Complex System Governance Development Methodology

Charles B. Keating and Polinpapilinho F. Katina

Abstract This chapter explores a development methodology for Complex System Governance (CSG). The conceptual foundations and reference model for CSG have been articulated elsewhere as well as in this book. While these foundations provide answers to 'what CSG is' and 'why it is important', our present focus is targeted to examine 'how it is done'. This chapter aims to achieve three primary objectives. First, an introduction lays the foundation for elaboration of the CSG Development Methodology. This includes aspects of CSG and methodology essential to the following exploration of the CSG Development Methodology. Second, a 3-staged methodology for CSG development is examined. This 3-staged methodology includes Initialization (setting the current state of CSG and the supporting context), Development Mapping (analysis to determine priorities, feasibility, and capacity for CSG development), and Development (selection, planning, and execution of priority development initiatives to enhance performance of CSG functions). Third, several critical issues concerning the deployment of the CSG Development Methodology are examined. A spectrum of possible CSG methodology deployment concerns and associated issues are examined. The influence of these issues on design, execution, and the ultimate evolution of CSG for an organization (system) is examined. The chapter concludes with application-based insights for advancing CSG Development Methodology.

Keywords CSG development methodology · System development · CSG deployment

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1 Introduction

There are a multitude of increasing pressures stemming from complex systems and their inevitable problems. The cadence of this reality for practitioners might be captured in four themes that permeate the modern landscape of complex systems. These themes have been extolled in various forms in numerous prior Complex System Governance works ([1–4], Keating and Katina [5]). Following these works, we might summarize the themes and their implications for CSG Development in Table 1. Interestingly, although these conditions are not 'new' in the sense that they just arrived, it seems as though success in dealing with them has had minimal effectiveness. There are a myriad of approaches, both past and present, with good intentions to address our deteriorating conditions. However, we seem to be continually confounded with abysmal results, high human costs, and an increasing array of approaches and advice that falls short of expectations.

There is no definitive explanation as to why the present conditions exist or are permitted to continue to exist. Nevertheless, we offer an explanation based on several insights as to why the 'status quo' response strategies continue to exist. This continues to be the case even though system difficulties are not being adequately addressed. Although these strategies might have 'worked' in the past, their continued appropriateness and success as a response to complex systems/problems are challenged. Among these 'status quo' strategies are:

(1) *Sacrifice of Holistic Management*—Technology has been, and will continue to be, an important contributor to increasingly complex systems/problems. However, overreliance on technology to provide solutions is shortsighted. Complex systems/problems have a range of dimensions beyond technology. These additional dimensions may diminish the effectiveness of technology as the exclusive centerpiece in addressing complex systems. Other dimensions, including human, social, organizational, managerial, political, and policy can be decisive in providing resolution breakthroughs for complex systems/problems. In essence, a holistic approach is necessary and should not be sacrificed for superficial technology only treatments.

(2) *Focus on Short-Term Expedience*—Complex systems do not appear or propagate overnight. Instead, they take time to evolve to their current state. The expectation that they can be changed in a 'revolutionary' manner is shortsighted. On the contrary, complex systems require taking the 'long view'. This shifts the focus to their evolutionary development that unfolds over time, not instantaneous gratification from superficial treatment of surface issues. This is not to diminish the need to take immediate action to correct system deficiencies. However, pursuit of only short-term strategies that sacrifice system long view development invites continual operation in 'crisis' mode.

(3) *Piecemeal Development*—All systems evolve through a process of development. Unfortunately, for many this process evolves without purposeful direction. Instead, the system structure is modified in a *self-organizing* (unconstrained modification) or *ad hoc* (piecemeal modification) fashion. In contrast,

Table 1 Conditions facing system practitioners

Condition	Explanation	Implications for governance development
Uncertainty escalation	At a most basic level, uncertainty suggests that precise cause-effect relationships cannot be known for complex systems. Thus, normal approaches that assume complete knowledge and deterministic analysis (mathematical formulations) to address complex systems are incompatible with systems marked by uncertainty. As complex systems become more 'complex', uncertainty will rise—as will the inability of traditional reductionist-based approaches to successfully resolve issues	Governance development must take into consideration that uncertainty will pose several challenges, including: (1) inevitable fallibility of any approach, which requires constant questioning and adjustment, (2) appreciation of the uniqueness of each complex system, thus requiring an equally unique approach and subsequent journey for governance development, and (3) expectations that must be tempered for development outcomes, as the precise results cannot be known or predicted in advance
Ambiguity propagation	Complete knowledge and understanding for complex systems are illusionary propositions. Instead, there will always be a lack of clarity concerning the nature of each unique complex system, the unique domain within which it exists, and the unique context within which the system is embedded. Knowledge and understanding are continually refocused as they emerge over time and new knowledge of a complex system continually unfolds. The result is high levels of ambiguity, or a lack of clarity. This lack of clarity is not necessarily due to carelessness, omission, or intentional ignorance. Instead, it is natural and should be expected for complex systems	Ambiguity is simply a product of incomplete understanding of complex systems and their context. Irrespective of desire or intent, complex systems will always exist in conditions of incomplete understanding. Therefore, their development will also be mired in conditions of incomplete understanding. The challenge for governance development is found in the necessity for continuous accounting for ambiguity. This entails reduction where possible, acceptance where necessary, and accounting for development influences where feasible

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purposeful development concentrates on system modification based on appreciation of the whole system needs, priority (greatest need), and feasibility (what can be taken on within resource constraints with a reasonable possibility of success).

Table 1 (continued)

Condition	Explanation	Implications for governance development
Complexity acceleration	Central characteristics of complexity include a large number of richly interrelated elements, dynamic shifting of the system and our knowledge of that system over time, and emergence of unpredictable behavior, structure, and performance over time and operation of the system. For complex systems, complexity is not a temporary condition that will de-escalate over time. On the contrary, complexity, and its inevitable impacts, will continue to escalate as systems evolve and become increasingly interconnected, unknown, and unpredictable	CSG development must accept that complexity is not going to diminish and will most likely be exacerbated by prevailing trends. Implications for CSG development include finding better ways of dealing with elaboration (increasing interconnectedness), emergence (unpredictable patterns), and dynamics (rapid changes). Purposeful CSG development must offer continual modification of system design and execution to compensate for accelerating complexity
Holistic dominance	The landscape of complex systems is dominated by the dynamically shifting impacts of technology, human, social, organizational, managerial, political, and policy dimensions. While it would be easier to deal with singular aspects of complex systems (e.g., technology), the realities suggest that the holistic range of factors must be taken into account. In addition, these impacts can, and will be, subject to changes over time in terms of their importance and influence	For CSG development there must be an appreciation and accounting for the holistic spectrum of influences on system performance. The entire range of technology, human, social, organizational, managerial, political, and policy factors must be considered. These factors, and their interconnections, must be included in development to improve the design and execution of CSG functions
Information challenge	It is an understatement to suggest that complex systems are beset with exploding data and information. This is not new. However, the traditionally held relationships of data, information, knowledge, and wisdom must be questioned for continuing relevance and applicability for complex systems. The structuring and ordering of expanding data confound complex systems. Beyond increasing volumes, data challenges for complex systems also include veracity issues, misinformation, and accessibility issues	CSG development must be mindful of the flows and interpretation of information within and external to the system. Design and execution of CSG functions rely on information to perform. Thus, CSG development must include a focus on two aspects: (1) ensuring that information is trustworthy and (2) design for the right information is available at the right place and the right time to support consistency in decision, action, and interpretation

(continued)

Table 1 (continued)

Condition	Explanation	Implications for governance development
Contextual influences	All complex systems have a unique context within which they are embedded. This context includes the circumstances, factors, conditions, or patterns unique to the system. Context both enables and constrains a system. Similarly, the system constrains and enables the context. Separation of a system from its context is a false separation and only serves as a convenience for purposes of analysis. It is noteworthy that context is dynamic and will change over time and as system knowledge evolves and the context experiences shifts	CSG development that does not account for the context within which the system is embedded is deficient. CSG development must consider contextual influences on the system of interest, development execution, and expectations. Contextual considerations are not a one time effort. Instead, context must be continually monitored, assessed, and accounted for during CSG development. Without accounting for context, CSG development is incomplete

(4) *Treatment of Complex Systems as Simple Systems*—While the complexity of systems has continued to rise exponentially, so too has the desire to 'reduce' them. This is pursued under the false assumption that this will permit them to be more effectively addressed. The treatment as simple systems when they are actually complex systems are fraught with problems (see Kurtz and Snowden [6]. Unfortunately, this often results in oversimplification of complex systems and their problems. As Mitroff [7] suggests, the result of incorrect treatment results in solving a problem. Unfortunately, it is likely the wrong problem irrespective of how efficiently it might be solved.

(5) *Process and Event Centric Focus*—One strategy frequently deployed to engage, and 'tame', complex systems is through the establishment of standardized and repeatable processes and events. Emphasis on processes and events strategies falls short in the treatment of complex systems. There simply is no degree of process or corresponding events that can substitute for understanding the purpose, function, organization, and operation of a complex system. Processes will always fall short in achieving systemic integration. In this sense, a process-based strategy is a reductionist treatment of complexity. The reliance on events is sure to suffer the same fate for complex systems.

(6) *Complication as an Approach to Deal with Complexity*—The original intent of many systems is to provide a streamlined approach to support the effective resolution of a problem or fulfilment of a need. However, in practice, this resolution is often conveyed as adding more processes, procedures, requirements, and regulations. All of these well-intentioned complication efforts attempt to achieve mastery over complexity. Unfortunately, addressing complexity with

overcomplication is ineffective, introducing unnecessary constraints that can diminish system performance.

(7) *Emphasizing Output Over Outcome*—System outputs are identified as tangible, verifiable, and objective artifacts (products/services) consumed by external entities in the system environment which find value in the outputs. The 'output' mindset is grounded in an underlying set of values and beliefs (worldview through which all that is sensed is processed). This output worldview informs trade-offs and decisions concerning the formulation of system design, execution of that design, and activities to develop and evolve the design/execution over time. For example, many systems focus on tracking performance of cost, schedule, and technical achievement. After all, these attributes are objectively measurable. However, these indicators are 'systemically' limited in their measuring the value of a system. While these indicators (cost, schedule, performance) are necessary aspects of system performance, they alone do not provide sufficiency as a set of system judgments. Instead, more appropriate for consideration is the addition of 'outcome', which is concerned with the utility provided by the system. In effect, outcomes measure to what degree a system fulfils a need or effectively resolves a problem—from the perspective of individuals/entities that have the need or problem.

(8) *Global Control as a Goal*—Ultimately, a systems perspective of control involves establishment of a minimal level of constraints that can assure continued performance [8]. The excess constraint in a system (control) wastes resources and limits local autonomy (experiencing freedom and independence related to decisions, actions, and interpretations). The common perspective of excessive global control is what has been described as overregulation, bureaucracy, and excessive constraint without evidence of commensurate value added to the system.

Figure 1 is a summary of the relationships between the nature of the CSG landscape and the current state of common coping strategies targeted to address those issues. This does not suggest that there have not been exceptional approaches for dealing with complex systems (see Jackson [9]) or that the listings provide a definitive articulation of response strategies or the landscape. However, there is much room for improvement in developing new modes of thinking, which can in turn produce alternative methods to effectively address increasingly complex systems and their constituent problems.

There is not a universally accepted theory, methodology, method, or set of standards to assure success in dealing with the pressures of our current circumstances with complex systems. We expect this is not only the present case but will continue in the future. In fact, Jackson [9] identifies multiple systems-based approaches to deal with complex systems problems—ranging from emphasis on dealing with complex systems across technical, process, structure, organizational, and coercion emphases. Similarly, Keating [8] has identified 15 different systems-based approaches to deal with complex systems/problems. The different approaches demonstrate the difficult nature of selecting an appropriate methodology(ies) for dealing with complex

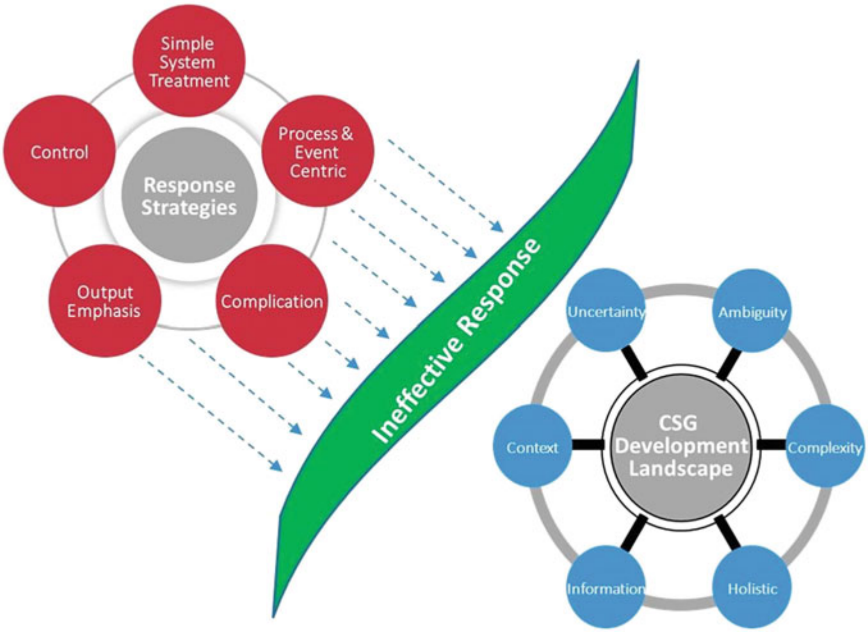

Fig. 1 Ineffective response strategies to CSG landscape

systems/problems. Nevertheless, as opposed to 'do nothing', something must be done if we are to enhance our prospects for making improvements to complex systems and more effectively addressing their constituent problems.

CSG development methodology offers a unique and distinguishable methodology for complex systems. Methodology is consistent with Checkland's [10] perspective of a methodology, which suggests that a methodology provides a framework, more specific than philosophy, but more general than a detailed method or tool. Therefore, a systems-based methodology must provide a framework that can be elaborated to effectively guide action. We have previously established our attributes for a systems-based methodology (Keating et al. [11]). Among these attributes are *transportability* (capable of application across a broad spectrum of applications), *theoretical and philosophical grounding* (linkage to theoretical body of knowldege), *actionable* (capable of leading to specific actions), *significance* (holistic capacity to address multiple problem system domains), *consistency* (approach capable of replication), *adaptable* (able to be modified to different circumstances for application), *neutrality* (sufficiently transparent to preclude biases), *multiple utilities* (capable of application for a range of system development initiatives),*and rigorous*(capableof withstanding external scrutiny). Given this set of distinguishing attributes of methodology, which will be subsequently expanded, the implications for CSG development, baseon functions and communication channels, are summarized in Table 2. Although the listing is certainly not intended to be exhaustive, it does offer insights for our thinking with

Table 2 CSG functions, associated communication channels, and implications for CSG development

CSG function	Description and associated communications channels	Implications for CSG development
Metasystem five (M5)—policy and identity	Provides for overall steering and trajectory of the system. Maintains identity and balance between current and future focus. Communication channels—Command (nonnegotiable directives) and Algedonic (system warning)	Identity provides a reference point to ensure consistency in decisions, actions, and interpretations. This serves to guide system development priorities and execution
Metasystem five star (M5*)—system context	Focused on the systems of interest specific and unique context within which the metasystem is embedded. Context is the set of circumstances, factors, conditions, trends, or patterns that enable or constrain execution of the system. No directly associated communication channels	CSG development is tempered by the context within which it must be executed. Feasible development is impacted by contextual constraints and enablers. Development must include contextual development as well as the system of interest
Metasystem five prime (M5')—strategic system monitoring	Provides oversight of strategic system performance indicators, identifying performance that meets, exceeds, or fails to meet established expectations. Informs the other functions, primarily M4 and M5 as to strategic trajectory performance. Communication channel–Dialog (examination of purpose and essence of system)	Strategic system performance takes a long view perspective for measuring CSG evolutionand trajectory over time. This is opposed to 'operational performance' which is focused more near term and local 'system centric'
Metasystem four (M4)—system development	Maintains the models of the current and future system. Focused on long range development of the system to ensure future viability(existence). No directly associated communication channels	Purposeful system development requires that the current state and the desirable future state be articulated and managed for shifts over time
Metasystem four star (M4*)—learningand transformation	Facilitates system learning based on correction of design errors in the metasystem functions and planning for transformation of the metasystem. Communication channel—Learning (identification of system adjustments to variabilities)	CSG development requires that learning (detection and correction of errors) be focused on system redesign (modification of design) as well as efficiency (execution within current design)
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. Communication channel—Environmental scanning (provides intelligence of external conditions)	Understanding constraints and enablers stemming from the environment is critical to CSG development. The environment, and its shifts, will both enable and constrain CSG performance

(continued)

Table 2 (continued)

CSG function	Description and associated communications channels	Implications for CSG development
Metasystem three (M3)—systemoperations	Sees to the day-to-day execution of the to ensure that the overall system maintains established performance levels. Communication channels—Resource bargain/accountability (resource distribution and output expectations) and operations (providing directions for system operations)	CSG development must focus on the long range. However, there must be a balance established between long and short range focus and resource distribution
Metasystem Three star (M3*)—operational performance	Monitors operational system performance. Concentrates on identifying and assessing aberrant conditions, exceeded performance thresholds, or anomalies. Communication channel—Audit (provides monitoring of routine as well as emergent anomalies in system performance for variabilities)	Operational performance must be considered for CSG development. The impact of development decisions on present operations must be considered
Metasystem two (M2)—information and communications	Designs, establishes, monitors, and maintains the flow of information and consistent interpretation of exchanges (communication channels) necessary to execute metasystem functions. Communication channels—Coordination (provides for harmonizing elements within the system) and Informing (providing for routine information in the system)	Design and execution of communications is critical to both present as well as future system development. Communications must respect both present and future considerations as CSG development is undertaken

respect to the establishment of the CSG development methodology. In this chapter, we examine CSG methodology as a systems theory-based, conceptually grounded, and action-oriented approach to dealing with complex systems. These systems are subject to the problems consistent with Ackoff's [12] notion of 'messes' (interrelated sets of problems that are not well formulated, understood, or easily resolved) as well as Rittel and Webber's [13] depiction of 'wicked problems' (problems that are intractable with current levels of thinking, decision, action, and interpretation).

To serve our primary purpose of exploring CSG development methodology, we have organized the chapter to accomplish four primary objectives. First, we present an overview of the CSG methodology. This methodology is consistent with, and expands, a previous first generation methodology for CSG developed by Keating and Katina [8, 14]. This examination is focused on elaboration of a three phased approach to achievement of CSG development. Second, each of the three stages of the CSG development methodology are examined. Third, we examine critical issues in the deployment of CSG to develop a complex system. Critical issues, as well as suggested mitigation strategies, are explored. Fourth, a set of application-based insights is explored. The chapter closes with a summary that capsules the critical points of the chapter.

2 CSG Development Methodology Background

As a response to the difficulties in dealing with complex systems, CSG has emerged as an evolution of system of systems engineering (Keating and Katina [3, 5, 8]). CSG is defined as the 'design, execution, and evolution of the [nine] metasystem functions necessary to provide control, communication, coordination, and integration of a complex system.' (Keating et al. [15]). CSG is a theoretically grounded (systems theory, management cybernetics, system governance), model-driven (CSG reference model), action-oriented (definition of strategies and actions to improve a situation) approach to capture and understand complex systems. Two primary drivers of CSG, and foundations for a CSG development methodology, are the theoretical underpinnings and the derivative reference model. Although the complete coverage of CSG is beyond the scope of this chapter, we provide the essence necessary for systems theory and the CSG reference model for the CSG development methodology.

2.1 The Essence of System Theory for CSG Development Methodology

There is not a singular or widely accepted definition of systems theory. The most basic tenet of systems theory, *holism*, can be traced to the writings of Aristotle, who proclaimed that the whole is more than the sum of parts. Since the initial development of systems theory in the 1940's, there are a host of scholars and practitioners who have been recognized as instrumental in systems theory development, including such notable individuals as Anatol Rapoport, Norbert Weiner, Karl Ludwig von Bertalanffy, and Ross Ashby (Klir [16]; Laszlo and Krippner [17]). Systems theory emerged as an alternative to 'reductionism,' which is based on the concept that a system can be understood by successively 'breaking it down' to the level of parts. In effect, from the parts a complete understanding and objective knowledge of a system is possible from a reductionist perspective. In contrast, *'holism',* as the most fundamental attribute of systems theory, holds that a system must be understood in terms of the emergent properties that result from interactions and relationships between elements in a system. Thus, complete system knowledge is not possible and certainly not deducible from the parts independent of their interactions. Following earlier works from Adams et al. (2014) and Whitney et al. (2015) we suggest the following points that systems theory holds for CSG:

1. Offers a set of axioms (taken for granted knowledge) and propositions (collection of principles, laws, and concepts that explain the behavior, structure, and performance of systems).
2. Suggests that violation of system propositions carry consequences and contribute to diminished system performance or outright failure.
3. Provides a theoretical and conceptual grounding that anchors CSG in a stable and enduring body of knowledge.
4. Serves to inform understanding, explanation, and 'plausible' prediction for system behavior and performance.
5. Provides insights and cues into more effective design, execution, and development of governance for complex systems.
6. Enhances capacity for more effective thinking, decision, action, and interpretation with respect to complex systems and their problems.
7. Offers a worldview, rooted in *holism*, that defines how CSG embraces complex systems, situations, and problems that are encountered.

Systems theory offers the doctrine which provides a bridge between systems science and CSG.

2.2 The CSG Reference Model

The CSG reference model is a representation that describes the specific functions and communication channels that must be performed to govern any complex system. The reference model includes nine metasystem functions. The functions (Keating and Bradley [18], Keating and Katina [5]) and their implications for CSG are identified in Table 2.

For the metasystem functions identified in Table 2 there are four important points of emphasis. First, the functions do not operate independent or mutually exclusive of one another. Instead, they are interrelated and affect, and are affected by, the other functions. Second, the functions are performed by mechanisms. Mechanisms are the governance artifacts that permit achievement of the specific functions. For example, a quarterly strategy meeting might be a mechanism to support the M4 development function. The total set of mechanisms for the metasystem functions determines the 'set adequacy' given the unique system and context. Third, the execution of the metasystem functions determines the level of governance effectiveness and ultimately system performance. Fourth, governance effectiveness will also be affected by the degree of 'purposeful' design of the metasystem functions. Without engagement in purposeful design (construction of the set of mechanisms to perform metasystem functions) it is doubtful that CSG development will achieve intended performance improvements. Thus, purposeful design of metasystem functions serves to enhance governance in a holistic fashion, avoiding a piecemeal or ad hoc approach to governance and ultimately system performance.

2.3 Making CSG Actionable Through Methodology

The underlying theoretical grounding for CSG is anchored in three fields, including: *systems theory* (the set of axioms and corresponding propositions that explain and predict the behavior and performance of complex systems), *management cybernetics* (described as the science of effective system structural organization), and *system governance* (the provision of system direction, oversight, and accountability). However, development must focus on a different aspect of CSG. The development focus is on examination as to 'how' CSG can be engaged to improve a complex system or address its problems. In essence, how we can make the CSG theoretical foundations and derivative CSG reference model actionable for improvement of governance for complex systems. This becomes the role of a CSG development methodology. CSG development is the 'purposeful exploration and development of governance functions for a system of interest'.

The CSG development presented in this chapter continues to evolve. This evolution progresses as new applications are engaged and our knowledge of CSG, its underlying theoretical/conceptual foundations, and learning from real world applications continue to advance the methodology. The concept of methodology is certainly not new. In fact, notwithstanding the newness of the CSG field, the current state of research in CSG development methodology is sufficient to suggest examination beyond the first generation high level articulation first posed by Keating and Katina [8, 14]. That first generation approach has evolved as new discoveries continue to emerge from intensifying research exploration and applications of the developing CSG field. This chapter articulates the current state of knowledge for CSG development methodology.

Methodology can be an imprecise term. Our current examination of CSG development methodology follows Checkland's [10] perspective which suggests that a methodology provides a framework, more specific than philosophy, but more general than a detailed method or tool. Therefore, a systems-based methodology must provide a framework that can be elaborated to effectively guide responsive action. Based on prior works on methodology development [8, 14, 19], Table 3 expands the set of attributes mentioned earlier. These attributes should be considered as essential to an effective methodology, as well as the implications specifically targeted to CSG development methodology.

Having established the conceptual foundations for CSG, we now shift attention to articulating the current state of the CSG development methodology.

3 CSG Development Methodology

CSG development is the 'purposeful exploration and development of governance for a system of interest'. CSG development methodology is the high level approach that identifies 'what' must be done for development. The specific details of 'how'

Table 3 Attributes of a methodology and CSG implications

Attribute	Description	CSG development methodology implications
Transportable	Capable of application across a spectrum of complex systems, problems, and contexts associated with the discipline. The appropriateness, or applicability, of a methodology for a range of circumstances and system problem types will confirm (or not) any claim of transportability	The CSG development methodology must remain applicable across an extensive range of systems, problems, and contexts. However, there must be a tempering for application, as no methodology has universal applicability
Theoretically and philosophically grounded	Grounded in an explicit theoretical body of knowledge and philosophical underpinnings. This guides the appropriate application, utility, and expectations of the methodology	Systems theory is the theoretical body of knowledge to which the CSG development methodology is grounded. This includes the principles, laws, and concepts that delineate the behavior, structure, and performance of complex systems. Also, philosophical (ontological, epistemological, and methodological) underpinnings are found in 'systems', instantiating conceptual foundations stemming from holism
Actionable	Provide detail sufficient to frame and guide actions appropriate for methodology application. They must not prescriptively define implementation details. However, they must define at a high level 'what' must be done to proceed and become actionable	The CSG development methodology is constructed to define 'what' must be done for application. However, the methodology stops short of providing constraining details of 'how' it must be deployed. This is left to the detailed application planning for deployment
Significance	Exhibit a capacity to drive significant understanding, action, and improvement across a holistic range of technology, organizational, managerial, human, social, political, and policy dimensions of a complex system	CSG development methodology is focused to turn advanced understanding into strategies, actions, and activities to make system improvements. These improvements cross the holistic spectrum of a complex system

(continued)

Table 3 (continued)

Attribute	Description	CSG development methodology implications
Consistency	Provide replicability of approach and results interpretation based on deployment within similar contexts. They must be transparent, with clearly delineated details regarding the design, analysis, and transformation of systems	The generalized framework for CSG development methodology provides a consistent approach. However, it also provides for tailoring to the unique nature of a system of interest and its context
Adaptable	Capable of responding to changing conditions or circumstances by allowing modifications of approach, configuration, execution, and expectations while retaining their fundamental frameworks. This is methodological latitude	The CSG development methodology retains flexibility to adjust to shifts in system knowledge, context, or problem framing. This permits adjustments prior to and during execution
Neutrality	Account for and limit external influences on design, execution, and interpretation of results. Their use must explicitly identify biases, assumptions, and limitations integral to application	Biases will exist in application of the CSG development methodology. However, care must be taken to acknowledge and minimize their potentially negative influence on design, execution, and interpretation of results
Multiple utilities	Support a range of applications, ranging from limited to comprehensive. Targeting desirable results ranging from identification of feasible system improvements (e.g., workforce development) to comprehensive system transformation (e.g., major system redesign effort)	CSG development methodology is capable of providing a range of results. These results can range from limited feasible improvement initiatives to comprehensive design for continuous system transformation
Rigorous	Sufficiently detailed to permit consistency in design for execution, irrespective of the uniqueness of the system of interest and the context with which it is embedded	A CSG development methodology must provide sufficient detail to define precisely what will be done and permit tailoring to define how it will be accomplished

the aspects of the methodology are accomplished are left to the detailed design that must be tailored to the unique circumstances, system, and context of the system. CSG development has previously been presented as a first generation methodology [8, 14]. Since this first generation, there have been significant strides forward in our understanding of deployment of CSG in operational settings. In this section, we discuss the current state of CSG development methodology based on shifts in our knowledge.

The CSG development methodology consists of three primary stages that define CSG development. Recall that the governance functions must be performed by any system that maintains viability (existence). However, just as each system is unique and exists in a unique context, the specific approach to CSG development must be tailored to appreciate that uniqueness. For succinctness, we have identified and elaborated the three primary stages of CSG development from the initial work [8, 14] describing the first generation CSG development methodology (Fig. 2).

The first stage of CSG development is *initialization.* This stage provides an initial understanding of the situation, answering the question *'What is the state of the system of interest and its context?'*. Initialization consists of two primary objectives. First, the nature and structure of the system of interest is established. This serves to articulate the current state of the system under exploration. Second, the context within which the system of interest is embedded is explored. Initialization provides a rigorous systems-based understanding of the system and its context. Completion of the *Initialization* stage provides a foundation for the second stage of CSG development, *development mapping.*

The second stage of CSG development, *development mapping*, is focused on establishing the analysis and implications for what was learned from *initialization.* This stage seeks an answer to the question, *'What do the different products from the initialization stage suggest for development?'*. This requires a deep introspection

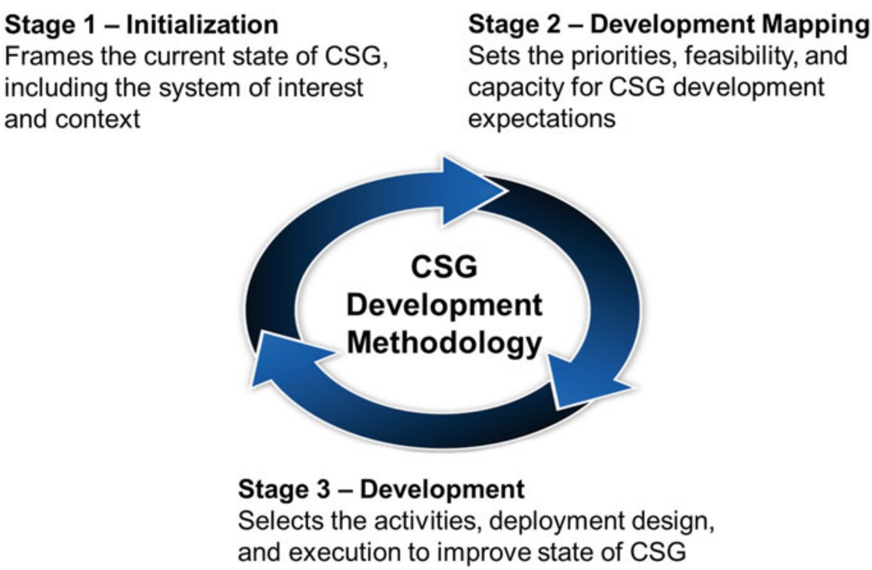

Fig. 2 Three stages of CSG development methodology

into the results of the *initialization stage*. Ultimately, the results of the *development mapping* stage specifies: (1) a profile that establishes the current state of CSG performance/maturity/sophistication, and (2) the system and context to determine the nature, types, and priority consideration for CSG development with the potential for the greatest impact.

Development is the third stage of the CSG development methodology. The two prior stages were passive and not directed to initiation of action/activities to enhance the state of CSG. This third stage identifies and engages the feasible activities (based on priorities, capability, capacity, and resource constraints) that can be undertaken in development of CSG. Three important aspects to this stage include: (1) determining the feasibility as to the different types of activities that might be successfully engaged based on the current state of CSG (established in the initialization stage), (2) the CSG development stage also includes the prioritization of activities—based on consideration of the overall state of governance, context, and resources—directed to making more informed CSG development investment decisions with greatest potential impact, and (3) selection and execution of suitable activities that are targeted to make either 'contextual' improvements or metasystem governance function improvements. Therefore, the success of initiatives can be evaluated against the shifting profile of *context* and *governance state* to which they are targeted. While not absolute in their prioritization and selection, a much more rigorous and holistic selection process can be engaged. Hence, the continuous development of CSG through an evolutionary approach is engaged. Selection of 'appropriate' initiatives results in increasing GSG capabilities and advancing the context. The result is that the 'feasible development initiative space' continues to increase in size and depth. Thus, CSG development becomes a 'virtuous circle' continually increasing the level of CSG sophistication and resulting state of performance.

The three stages of CSG development methodology are presented with a clear degree of separation. However, it must be noted that this is purely for the convenience of presentation. In reality, their separation is not clear cut. The three stages do not operate independent or mutually exclusive of one another. Instead, there is a constant comparative nature to their progression. For example, it is possible that the mapping or development stages may suggest a 'recalibration' of the initialization stage outputs/outcomes. This is particularly the case as new knowledge is generated by the continuing and deepening exploration of the state of governance/context and execution of development initiatives. After an initial 'first pass' through the three stages of development, the continual cycling of the methodology increases the state of governance.

In the following sections, we provide an elaboration of each of the three stages of the CSG development methodology. This perspective of CSG development continues to mature, as our sophistication, knowledge, and insights evolve with each successive application of CSG development. The initial works on the CSG field and methodology have provided a strong theoretical and conceptual grounding for our current state of development, including the CSG reference model [20], the emerging CSG field (Keating and Katina [5, 21]), and engaging CSG (Keating and Katina [5]).

To set a frame of reference for the detailed examination of CSG development, six overarching themes are provided for a supporting context. This context is essential to understanding the limitations and development expectations for CSG.

1. *Continuous and Deepening Development Cycle*—Engagement in CSG development is not intended to be a singular event with a clear 'stopping point'. Instead, it is cyclic in nature in that it is intended to operate on a continuing basis. Also, over successive development 'cycles' the expectation is that the state of CSG continually matures.
2. *Systemic Worldview Limits Pace and Comprehensiveness of Development*—The state of systemic thinking (worldview) held by the individuals and the system are taken into account in the initialization stage. However, the pace and depth of CSG development will be limited by the systemic worldview.
3. *Contextual Development Accrues*—Development initiatives for CSG also include development of the context in parallel with the evolving state of CSG. Context is both enabling and constraining to CSG and must be considered in development. Not taking context into consideration is short sighted and will not generate the potential advances that can result from including context.
4. *Development Targets Multiple Levels*—Development is not restricted to the complex system of interest. Instead, in addition to the system of interest, CSG development must also focus on individual, organizational, support infrastructure, and context. Thus, CSG development is holistic in the areas subject to development activities, which may span multiple areas. It is constraining to only consider the state of CSG in selection and execution of development initiatives.
5. *Emphasis on Front End Framing*—The application of CSG development is heavily weighted to the 'initialization stage' which exist at the front end. This sets the stage for all that follows. Although all stages are important, the focus on the initialization stage is critical to get correct. If the framing is insufficient, poorly performed, or incomplete there is little chance that the effort will provide the intended utility. Additionally, through repetitive 'cycling' the initialization becomes *re-initialization* which is a continual recalibration of the state of CSG and the context for the system of interest.
6. *The Metasystem is a Unifying Concept*—The metasystem is the set of functions that must be performed for systems to remain viable (continue to exist). These functions identify *'what'* must be achieved, not *'how'* they must be achieved (by specific mechanisms). Ultimately, the performance of the metasystem functions and their associated communication channels determines the level of system performance capable of being achieved. The metasystem provides governance (*communications, control, integration, and coordination)* for the system entities to operate as a unity to produce value which is consumed external to the system. CSG maintains system coherence (identity) and cohesion (unity). In effect, at the most basic level, the metasystem keeps the system from either collapsing from external pressures or flying apart from internal pressures. It is the 'glue' that allows the system to continue in the face of increasing complexity.

Thus, development has the focus of both maintaining as well as evolving the metasystem functions, their communication channels, and the context.

With this basis for the CSG development methodology we move forward to explore in depth the three stages of the methodology.

Vignette
What about the metasystem?

The importance of the metasystem is vital to system effectiveness. However, in this situation we describe a scenario where the metasystem functions of an organization were identified as underdeveloped. This organization recognized that there were difficulties in being able to adequately respond to customer issues. The university-based organization was comprised of several departments, each with its specific set of responsibilities and roles to perform in the operation. For instance, there were separate departments for finance, admissions, registration, housing, food services, and student engagement. However, participants acknowledged that there were several apparent issues, including: (1) customers rarely had an issue that was confined to one department for resolution, (2) there were coordination problems between the different departments in dealing with issues that 'fell between the cracks,' (3) while the different departments operated efficiently [by their individual measures], the overall system was deficient in performance without any true measures established beyond individual departments, and (4) communications between departments, particularly where issues were not 'owned' by an individual department was ineffective. Through a participatory CSG exploration of the system, there were several conclusions that became apparent. First, the metasystem functions that were responsible for system communication, control, coordination, and integration were largely left to be assembled and executed absent of purposeful design (largely self-organizing). Thus, the orchestration of the departments in a coherent and cohesive way was absent. Second, lacking effective mechanisms to perform metasystem functions, issues that required interactive coordination between multiple departments was difficult and inconsistent at best. The result was that each customer issue was treated as a unique case, to be managed by whomever elected to accept the challenge to resolve it by bouncing back and forth between different 'involved' departments. Third, the individual departments were managed and operated very effectively. However, absent the purposeful design of the metasystem, the system struggled to perform when problems spanned multiple departments. This system demonstrated the necessity of the metasystem to effectively integrate, coordinate, control, and communicate by design as opposed to being left to self-organization.

3.1 CSG Development Methodology Stage 1—Initialization

The first and arguably the most important stage of CSG development is initialization. This stage accomplishes two primary objectives. First, the context for the system of interest is examined. Recall that the context is the set of circumstances, factors, conditions, trends, and patterns that influence, and are influenced by, the design, execution, and evolution of the system of interest (Keating et al. [22]; Keating and Katina [5]). The establishment of the context provides a critical set of insights into what might be influential in constraining/enabling the execution of CSG development. Table 4

Table 4 Framing the context for CSG development

Context activity	Purpose	Contributions/implications
Contextual attributes identification	Identifies the nature of forces that constrain or enable the design, execution, or evolution of the metasystem	• Forces may be internally/externally generated, formal/informal, tacit/explicit, or real/perceived • Forces may include circumstances, factors, trends, patterns, or conditions that influence the metasystem • Forces may range across the spectrum of technical/technology, organizational/managerial, human/social, cultural, information, and political/policy • The worldview(s) in play for the system (including values, beliefs, and logic) must be made explicit for examination • Context and its understanding are not static. Context can and will change over a development effort. This can be by design or simply by emergence of new knowledge. Context must be kept up to date throughout a CSG development effort
Individual capacity for systemic thinking	Establishes the level of systemic thinking that exist among those (owners, operators, designers, or performers) with responsibilities for design, execution, and development of the metasystem	• The level of systems thinking for individuals is instrumental in setting context • Ultimately the development level and activities capable of being undertaken are constrained, and enabled, by the systemic thinking capacity of those who will engage CSG development • Determination of feasible activities and development expectations must be metered by the level of systemic thinking present in participating individuals • A diversity in systems thinking capacity is desirable to avoid an overly homogeneous representation

(continued)

Table 4 (continued)

Context activity	Purpose	Contributions/implications
Entity competence for systemic thinking	Provides the level of knowledge, skills, and abilities related to systemic thinking for organizations (systems) contemplating engagement in CSG development	• While individual capacity for systemic thinking is necessary for determination of CSG expectations, it alone is not sufficient for this determination • The aggregate level of systems thinking capacity will be a major determinant in CSG development and how much scarce resources need to be allocated to enhancing the aggregate level of systems thinking • At the organization (system) level the degree of joint proficiency in collective systemic thinking knowledge, skills, and abilities will meter the feasible activities and expectations for CSG development
Supporting infrastructure compatibility	Establishes the degree to which the basic physical and system support infrastructure (e.g., support systems, processes, procedures, facilities, and resources) are enabling or constraining for CSG execution and development	• Irrespective of good intentions or redesign of the metasystem for CSG, the supporting infrastructure must not be in conflict with the execution or development activities for a CSG initiative • Compatibility issues, be they conceptual or physical, must be taken into account in initialization for CSG development • Support infrastructure can be both enabling as well as disabling and subject to change over time and with new knowledge
System leadership Assessment	Identifies the degree to which the existing state of leadership in CSG is consistent with that required for development	• System leadership is a critical aspect of context for CSG • The nature and role of leadership existing in a system offers both systemic constraints and enablers for CSG development • System leadership is 'different' than traditional notions of leadership in both what is influenced, and the specific role played in CSG development

(continued)

Table 4 (continued)

Context activity	Purpose	Contributions/implications
Communication channel identification	Communications is focused on the flow and interpretation of information in CSG metasystem functions	• The different mechanisms, and their effectiveness, for performing the different communication channels required for CSG are established • Both formal and informal communications are considered • The degree to which communication is effective will limit or enable CSG development

is elaborated from earlier work in CSG development [8, 14] and provides a description of the activities, their purpose, and the contributions/implications for framing of context during the initialization stage of CSG development. Second, the current state of CSG for the system of interest is established. This constitutes the second aspect of framing for the initialization stage. The current state articulation involves mapping of the system of interest, the environment, governance architecture/requirements fulfilment, pathologies (system governance deficiencies), and balance. In sum, the initialization stage sets a 'baseline' from which further CSG development progress will be informed.

Establishing the current state of the system of interest for CSG development is the second aspect of framing conducted in the initialization stage. This requires *'framing'* for the system of interest. This operates in conjunction with the establishment of the context for the system of interest. Framing of the system of interest provides a set of representations that serve to depict the metasystem in relationship to the system(s) that it governs. The system of interest framing establishes the design configuration and execution of the metasystem, articulating the technical design details of the metasystem as well as the effectiveness in execution of that design. The major elements of the *metasystem framing* activity in the initialization stage of CSG development are described in Table 5 (adapted and elaborated from [8, 14]).

The primary product from the initialization stage is a CSG profile. This profile represents the current state of CSG and the context for the system of interest. In addition, the initialization stage is the most intense of the three stages of CSG development. However, if the appropriate level of energy and resources are not invested in the execution of this stage, the remainder of the CSG development stages are sure to be suspect at best. The initialization stage provides a baseline against which: (1) further analysis can be conducted to identify and prioritize developmental areas, (2) shifts in the 'governance landscape' can be captured, (3) the specific fit of future CSG development initiatives can be determined, and (4) holistic development of CSG can be supported based on the comprehensive picture of the state of CSG provided from the profile generated during initialization. It should be noted that what is discovered

Table 5 Framing the metasystem for CSG development

Framing activity	Purpose	Contributions/implications
System of interest identification	Identifies the system for which CSG will be examined, noting the boundary conditions as well as the metasystem governance configuration	• Definition of the system of interest must be made explicit (included entities/systems/subsystems, relationships, transformation, and boundaries) to focus the development effort • Definition of the specific criteria for inclusion/exclusion to establish the boundary conditions and separate the system from the environment is essential • The system of interest identification will be incomplete, fallible, and change over time. It should be continually modified with new knowledge and development initiative improvement results
Environment definition, mapping, and assessment	Define the environment within which the system is embedded. Focus on definition of relevant aspects outside the boundary of the system of interest. Map critical aspects of the environment and assess their implications	• Definition of the environmental forces (enabling/constraining) must be made explicit (mapped) and assessed for CSG implications • All aspects of the environment are not of equal relevance for CSG development • The most relevant (influential) aspects of the environment must be taken into consideration • The environment, its relevant aspects, and assessment will change over time and with new knowledge throughout the development effort

(continued)

in the initialization stage will evolve as new knowledge and understanding of the system of interest and context emerge throughout the effort. *In essence, the initialization stage provides the current state of CSG and captures the context within which it is embedded.*

Table 5 (continued)

Framing activity	Purpose	Contributions/implications
Governance architecture definition	Establishes and represents the particular 'architectural' views in a CSG architecture framework following Carter (2016)	• The different architectural views for CSG provide the relationships between the different mechanisms performing the metasystem governance functions • Supports the discovery, development, and maintenance of information necessary for evolution of the governance architecture • Produces (model centric outcomes/representations) of the structure, behavior, and performance of CSG • Facilitates greater understanding of the system of interest and facilitates identification and prioritization of deficiencies targeted for system performance improvement
Reference model requirements assessment	Provides an examination of the function of CSG against the requirements specified for the CSG reference model	• Assessment allows determination of 'how' the metasystem functions are performed against the 'what' must be performed (established by the requirements) • Gaps in the adequacy of coverage for metasystem functions can be identified as well as the effectiveness of individual mechanisms being used to support achievement of those functions
Metasystem pathologies identification and assessment	Establishes the degree to which variations from systems theory propositions (principles, laws, and concepts) are perceived to impact performance of CSG	• Identification of pathologies can be established against the backdrop of systems theory and the functions of the CSG reference model • Assessment of identified pathologies provides insights into the conditions that limit CSG performance

(continued)

Table 5 (continued)

Framing activity	Purpose	Contributions/implications
State of system balance	Identifies the classification for a system of interest and positions the system balance along tensions in design, change, and control dimensions. The past, present, and future state balance is identified	• Classification of system balance provides insights into the nature of the system and the corresponding implications for CSG based on the balance assessment • The specific positioning of a system with respect to the degree to which tensions are perceived to be appropriately balanced provides insights into effectiveness of CSG performance • Perceived gaps between past, present and future state balance are identified and interpreted

3.2 Stage 2—Development Mapping

The initialization stage for the CSG development methodology provides a significant data set that serves to *'frame'* the context and state of CSG for the system of interest. The second stage of CSG development methodology, *development mapping*, is focused on understanding the nature, meaning, and implications of the data and representations produced in the initialization stage. The original CSG development methodology [8, 14], identified this stage as *governance readiness level (GRL)* assessment. Our applications and further explorations of CSG suggested that GRL was too narrow in its formulation. Thus, *development mapping* was constructed to widen the nature and scope of this stage. The *development mapping* stage is directed to achieve three primary objectives:

1. *Process the results from the Initialization Stage.* The initialization stage produces a plethora of outputs (framing) that serve as inputs to the development mapping stage. Among these outputs are the depiction of the system of interest, the system of interest metasystem functions, and the context. Processing includes identification of the critical themes, insights, and implications stemming from the initialization stage outputs. A critical aspect of CSG development mapping is examination of the system context to identify enabling and constraining forces that influence the performance of CSG functions and will limit/enable CSG development.
2. *Identify, catalog, and rank order pathologies that exist in CSG functions with respect to their existence, impact, and resolution feasibility.* Pathologies are aberrations from normal or healthy conditions in the metasystem functions for CSG [3]. This provides a state of CSG functions performance for the system of interest. In effect, the *"CSG Landscape"* is established.

3. *Define the governance readiness level (GRL).* The GRL is a classification of the 'maturity' that exists in CSG for the system of interest. The GRL will determine the types of CSG development activities that can be undertaken with a reasonable feasibility of success. There are currently nine levels of CSG readiness (Table 6) for classification. This classification serves to position CSG for the system of interest along a spectrum that corresponds to the 'maturity' of CSG. Implications

Table 6 Escalating complex system governance readiness Level classification

GRL	Description	Assessment implications
Nascent	No knowledge of CSG or the systemic worldview essential to understand CSG functions. No representations of the CSG functions, communications channels, or state of CSG. Unknown state of systemic thinking, development constraints, environment, or potential for engagement	• 'Clean sheet' CSG development possibilities • Requires training/education to develop rudimentary understanding of CSG, systems thinking, and the possibilities that development offers • Relevance/utility not apparent
Embryonic	Minimal knowledge of CSG or the systemic worldview necessary to engage in CSG development. No representations of the CSG functions, communications channels, or state of CSG. Unknown state of systemic thinking, development constraints, or potential for engagement	• Some minimal CSG exposure • Requires additional depth/sophistication through generalized education/training on the systems worldview, nature of CSG, and potential for development • Requires training/education to development rudimentary understanding of CSG and the possibilities that development offers • Relevance/utility considered
Forming	First level engagement in CSG and developing the essence of the systemic worldview which underpins CSG. No representations of the CSG functions, communications channels, or state of CSG. Unknown state of systemic thinking, development constraints, or potential for engagement. Utility and value not entirely clear with respect to expectations/potential offered by CSG	• Demonstration of CSG development opportunities through training/education • Understanding the potential that CSG development might offer • First contact looking superficially at the state of CSG and the environment • Requires training/education and application exposure to CSG
Formulated	Engagement in CSG with appropriate level of systemic thinking. Articulation of critical aspects of CSG functions performance. State of systemic thinking and inconsistencies identified, contextual considerations examined	• Systems Thinking capacity understood with respect to environmental demand • Training/education in systems escalated to enhance systemic worldview • Impacts of CSG development utility understood, acknowledged, and supported through realization of CSG state deficiencies

(continued)

Table 6 (continued)

GRL	Description	Assessment implications
Implemented	CSG development methodology deployment initiative planned, resourced, and implemented. Clear designation of preliminary state of CSG, environment complexity, and systems thinking capacity. Expectations for CSG development specified	• CSG development engagement foundations established • Appropriate level of systemic thinking capacity determined and adequate • Clear roles, responsibilities, and accountability are established • Development strategy, timing, resources, and expectations articulated • System performance measures and initiative success defined
Developing	First pass through CSG development methodology accomplished. Framing of context and system of interest established. Composite mapping of the state of CSG constructed, pathologies identified, feasible development initiatives defined and implemented. First generation mapping of the system of interest, CSG functions, communication channels, and environment implemented	• Assessment of development initiative(s) success conducted • Advancement in systemic thinking capacity, state of CSG, and communication channels identified • Clarity in definition of representations for the system of interest, environment, and context established
Developed	Continual passing through CSG development methodology stages. Deepening systems thinking capacity and development endeavors that can be engaged. CSG functions improvement, pathologies reduced, and performance indicators improvement achieved	• Embedding of CSG development into support infrastructure, processes, and context development • CSG ingrained into strategic operations as a 'way of doing business' • Systems language and thinking are routine • CSG development continues to progress in maturity and depth of sophistication
Evolving	CSG is not 'in addition to' the strategic work of the system but becomes the primary work of the system. Additional resources are not allocated specifically for CSG. Instead, CSG is just the approach to accomplishing the work of the system. Continuous evolution of system design, execution, and development are the routine	• CSG is no longer separate from the system of interest • CSG functions and communications drive thinking, decisions, actions, and interpretations for the system • CSG design, execution, and development is a preoccupation of system leadership

(continued)

Table 6 (continued)

GRL	Description	Assessment implications
Evolved	CSG begins to be projected beyond the system of interest. Influence, through demonstration, demands, and expectations become routine to the system. System value is not only in what products/services are produced, but how they are produced. New employees, stakeholders, customers, and entities are exposed to the CSG way of accomplishing the work of the system. The system culture does not distinguish CSG as separate from the operation, but rather it defines the operation of the system	• System identity provides an unambiguous reference point for clarity in decisions, actions, and interpretations for the system • External engagement is transparent, trusted, and effective • CSG is embedded in processes, procedures, support infrastructure, and context without provocation • Development of external entities is achieved by subjecting them to the standards and expectations upon which the system has been designed, executed and evolved

for CSG development, based on the GRL classification, are identified. The implications include identification of the nature and types of feasible activities that can be pursued for CSG development with a reasonable chance for success.

Significant progress has been made in the second stage for CSG. However, it still remains the least mature of the three stages of the development methodology. As this stage continues to develop, there are three important aspects driving future development. First, the processing of the initialization stage results, ultimately framing the state of CSG, captures (measures) a present state of CSG development. There is not a judgment of good or bad, but the state simply remains a depiction of the 'maturity' of CSG and the context for the system of interest at the point of assessment. It offers a reference point that provides a source for dialog as well as a baseline against which the continuing development of CSG can be examined. Second, framing results are a limiting factor as to the nature and types of activities that are appropriate undertakings. Attempts to engage CSG development initiatives that are beyond the capacity of the system to execute are ill-advised. Thus, the activity types that are feasible, given the current state of CSG development, can be identified. This offers a sophisticated 'metering' for the types of activities that are appropriately compatible with the state of CSG development. Over time and with purposeful development initiatives, we would naturally expect the state of CSG to evolve to higher levels of maturity, increasing performance levels, and escalation of the nature and types of development activities that might be pursued.

Third, the results from the development mapping stage provide a direct input into the following governance *development* stage. The nature and scope of activities that might be successfully undertaken to advance the state of CSG are limited by the state of CSG and the context. Therefore, the determination as to whether activities are compatible is important to ensure that expectations for CSG development are consistent with the capacity held by the system. By engaging development activities that are within the capacity of the system to successfully execute, the system reduces the probability of unsuccessful endeavors to enhance CSG.

3.3 Stage 3—Development

The third stage of CSG development, *Development*, is focused on making the first two stages actionable. At a fundamental level *development* is the process through which the meta system is purposefully altered to support future viability. Development is driven by two primary considerations. First, what are the highest priority governance development activities that offer the greatest enhancements. These activities are deemed to be the high priority targets for development. Second, irrespective of priority activities, the selection of engagement initiatives must consider what is feasible. Feasibility is a function of what capacity the system has to engage activity (ies) with a reasonable expectation for successful outcomes (i.e., GRL). This involves purposeful improvement of the system of interest (design, execution, development) as well as context (support infrastructure, leadership, etc.). Ultimately, the purpose of governance development is to enhance system performance through progression of the GRL to more desirable, feasible, achievable, and sustainable levels. As the state of CSG escalates, so too does the level of improvement activities that are advisable to be undertaken. In addition, this stage also attempts to influence the context in ways that will enhance the ability of the system to perform at a higher level.

Table 7 identifies the details of the five interrelated elements that comprise the *development* stage. These five elements include: (1) *Exploration*—concentration on the performance of the metasystem functions with input from the prior two stages, (2) *Innovation*—identification and prioritization of feasible decisions and actions to improve the metasystem functions and context, (3) *Transformation*—implementation of innovation strategies to improve the metasystem functions or context, (4) *Evaluation*—continuous monitoring of the metasystem performance improvements underway, and (5) *Evolution*—monitoring long range system trajectory consistency with a desirable future state for the system of interest, state of governance, and context. It is important that these 5 activities are not intended to be mutually exclusive or independent of one another. Instead, they are continually interactive. Additionally, the development stage becomes a 'cycle within a larger cycle.' This permits the continual evolution of CSG to increasingly higher levels of maturity and ultimately enhanced system performance (Fig. 3).

There are five critical points of consideration for the continuous achievement of the development stage of the CSG development methodology. First, while the different governance development activities are presented as separate, they are not independent or necessarily executed in serial fashion. In fact, they are interrelated and overlapping. Therefore, the consideration and performance of the different activities in the development stage cycle are not mutually exclusive of one another. In essence, they set a frame of reference for a holistic and continuous engagement for CSG development. Second, development of systems is not something that would be entirely

Table 7 Interrelated activities for CSG development

Governance development activity	Purpose	Objectives
Exploration	Holistic analysis and synthesis of metasystem design, execution, and pathologies	• Systemic investigation and self-study of the metasystem initialization profile and development mapping • Identification of set completeness of CSG function mechanisms, effectiveness implementing CSG functions, and effectiveness of individual mechanisms • Conduct systemic inquiry to explore multiple perspectives of the metasystem functions and context • Identify, represent, and prioritize systemic meaning and implications of deficiencies, pathologies, and patterns • Define the metasystem current state and trajectory • Examine models of current system, future system, environment, and context
Innovation	Definition of compatible and feasible metasystem development priorities, strategies, initiatives, and actions	• Develop the high level strategy for systemic modifications to the metasystem • 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 • Definition of capabilities and competencies (individual and organizational) necessary to engage systemic innovations to advance the GRL and evolve context • Definition of system capacity (resources, infrastructure) and compatibility for engagement of systemic innovation initiatives

(continued)

Table 7 (continued)

Governance development activity	Purpose	Objectives
Transformation	Implementation of systemic metasystem governance strategy, actions, and initiatives to influence system trajectory, GRL advancement, and contextual development	• Holistic deployment planning and resource allocation for initiatives in support of metasystem governance development • Assignment of responsibilities and accountabilities for achievement of transformation initiatives • Exploration of the potential failure modes and mitigation actions necessary to increase probability of success of launched initiatives • Launching of selected initiatives to enhance the metasystem • Assessment of 'rogue' initiatives against the deficiencies, pathologies, and priorities (blueprint) for strategic system governance development
Evaluation	Assessment of the effectiveness of metasystem initiatives and enhanced performance of the metasystem	• Identification of the minimal set of indicators that serve to show progress of the metasystem development efforts • Assess effectiveness of initiatives undertaken for systemic metasystem transformation • Provide feedback for continuing relevance of transformation strategy in light of new system knowledge, understanding, and contextual change

(continued)

Table 7 (continued)

Governance development activity	Purpose	Objectives
Evolution	Setting and monitoring the maturation and trajectory of metasystem governance and system identity	• Assure the long range purposeful trajectory of the system in response to internal and external shifts • Enhance the continuing maturity (GRL advancement) of the system of interest, taking the long view and not corrupted by short-term aberrations • Ensure continuity, sustainability, and viability of the system in relationship to changes in context and the environment • Prevent system erosion through methodical development consistent with shifting demands on the system of interest • Updating of the initialization and development mapping stage products based on evolving CSG

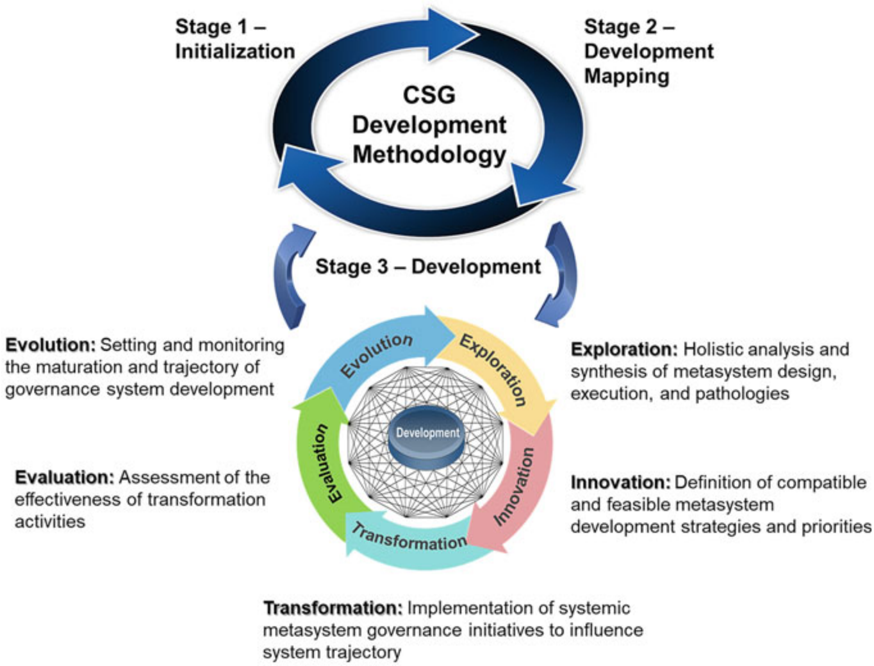

Fig. 3 Development cycle within the CSG development methodology

'new' to a system. On the contrary, systems are always undergoing different 'development activities' that enhance viability (continued existence) prospects. Unfortunately, development is frequently not achieved in an integrated, holistic, or purposeful fashion. The result is a 'hodgepodge' of activities that while well-intentioned individually, in total they are a fragmented aggregation of apparently unrelated activities. In contrast, while some system development might accrue from fragment activities, CSG development is targeted, integrated, and conducted in a purposeful manner. In this sense, the highest priority activities to address pressing deficiencies and the overall fit of activities to the 'whole of development' are key to CSG development. Third, the actions invoked in this stage of CSG development are directed to enhance the maturity of CSG. This becomes 'objectively' measured through activities targeted to make improvements in the GRL and context for the system of interest. By focusing on the input from the *initialization* and *development mapping* stages, the *development* stage proceeds from a more informed set of insights. This advantage stems from the clarity in focus from the identification of CSG gaps, setting of priorities based on the most pressing needs for CSG development. Targeted development can be pursued based on identification of what is feasible given the current state of CSG.

A fourth critical consideration involves the continuing cycling of the *development* stage. Thus, increasingly difficult activities can be taken on as the state of governance matures, the system of interest improves performance, and the context is modified to reduce constraints and amplify enabling factors. Fifth, development also serves as a 'litmus test' to understand the relationship of existing initiatives to the governance development priorities. Thus, decision makers are provided actionable intelligence concerning the contribution of different 'well meaning' activities currently underway or being contemplated to improve the state of CSG. If development initiatives, either ongoing or being considered, cannot be 'justified' as to their relevance to the most pressing needs for improving the GRL and context, they should be called into question. Additionally, the feasibility of different ongoing or planned activities should be considered with respect to their probability of success. What decision makers are ultimately provided through CSG development is: (1) a landscape of system development needs, (2) a prioritization of those needs that also considers feasibility of addressing those needs given the state of CSG and context, and (3) a sound foundation to suggest 'reallocation' of existing resources or 'redirection' of future system development resources to more productive development activities.

CSG development has not been conceived as an easy approach to system improvement. On the contrary, the development path is difficult. The approach presented is comprehensive, theoretically/conceptually grounded, and resource intensive. It requires a sophistication and capacity for systems thinking if it is to be properly engaged. It also requires a supportive context. While a comprehensive application of CSG development is preferred, this does not preclude more limited and modest CSG development activities. For example, upon discovering limitations in systems thinking capacity, there may be an initiative launched to enhance the systems thinking capacity across the workforce. The path to CSG is fraught with potential obstacles that should be considered by individuals or entities contemplating a CSG effort. In the following section, we provide some challenges that should be considered by practitioners considering pursuit of CSG development.

Vignette
The Power and Pull of the Status Quo

The full engagement of CSG development is difficult at best and ill-advised at worst. In recounting a particular attempt to engage CSG, there were several instructive points discovered. As a background, in this situation an organization was 'interested' in what CSG might have to offer and was willing to engage in a brief overview and introductory entry exercise. The entry exercise consisted of establishing a 'snapshot' of the level of systemic thinking capacity in the group, the demands being placed on the organization by the environment, and the current state of CSG in place to govern the organization (system). The results of the 'snapshot' were less than stellar for an organization that considered itself to be 'on the top of their game and industry leaders'. Three instructive points are offered. First, a clear development path forward from the initial results was desirable, but not explicitly provided. There is a clear expectation that regardless as to how CSG is presented, if the mindset is one of 'being told what to do next,' there is great difficulty in thinking that CSG will be embraced, much less successful. Second, organizations (systems) are often focused on immediate problems. CSG requires a focus on the 'long view' and development versus solving direct problems. The linkage of system development as a source of long range problem dissolution was difficult in this case, if not impossible. A mindset dominated by a focus on near term, local problems, and limited engagement expectations left little room for CSG consideration *that is focused on long-term, global understanding, and more comprehensive examination. The look for the 'quick fix' placed the nature, thinking, and contributions of CSG in question. Third, when participants returned from the momentary level of thinking/exploration invited by CSG to their 'routine jobs/patterns', any progress quickly returned to a focus on the status quo. The preoccupation with immediate, here and now, issues (urgent/important) could not be suspended for engagement in the out there and future (not urgent/important) that is called for by CSG. Fourth, the very nature of CSG development is threatening to existing power structures. These structures were certain to be called into question through further exploration and immersion in CSG development. In this particular case, the introspection, transparency, and identification of governance deficiencies were too great for the status quo to risk engaging. After all, deficiencies in CSG design, execution, and development can be perceived as a threat to a leadership that has responsibilities for the CSG functions that appear to be questionable. Leaving the level of uncertainty 'as it' was considered much more palatable and less risky than uncovering governance/leadership deficiencies overseen by responsible executives. In effect, better not to ask questions that would likely produce uncomfortable, threatening, or divisive answers. Irrespective of how much there was recognition of the value that might be possible in developing CSG, the powerful 'pull of the status quo' was successful in diverting the momentary engagement in CSG back to the day-to-day issues and crises.*

4 Challenges for CSG Development Methodology Deployment

CSG is a *systems-based, holistic, and purposeful approach to complex system development*. CSG offers significant value to help address some of the most vexing problems faced by practitioners (owners, operators, designers, performers) responsible for governance of modern complex systems. However, implementation of CSG development is certainly not free of difficulties and challenges. Despite the offerings of the approach, there are trepidations for engaging CSG which suggest that development should not be taken lightly. CSG development is an approach that requires continuous and purposeful design, execution, and evolution of metasystem functions. The CSG development methodology is an approach to address CSG development.

Success in CSG is not contingent on good will, noble intentions, or strength of desire. On the contrary, success in CSG will be mediated by several factors, several of which have nothing to do with the current state of CSG for the system of interest. Among these exogenous success factors are: (1) the *evolutionary design path* that has brought the system to its current state, (2) *the level of individual capacity* to engage in holistic systemic thinking and action necessary to implement CSG, (3) *organizational competency* for governance that focuses on having a requisite level of knowledge, skills, and abilities to effectively engage CSG, and (4) *support infrastructure enabling/constraining* impacts on CSG development. Each of these factors are examined below.

The *evolutionary design path* is a potential limiting factor in CSG development. The complex system design path defines how a system has come into being. System design (configuration) has three primary paths that might have been pursued. Each path has influences on how CSG development might progress. The first design path is a system coming about by *self-organization.* The *self-organization* approach to complex system design is centered on permitting the relationships and activities undertaken for system benefit to ‘take their own unfettered’ course of development. This is basically unconstrained design where the structure, behavior, and patterns of relationship are permitted to emerge without constraint. Self-organization is the ‘least energy’ approach to design. However, this system design approach is particularly troublesome when the resulting ‘low energy’ design falls short of producing desirable levels of system performance. The result of self-organization design is that *we get what we get, nothing more and nothing less.* As long as the self-organized system design provides performance that remains at an acceptable level, this approach to design must be deemed to be adequate. It has required the least investment of scarce resources for system design. However, as systems become more complex, it is doubtful that unfettered self-organization will produce the levels of sustainability sought in response to internal flux and external turbulence. In this case, self-organization of design for CSG fails to provide sufficient constraint necessary to maintain desired performance levels.

A second approach to system design and development is through *accretion*—where new elements, activities, or modifications occur in a piecemeal or ad hoc fashion. The result of an accretion approach to system design is that systems are fragmented. They are absent an organizing logic that can explain how the system development ‘makes sense’. Instead, a disorganized and uncoordinated set of development initiatives are undertaken. Thus, in accretion, additions are made to the system without consideration as to their holistic fit to the larger system. While individually these additions might seem beneficial, incorporation into the larger system might produce unintended consequences that will negate the anticipated benefits upon which their inclusion was perhaps based. At some point a system designed and developed through accretion will cease to make sense. The logic and structure of the design and development are neither apparent nor capable of effectively sustaining the system.

Too often the development of modern complex systems follows development by accretion or self-organization. CSG calls for a third alternative for system development. This alternative is for *purposeful and holistic* development. Purposeful development requires that system development be holistic (considered as an integrated unity) and achieved in a deliberate fashion (purposeful). This is not to suggest that purposeful development does not deviate from the initial formulation. On the contrary, purposeful development is constantly adjusted to shifts in knowledge, understanding, and interpretation of ongoing development results. *Purposeful and holistic* development stands in stark contrast to the pattern observed for development of many modern complex systems. Understanding how a system design has developed (self-organization, accretion, or purposeful design) is influential in how a CSG development endeavor might proceed and what might be reasonable with respect to expectations. If a system is not meeting desirable performance levels, with design having occurred by self-organization or accretion, this might suggest difficulties in instituting CSG development. This does not suggest that CSG cannot be undertaken but rather may forecast a difficult development path ahead.

The *level of individual (participant) systems thinking capacity* has a direct effect on the planning, execution, and expectations for a CSG development endeavor. A development effort is contingent upon the level of systems thinking held by individual participants. The level of systems thinking capacity has nothing to do with strong will, desire, or good intentions. On the contrary, while those elements might contribute to success, they are not indicators of the level of sophistication in system thinking held by the individuals or the aggregate group. Lower levels of systems thinking capacity will limit the types of activities that might feasibly be undertaken to develop CSG. In fact, a low level of systems thinking capacity (individual, group, or both) might indicate that until that is elevated to an acceptable level, it might be a focus for CSG development. This might be through education, structured application, or training programs to enhance systems thinking.

Beyond systems thinking capacity, *organizations have a level of competency (knowledge, skills, and abilities) for engaging CSG.* This competency level will be influential in how CSG development might be performed and what results might be expected for engagement. Competencies might include not only systems thinking skills, but can extend to such reinforcing competencies as leadership, modeling, communication, etc. The array, distribution, and development relevance of competencies are important considerations with respect to the design, execution, and expectations of a CSG development endeavor. It is important to acknowledge that competency development can be built into a CSG development endeavor. However, this should be deliberate rather than an after the fact acknowledgment that competencies are limiting the nature and type of CSG development activities that can be engaged.

Support infrastructure is an important consideration for CSG development endeavors. Support infrastructure includes such aspects as facilities, instrumental policies/processes, procedures for implementing system changes, and management directives. Support infrastructure can be enabling or disabling for a CSG effort. If the support infrastructure can assist in achieving implementation of system development initiatives, it should be utilized to maximum effectiveness. Likewise, if the support infrastructure is a limiting factor to development initiatives, it must be taken into account and part of the design for CSG must include how it will be changed or otherwise addressed. Support infrastructure should be considered and incorporated accordingly as it impacts CSG development. It is shortsighted to engage support infrastructure at later stages of instituting development initiatives when they should have been considered much earlier.

Although the pursuit of CSG development seems enticing, it should not be entered into lightly. CSG development is difficult and has limitations. However, all systems-based approaches attempting to deal with complex systems and their associated problems have limitations. For realistic caution in pursuing CSG development, we offer an additional set of important points for consideration:

1. ***CSG development must involve the system practitioners (owners, operators, designers, performers) who are accountable and responsible for sustainable***

system performance. CSG development pursuit without engagement of these individuals is unlikely to achieve anticipated results. There is no shortcut for involving system practitioners. The responsibility of CSG development cannot be delegated to others or relegated to the status of 'just another initiative.'

2. ***The design for comprehensive CSG development is fallible and must be continually adjusted.*** It is naïve to engage in CSG development assuming that action outcomes can be known in advance. Instead, care must be taken to understand that the design for CSG development is not prescriptive and cannot be static. CSG development must adjust in response to changes in the system itself, the external environment, and the context within which CSG is embedded. The *rate of change for CSG development* design must minimally keep pace with the rate of change in the system, external environment, and context.
3. ***Systemic worldview is critical to performing CSG development.*** The worldview impacts interpretation and framing of all that is encountered for both individuals and organizations. For systems it can range from reductionist (seeing the world as parts and capable of being discreetly broken down and the system understanding existing in the parts) to holistic (seeing the world as defined by relationships and understanding at the whole rather than part level). CSG implementation relies on a holistic systems worldview. Worldviews short of this expectation portend difficulties at later stages.
4. ***CSG development value can accrue across multiple levels.*** CSG can enhance and add value to individuals, entities, and organizations. Care must be taken not to exceed reasonable expectations and feasible achievements in CSG deployment across any level. Although judgment of value is subjective, CSG efforts/expectations should be specified in ways that can be supportive of conclusions regarding the provision of that value.
5. ***The nature of CSG development is evolutionary rather than revolutionary.*** Therefore, the implementation of CSG development requires 'the long view' and patience. Expectations for CSG development must be appreciative of the current state of governance for a system of interest and the context for that system. These will dictate what level of system improvement activities might be feasibly engaged over the near and long-term. Initial excitement and enthusiasm should be tempered, particularly early on in a CSG development endeavor.
6. ***There is inherent 'risk' in engaging comprehensive CSG development.*** It is important to recognize that there is the potential to 'fail' in CSG development. This brings personal and professional risk to participants in the design, execution, and development of CSG. The structuring of CSG efforts should shift levels of risk to facilitators, the system, and the process. Emphasis must remain on engaging feasible activities that increase the state of CSG and evolve the context. As CSG value is seen, the perceived level of risk should diminish.
7. ***Deeper explorations into CSG expose deeper levels of deficiencies.*** CSG exploration can discover inconsistencies that cannot be easily remedied under the current system and context limitations. There is certainly the possibility of discovery of deep systemic issues for which the level of CSG maturity is not

capable of handling. This can represent threats to systems stability and must be appropriately managed.

8. ***CSG development is a protracted 'self-study' of the system of interest, enacted through a new set of lenses, corresponding language, methods, and tools.*** New thinking requires new language, which can produce alternative decision, action, and interpretation in route to pursuit of different outcomes (system performance levels). The willingness to engage in protracted self-study is essential for realization of the benefits offered by CSG development. There is no shortcut to the reflective self-study required for CSG development.
9. ***Engaging CSG development is not a trivial endeavor.*** It is hard work, requiring significant investment of resources, patience to take the 'long view', and sacrifice of instant gratification for sustainable longer term performance improvement. Superficial CSG efforts are not likely to produce desirable or sustainable results, and in fact may make matters worse. Outcome-expectation desires that are incongruent with investments of time, energy, and resources are likely to produce less than desirable results.

The challenges facing CSG development are certainly not insurmountable. They are provided to ensure that practitioners considering CSG development are aware of what CSG development entails. This does not suggest that elements of CSG development (e.g., improvement in individual systems thinking capacity) will not be beneficial or that the deployment of CSG development is a binary 'all or nothing' proposition. On the contrary, there are certainly benefits to be derived from more limited applications of CSG development. However, what can be achieved by CSG development must be consistent with the commitment invested in development efforts. There must be a tempering of expectations based on the multitude of factors that must be taken into account. Ultimately, CSG development is about shifting the governance landscape for a system of interest.

5 Application-Based Insights for Advancing CSG Development Methodology

Thus far, this chapter has provided a grounding background for CSG, a development methodology for deployment of CSG, and a set of concerns for deployment of CSG. The application of CSG has produced many insights from initial efforts. To push the CSG development methodology forward, several of the key insights from application efforts and their implications include:

1. INSIGHT: *Systems worldview is a limiting factor for CSG deployment.* CSG is a systems-theory-based approach to development of the governance functions for a complex system. Engagement for CSG development requires a sufficient grounding in the systems worldview to secure potential gains from deployment. The systems worldview embraces a nonlinear and holistic perspective of all that is encountered. The absence of this requisite systems worldview in those

participants for a CSG deployment is problematic. It is naïve to think that CSG development methodology can be deployed as intended, or achieve the expected results, absent a requisite systems worldview. In response, the CSG development methodology includes, as an upfront effort, the establishment of the state of systems thinking capacity for individual participants as well as the aggregate of participants.

2. INSIGHT: *CSG itself is not a viable entry point for engaging in a CSG development effort.* Although CSG has much to offer for improved system performance, realistically it is not the highest priority for those who might be considering engagement. Those practitioners and entities that stand to gain the most from CSG initiatives are instead focused on 'their problems' and maintaining viability (existence) of their system. Thus, the more appropriate entry point for CSG is to first understand their problems and then draw the linkage to potential CSG value contributions. By engaging in *initialization* activities (e.g., context definition) the direct linkage to the system and utility of further examination through the CSG lenses can be demonstrated. Making this connection between ongoing problems and CSG is critical to draw attention to the possibilities that CSG might bring related to their most vexing issues.
3. INSIGHT: *Starting 'shallow and slow' is preferable to 'deep and fast' to build momentum for CSG.* Engaging CSG is difficult at best and potentially overwhelming at worst. Comprehensive CSG is fraught with difficulties. Completing a marathon is not a short or trivial matter. Capacity must be slowly built as endurance increases as do the prospects for successful completion. CSG engagement is similar. CSG is not a binary (all or nothing) proposition. Instead, there are a spectrum of activities (training, development, modeling, etc.) and focal levels (practitioner, system, enterprise, problem) that might be pursued in the development path to enhance CSG. Through the successive building of confidence and depth of activities, sufficient momentum can be created to engage CSG at increasingly sophisticated levels.
4. INSIGHT: *CSG functions, in an existing system, are already being performed, and thus it is not an 'in addition to' endeavor.* Unlike more traditional system interventions that seek to address a new concern by introduction of a totally new initiative (e.g., Lean, Six Sigma, TQM, BPR, Agile, etc.), CSG functions are already being performed by a system that is viable (exists). Thus, CSG is focused on understanding and potentially improving that which is already being performed. Therefore, the language, thinking, and explorations of CSG are applied to an existing system to improve execution of CSG functions which are already being 'tacitly' performed.
5. INSIGHT: *For CSG engagement, the initial risk should be borne external to the system and participants.* CSG endeavors, irrespective of scope, take resources and present risks to participants and their system of interest. It is unrealistic to expect participants to totally shoulder the 'risk of failure.' Instead, the CSG facilitator should bear the burden of time and risk until the value of investment (time) and utility of CSG engagement (valued results) meet an acceptable *risk-value-cost* trade-off. In effect, CSG should be conducted in a 'safe to

fail' mode. In this sense, initial CSG engagement should offer prospects for an approach that provides high value, low investment, and low risk of failure. This was the concept behind the 'CSG entry' crafted to introduce CSG to potential participants (Keating and Katina [5]).

This set of insights for CSG deployment has been drawn from initial experiences with various applications referenced in the work of (Keating and Katina [5]). While this listing is not all inclusive, it does provide a starting point of considerations for the deployment of CSG development methodology.

6 Summary

In this chapter, we have provided an examination of the CSG development methodology. The examination provided a background into the problem domain that CSG is designed to address. Central to this problem domain are the characteristics of *ambiguity* (lack of clarity in the system and its context), *uncertainty* (the breakdown of explanations rooted in cause-effect relationships), *holism* (loss of meaning from reduction to the component level), *complexity* (excessive number of elements, rich interrelationships, dynamic interaction, and emergence), and *contextually embedded circumstances* (factors, and conditions impacting and impacted by the system). Given this problem domain, CSG was offered as a theoretically grounded, systems-based approach to enhance system performance through the purposeful development activities targeted to improve performance of the system of interest and address contextual issues. Since the earlier work in CSG development methodology [8, 14], our knowledge, understanding, and perspectives have matured. This chapter represents the current state of knowledge for CSG development. While most of the previous work is still consistent with our viewpoint on CSG development, there have been some significant advances in the methodology. This current work represents our most recent state of knowledge. While that state is sure to change, as we continue to explore and learn more about CSG and its related phenomena, we are confident that this work represents a significant movement forward.

CSG development was presented as occurring in three primary stages (Fig. 4), including *initialization, development mapping,* and *development*. *Initialization* includes fixing the state of CSG for the system of interest and elaborating the context for that system. *Development mapping* targeted the setting of priorities for the greatest impact and feasibility of successful achievement for development areas. In this stage, the state of CSG is captured across a nine phased spectrum. This spectrum provides a notional limitation as to the types of activities that might be successfully (feasibly) engaged in development of CSG based on the classification. The final stage, *development*, is focused on the identification, planning, execution, and evaluation of activities selected to undertake in development of the state of CSG.

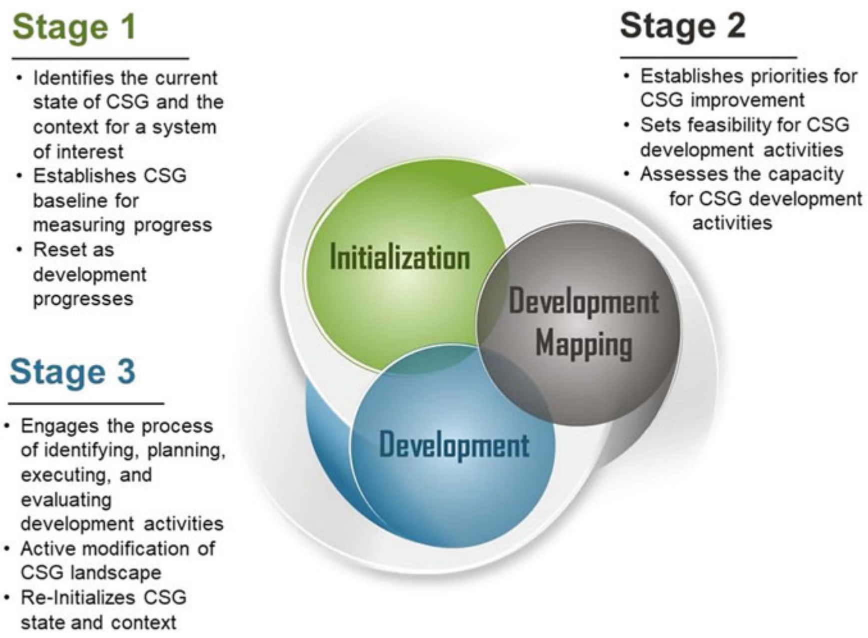

Fig. 4 CSG development methodology stages

CSG development was identified as a continuous cycling that provides the purposeful development of CSG. This purposeful development is steeped in selection of priority feasible activities that can be undertaken to improve the state of CSG as well as the context. Thus, the successive cycling is a continuous re-initialization, shifting of the development mapping, and increasingly deep selection of development activities.

Several success limiting factors were explored. These factors were identified as having a high level of impact as to what can reasonably be expected with respect to CSG development. The first factor dealt with the *evolutionary design path* that has brought the system to its current state. This path was presented as ranging from self-organization to accretion. Ultimately, CSG suggested a difficult path of purposeful design be preferable for increasingly complex systems. The second limiting factor was focused on the *level of individual capacity* existing within the system. Lacking a robust systems thinking capacity, the development of CSG would be limited. A third factor was the *organizational competency* for governance. This competency is focused on the level of requisite knowledge, skills, and abilities to effectively engage CSG. Lacking these skills, although CSG could be engaged, it is doubtful it could have the desired developmental impacts sought. A final factor identified was the *support infrastructure enabling/constraining* impacts on development. Without adequate support infrastructure, a CSG development endeavor would experience limitations in execution. The sum total of these factors was provided to interject a realistic sense of CSG development considerations and limitations.

Several challenges to the deployment of CSG were examined. These challenges serve to guide practitioners considering CSG to more fruitful discussions on the approach, expectations, and potential pitfalls. Several insights for CSG engagement were provided based on experiences from applications. The purpose of this listing was not to dissuade engagement of CSG. On the contrary, the examination was intended to ensure that the engagement of CSG would begin with a healthy appreciation of the nature, scope, and considerations that should be contemplated before taking on such an endeavor.

Exercises

1. Discuss three aspects of the complex system problem domain and their implications for conducting CSG development.
2. Which of the methodology attributes is most important for the CSG development methodology? Why?
3. For the *initialization stage,* discuss how that stage might be expected to change in subsequent development cycles for CSG.
4. Discuss the three forms of system design (self-organization, accretion, purposeful) and their implications for CSG development.
5. Given the considerations provided for CSG development, select and discuss your top three considerations. What guidance would you suggest for practitioners with respect to the considerations you identified?

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