governance functions and corresponding system laws.

The value accrued by CSG stems from: (1) scanning of the capacity an organization (entity) to engage in a level of systems thinking compatible with the complexity demands of the system environment, (2) exploration of the design and execution of essential governance functions, (3) identification and prioritization of system performance constraints tracked to problematic governance functions and violations of systems laws, and (4) establishment of developmental strategies across multiple levels essential to enhancing CSG to improve system performance.

To illuminate the applicability of CSG and potential contributions, we examine three scenarios of application.

## *4.1 SCENARIO 1: Workforce Capacity for System Thinking*

**Situation**: A workforce is continually behind in producing innovative thinking to effectively respond to complexity demands of their environment—resulting in crises, surprises, or inefficiencies. The errors continue to mount with increasingly deficient performance, discontent in the workforce, and the seeming inability to effectively function in relationship to the demands of the complex environment within which the system and practitioners must function.

**CSG Perspective Discussion**: A critical element of CSG is the dependence on the capacity of the workforce to engage at a level of systems thinking necessary to realize the inherent value in CSG. Without the correct frame of reference (system thinking capacity), the results desired from CSG are not likely to be achieved. In essence, if the workforce does not have the necessary systemic thinking skills, then CSG is just another approach that an organization might grasp at for relief. Regardless of how dire the organization circumstances might be, there is no shortcut to having the requisite capacity in individuals to effectively engage any systems-based endeavor. There are two primary drivers for this situation. First, as mentioned, is the capacity of the workforce to think systemically. Second is the degree to which the environment demands systems thinking capacity. Performance will largely be determined by the degree that there is a sufficient 'match' between the systems thinking capacity that exists in the workforce to that demanded by the environment they must navigate.

**CSG Response Discussion**: Systems thinking capacity (ST-Cap) and environment complexity demand assessment instruments can be used to identify gaps between ST-Cap of the entity (team, department, organization) and the demands of their environment. 'Critical' areas for enhancing ST-Cap are identified. Figure 6 depicts this gap along the seven dimensions of systemic thinking. As can be seen by the diagram, there are gaps between what is demanded by the environment and what the workforce is capable of providing. For example, in flexibility the environment demands over 80 percent. However, the workforce is only operating at roughly 20 percent. This disparity, left unattended to, is a source of system dysfunction.

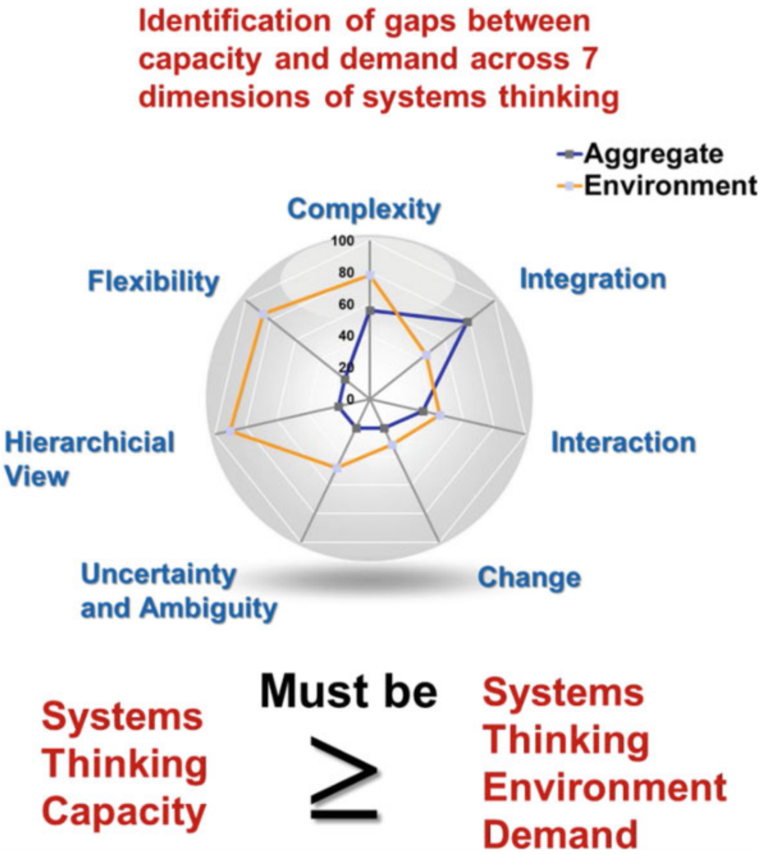


**Fig. 6** Gaps between systems thinking capacity and environmental demand

### 4.2 SCENARIO 2: System Governance Pathologies Identification

**Situation**: A focal system is experiencing continual failures (e.g., cost overruns, schedule delays, missed performance targets) that are resistant to improvement efforts. The external manifestations of failures are evident in either product/service quality, missing milestones, required customer completion schedules, or conflicts in the adequacy, utilization, or outcomes achieved for resources consumed. There have been several failed attempts to locate the source of the deficiencies, but there does not appear to be a singular root cause to which failures can be attributed. The result is sagging customer confidence, resource scarcity, and a diminished workforce from the anxiety and frustration being experienced without an apparent path forward or end in sight.

**CSG Perspective Discussion**: It is quite easy to identify the results for violation of underlying systems principles (evidenced as pathologies). Pathologies are the outward manifestation of underlying system design, execution, or development issues. Being able to properly trace the systemic issue requires a 'deeper dive' into the actual system producing the performance issues. In essence, a system can only produce what it produces, nothing more and nothing less. If the system performance is not consistent with that we desire, we must understand the system that is producing the undesirable behavior/performance. Focusing only on the outward signs (symptoms) of the underlying systemic issues can at best provide a temporary fix. At worst, more damage than good might accrue from superficial treatment of symptoms of underlying system deficiencies (pathologies).

**CSG Response Discussion**: Focal group completes a system governance pathologies assessment instrument. Deep system pathologies (aberrations from healthy system conditions) across nine governance functions are identified, mapped, systemically explored, and prioritized for response. This approach provides an opportunity to discover the underlying source of deficiencies in a system. These are not necessarily observable from the inspection of their superficial deficiencies produced. Figure 7 below shows a mapping of one particular pathology (of 53 different possible pathologies) in a system.

### 4.3 SCENARIO 3: System Governance Development

**Situation**: An organization has difficulty in providing a clear, coherent, and accountable system innovation strategy to address persistent criticisms from oversight bodies. External forces are continually challenging the organization to provide information, performance indicators, and reasons for major decisions and strategies being pursued.


**Fig. 7** Mapping deep-seated system pathologies in an organization

**CSG Perspective Discussion**: Although it is common to receive 'oversight' in the performance of the organizational mission, care must be taken to understand the degree to which the system is designed, executed, and developed such that oversight is not a burden but rather a welcomed opportunity to 'demonstrate' the system. As most systems are not purposefully designed, it is not uncommon to look at external 'hands' as an annoyance at best and at worst an impediment to performance. The need to constrain a system may in fact stem from inadequacies in the design or execution of a system to be commensurate to that which is demanded. Without a robust design against which to reference external perturbations, it is not likely that a system will generate sufficient resilience to effectively direct external 'meddling' in a system. System development should emphasize development of robustness in the design such that externally imposed 'reaching' can be better understood and responses can question the system design/execution for appropriateness to 'classes' of probing, not just individual cases.

**CSG Response Discussion**: Mapping of the CSG landscape provides visualization for analysis of the most critical challenges facing CSG development (peaks). Past, ongoing, and future planned system development initiatives are mapped against the existing governance landscape, pathologies, and system criticisms. 'Holistic' analysis provides clarity and focus for an integrated system development response strategy. Adjacent figures are representative of the current research, including the application of a 16-point CSG governance check. Figure 8 shows a mapping of a CSG landscape for a system.

## 5 Implications

With respect to development of CSG, there are two interrelated aspects. First, there is the development of active governing systems. This *governance development* is focused on identifying and engaging in a set of interrelated activities designed to establish, execute, and evolve the continuing development of the CSG metasystem functions. CSG development is always focused on identification and execution of feasible development activities consistent with initial assessments of the state of governance in an organization (system). Development involves purposeful improvement of the system of interest (context, pathologies, system). Ultimately, the purpose of governance development is to enhance system performance through the process of continual integrated activities to move the system to a more desirable, feasible, achievable, and sustainable level of performance. It would be shortsighted not to include the multiple aspects of development for CSG, including practitioners, organization, larger enterprise, support infrastructure, context, and system.

Table 3 below identifies the details of the five interrelated development activities that can be engaged to further *governance development*. These five elements include: (1) *Exploration*—examination of the performance of the metasystem functions, (2) *Innovation*—identification and prioritization of feasible decisions and actions to improve the metasystem functions, (3) *Transformation*—implementation of innovation strategies and initiative deployment planning to improve the metasystem functions, (4) *Evaluation*—continuous monitoring of the impact of strategies and initiatives undertaken to enhance metasystem performance, and (5) *Evolution*—monitoring development of system governance toward more desirable levels of performance and higher states of maturity.

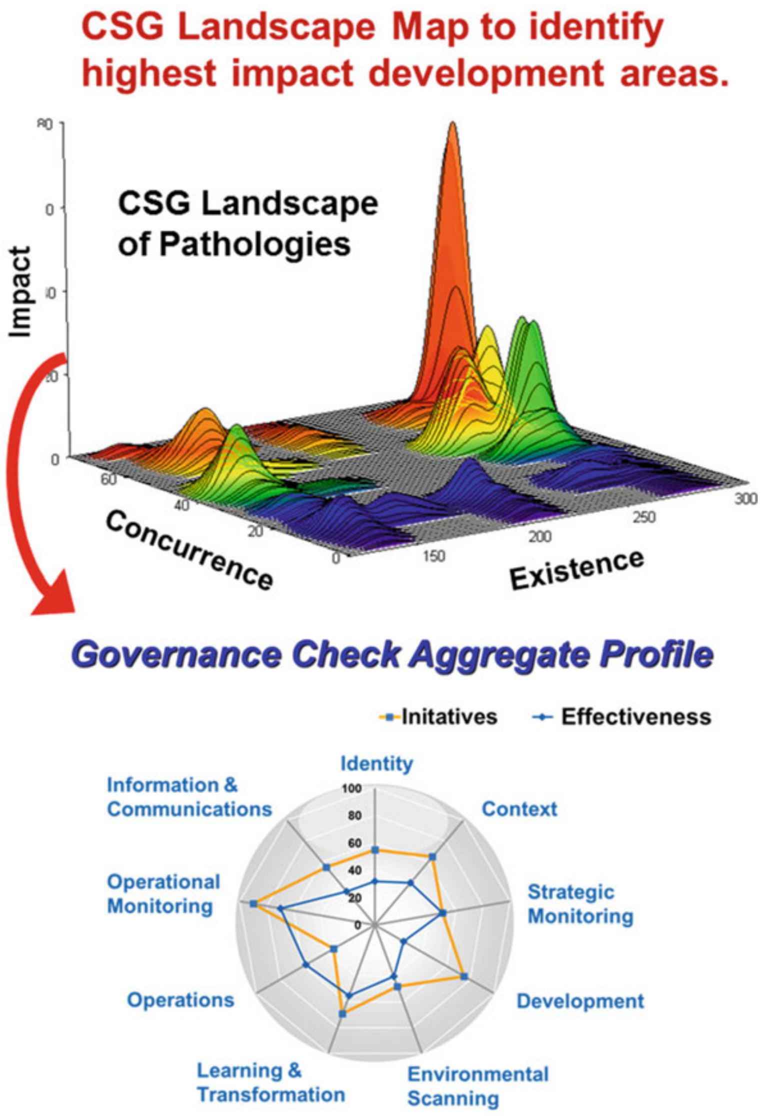


**Fig. 8** Mapping CSG landscape to identify the highest priority development areas

There are three critical points of consideration for implications concerning CSG development. First, while the different governance development activities listed above are presented as separate, they are not independent or linear in execution. In fact, they are considered to be interrelated and overlapping. Therefore, the consideration and performance of the different activities are not mutually exclusive of one another. In essence, they set a frame of reference for a holistic and continuous

**Table 3** Interrelated activities for CSG development

| Governance development activity | Purpose | Objectives |
|---|---|---|
| Exploration | Holistic analysis and synthesis of metasystem context, design, execution, and pathologies | • Systemic investigation and self-study of the metasystem<br>• Identification of completeness of the set of mechanisms performing CSG functions as well as the effectiveness of individual mechanisms<br>• Conduct systemic inquiry to explore multiple perspectives and implications for the metasystem state<br>• Identify, represent, and prioritize systemic meaning and implications of deficiencies, pathologies, and patterns<br>• Define the metasystem current state and trajectory<br>• Examine models of the current system, future system, environment, and context |
| Innovation | Definition of compatible and feasible metasystem development decisions, actions, priorities, strategies, and initiatives | • Develop the high-level strategy for systemic modifications to the metasystem<br>• Identification, evaluation, and prioritization of compatible and feasible (contextually) first-order (correction within existing system) and second-order (correction by system redesign) initiatives to advance governance of the metasystem<br>• Definition of capabilities and competencies (individual and organizational) necessary to engage systemic innovations to advance the state of CSG and evolve context<br>• Definition of system capacity (resources, infrastructure) and compatibility for engagement of systemic innovation initiatives |

(continued)

**Table 3** (continued)

| Governance development activity | Purpose | Objectives |
| --- | --- | --- |
| Transformation | Implementation of systemic metasystem governance developmental strategy, decisions, actions, and initiatives to influence system trajectory, advancement of CSG state, and contextual development | • Holistic deployment planning and resource allocation for initiatives in support of metasystem governance development<br>• Assignment of responsibilities and accountabilities for achievement of transformation initiatives<br>• Exploration of the potential failure modes and mitigation actions necessary to increase probability of success of launched initiatives<br>• Launching of selected initiatives to enhance the metasystem<br>• Integration and assessment of ongoing initiatives in relationship to CSG development strategy and priorities<br>• Identification and assessment of emerging 'rogue' initiatives against the deficiencies, pathologies, and priorities (blueprint) for strategic CSG development |
| Evaluation | Assessment of the effectiveness of metasystem initiatives, ongoing strategic performance of the metasystem, and development of the metasystem | • Identification of the minimal set of indicators (measures) that serves to show progression of the metasystem development efforts and shifting state of the metasystem<br>• Assess effectiveness of initiatives undertaken for systemic metasystem transformation<br>• Provide feedback for continuing relevance of transformation strategy in the light of new system knowledge, understanding, and contextual changes |

(continued)

**Table 3** (continued)

| Governance development activity | Purpose | Objectives |
|---|---|---|
| Evolution | Setting and monitoring the trajectory and maturation of metasystem governance and system identity | • Monitor the long-range purposeful trajectory of the system in response to internal and external shifts<br>• Enhance the continuing maturity (CSG state advancement) of the system of interest, taking the long view, uncorrupted by short-term aberrations<br>• Ensure continuity, sustainability, and viability of the system in relationship to changes in the system, context, and environment<br>• Prevent system erosion through methodical development consistent with shifting demands on the system of interest within the context and environment |

conversation concerning execution of CSG development. Second, the conversation and actions invoked in CSG development are directed to enhance the overall function of CSG. This is achieved by engaging activities targeted to make improvements in the state of CSG and context for the system of interest. There is an advantage that accrues from the depth of exploration that should be achieved on the 'front end' of CSG development. In particular, engagement in CSG without a workforce commensurate to the engagement offers limited probability of success.

A third critical consideration for CSG development stems from the explorations and mapping of historical, presently existing and future initiatives in relationship to CSG development priorities. This serves as a 'litmus test' to question the relationship of initiatives to CSG development. If initiatives are truly targeted to improving the system, their utility with respect to addressing priorities, deficiencies, and identified needs should be capable of withstanding scrutiny. Thus, decision-makers are provided actionable intelligence concerning the contribution of different 'well meaning' activities currently underway or being contemplated to improve CSG. If development initiatives, either ongoing or being considered, cannot be 'justified' as to their relevance to the most pressing needs for improving the state of CSG and context, they should be called into question.

CSG development is not envisioned as an easy approach to system improvement. On the contrary, it is viewed as a difficult development path. This path is fraught with potential obstacles that should be considered by individuals or entities contemplating engaging the approach presented for CSG development.

## 6 Exercises

The following exercises provide an opportunity to examine the concepts presented in this chapter through several questions.

1. For a situation of your choosing, identify elements from the depiction of the complex system problem domain identified in Fig. 1. What is the significance of the nature of this domain for practitioners? Future systems?
2. Identify a 'system superhero' that you have come across. Identify why this system superhero might be detrimental to the long-range survivability of the system(s) they continually save. What can be done in the case of a system superhero unwilling to 'relinquish' their superpowers over a system?
3. What do each of the three fields supporting CSG (governance, general systems theory, management cybernetics) bring to CSG development?
4. Succinctly explain the essence of the CSG paradigm identified in Fig. 4. What difficulties might be encountered in the deployment of this paradigm?
5. What guidance and cautions might you suggest for practitioners who might be considering initiation of a CSG-based initiative?

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