Editorial: Foundational perspectives for the emerging complex system governance field

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1 Introduction

An exhaustive literature review of *complex system governance* (GSG) generates a paucity of material. This is simultaneously interesting and troublesome. It is interesting in that there has been virtually nothing of rigorous depth developed that serves to explore the intersection of the 'complex systems' and 'governance' fields. In fact, as Calida and Keating (2014) suggest, each field has provided substantial contributions to improve the state of human existence. However, we note with interest that the fields have managed to develop and make significant contributions virtually independent of one another. We find the maintenance of this 'false' separation troublesome for several reasons. First, the potential insights that might accrue at the intersection of these fields are missed. Of course we cannot conclude that this intersection might produce anything of substance that the sum of the individual fields might produce independently. However, in true *holistic* systems fashion, we posit that together these fields might produce insights beyond what either is capable of if left to their own independent development.

Second, the problem domain currently faced by society beacons for novelty in developing new thinking and corresponding action. The reality of this problem domain is challenging the most central institutions necessary for society to function effectively (commerce, energy, education, finance, food, healthcare, housing, security transportation, and water). This problem domain has been previously summarised (Jaradat et al., 2014; Katina et al., 2014; Keating and Katina, 2011, 2012; Keating, 2014) as being marked by high levels of:

- *Ambiguity* – increasing lack of clarity in understanding/interpretation of both the system and context within which it exist.
- *Complexity* – systems so intricate and interconnected that complete understanding, prediction, control, or explanation is impossible.

- *Emergence* – unpredictability of events and system behaviours from constituent elements, known and experienced after they occur, without the possibility for prediction.
- *Interdependence* – mutual influence among systems through which the state of each system influences, and is influenced by, the state of interrelated systems.
- *Uncertainty* – incomplete knowledge casting doubt for decision/action consequences.

The problems emanating from this domain appear to be intractable. The current level of thinking and ineffectiveness of responses to this problem domain appears inadequate. We seem to be ineffective as the problems escalate and seemingly proliferate into all aspects of human endeavour. The search for, or expectations of establishing, precise cause – effect relationships that could suffice for developing solutions to the level of complex problems characteristic of the early 20th century have dissipated. The early formulations of Ackoff's (1974) 'messes' (i.e., interrelated sets of problems that are not well formulated, understood, or easily resolved) and Rittel and Webber's (1973) 'wicked problems' (i.e., problems that are intractable with current levels of thinking, decision, action, and interpretation) seem to aptly describe the domain that continues to confound our best levels of thinking, methods, and corresponding action. This problem domain is likely to continue as we continue to grapple with the complex systems and their constituent problems prevalent to the 21st century. Therefore, looking for new insights at the intersection of familiar yet separately developed fields might provide the potential for breakthrough thinking at their intersection. It would be shortsighted not to explore the possibilities that might be experienced in looking at the confluence of 'complex systems' and 'governance'.

Finally, complex systems 'obey' a set of non-negotiable laws, whose violation carry real and sometimes devastating consequences. Although the meaning and interpretation for system principles might be debated *ad nauseam*, the fact that all systems are subject to systems laws, and that there are consequences attached to 'violation' of those laws, is not the subject of opinion or debate. In addition, much of the development of the systems field, particularly hard systems approaches (e.g., traditional systems engineering), has assumed the existence of a *unitary* perspective concerning system purposes and goals. This perspective is largely based on the assumption that system objectives are rational and objectively pursued to increase system performance. Although soft systems-based approaches, such as Checkland's (1990) soft systems methodology, have attempted to offer alternatives to the *positivist* (objective, concrete, rational)-based approaches to those respective of a *less positivist* (subjective, interpretative, and irrational) perspective. However, we conclude that this soft systems thinking, however seductive in appearance, has not become accepted in mainstream engineering of solutions within complex problem domains, nor the educational systems that produce those who must grapple with these domains. In contrast, while it lacks the apparent rigor of systems-based approaches, the *governance* field is appreciative of more diverse and potentially conflicting *pluralist* perspectives on problems, appropriate approaches for resolution, and interpretation of the solutions. In addition, the *governance* field has a long history of having to deal with conflicting stakeholder perspectives, shifting boundaries (e.g., time, geography, and conceptual), and politically charged positions. Therefore, we conclude that the *complex systems* and *governance* fields have much to gain from exploration of joint development at their intersection. We also suggest that the intersection of these fields might prove fruitful in development of new and novel paths forward to address the myriad of existing and emergent complex system problems that have become the hallmarks of modern society and institutions.

Effectiveness in dealing with these problem domains beckons for individuals and organisations capable of engaging in a different level of thinking, decision, and action that can produce responsive paths forward in the wake of seemingly intractable problems. We suggest that CSG is an emerging field at the intersection of systems and governance with the potential to enhance capability for more effectively dealing with complex systems and their constituent problems. Through simultaneous development of the science (theoretical and conceptual underpinnings), methodology (guiding framework for application), and practices (real world deployment), CSG can be positioned to address failures in current approaches that fall short of expectations.

This special issue is dedicated to an initial focused effort to:

1. draw attention to CSG as an important emerging field focused on improving effectiveness in dealing with complex systems and their associated problems
2. provide several critical foundational perspectives concerning the essence of the CSG field
3. establish a trajectory for further development of the field and the corresponding contributions that might improve the performance of complex systems.

In this introduction to the special issue, we have focused on three primary objectives. First, following our introductory remarks concerning the nature of the complex systems problem domain, we provide a broad-based sketch of the emerging CSG field. This is intended to provide a levelling of the current state of the field and establish a reference context for the articles that follow in this special issue. Second, we introduce the interrelationship between CSG and the system of systems engineering (SoSE) fields. We establish the linkage of central elements of SoSE and project CSG as a natural evolutionary development for the SoSE field. This seeks to demonstrate not only commonality, but also the potential that CSG offers to move beyond some of the inhibitions and divergence being experienced in the SoSE field. Particularly, CSG might resolve the apparent dichotomy between the binary separation between the technical and non-technical aspects of complex system development characteristic of many SoSE-based approaches. We position CSG as a potential paradigmatic, methodological, and practice path forward for this seemingly intractable divergence (i.e., technical versus non-technical, hard systems versus soft systems, holistic versus reductionist) in SoSE. Third, the papers for this special issue are placed within the context of the emerging CSG field. Special emphasis is provided for their fit to the emerging CSG field as well as their interrelationship to one another. Finally, this introduction closes with an appreciation of the work, in both research and application, which must build upon these current efforts while purposefully suggesting a path forward.

This is an exciting time in the development of the CSG field. It is *new* (i.e., providing novelty in directions that are not unnecessarily constrained by prior momentum and proclivities of established and mature fields), *substantially grounded* (i.e., able to selectively draw upon preceding bodies of knowledge as deemed ‘appropriate’ for inclusion or interpretative amplification, e.g., systems theory, governance, and management cybernetics), and *promising* (i.e., creating potential for ‘breakthrough’ thinking, decision, action, and insightful understanding of society's most vexing present and future system problems). This special issue stands as a purposeful attempt to begin building the foundations for the emerging CSG field. It draws upon and extends prior works (Calida, 2013; Calida and Keating, 2014; Keating et al., 2014; Keating, 2014) that have sought to begin the task of articulating this field.

2 The emerging field of GSG

CSG is proposed as an emerging field with implications to assist practitioners in building capabilities to better diagnose and resolve deeper level systemic issues that impede system performance. As such, CSG seeks to identify and 'design through' fundamental system issues. These issues exist at deep tacit levels and appear only as superficial manifestations of deeper implicit underlying problems in structure, execution, or interpretation of complex system performance. The emerging CSG field is certainly not portrayed as a 'panacea' to singularly guarantee success with the present and future 21st century problems facing society. These problems permeate multiple sectors (e.g., commerce, energy, education, finance, food, healthcare, housing, security transportation, and water), waste resources, and invoke high human costs suffered at the hands of 'broken' systems. However, in response CSG does offer a compelling argument as a necessary, albeit not sufficient, way of better understanding the source of issues and potential alternative paths forward. Therefore, the opportunity exists to increase effectiveness in dealing with the problems characteristic of broken systems rampant across all of these critical societal sectors. In response, CSG is developing as a robust reply to the calls for a 'total systems view' based in holistic accounting across technology, organisational, managerial, human, social, policy, and political dimensions. This CSG view also spans the philosophical, theoretical, axiomatic, axiological, methodological, method, and application aspects of complex systems and their associated problems. Again, while CSG is not a remedy that assures better performing systems, it provides a solid complementary set of methods, tools, and thinking rooted in a strong conceptual foundation.

CSG is emerging as one of many systems-based approaches available to better deal with increasingly complex systems and their related problems. There have been multiple successful systems-based approaches to address complex system problems (Flood and Jackson, 1991; Jackson, 2003). However, in general, these systems-based approaches do not appear to be widely known, accepted, or practiced. This is unfortunate as they each have made unique contributions to increase the capacity to more effectively deal with complex system problems. These approaches, and the systems thinking upon which they are founded, are certainly not 'new'. In fact, the foundations of systems thinking have been traced as far back as the ancient Chinese work *The I Ching* (translated as *Book of Change* dated prior to 400 B.C.). From the earliest beginnings of mankind, the struggle with increasingly complex and troublesome systems has endured. The early Chinese work noted the dynamic nature of changing relationships among elements – a condition that has not changed in well over two thousand years since it emerged. Additionally, the central philosophical tenet of systems thinking, *holism*, can be traced back to the writings of Aristotle, who suggested that 'the whole is more than the sum of its parts'. Thus, 'systemic' thinking and approaches based on the tenets of this thinking are certainly not new. However, what is new in research-based applications of CSG is a more robust systems-based framework emerging to guide systemic inquiry, analysis, and (re)design. CSG works at the intersection of systems theory (used to focus on effective integration and coordination), cybernetics (focusing on communications and control), and governance (concerned with direction, oversight, and accountability). Ultimately, the development of CSG is directed to provide practitioners with increased effectiveness for better understanding, decision, action, and meaningful interpretations for the complex system problem domain with which they must contend.

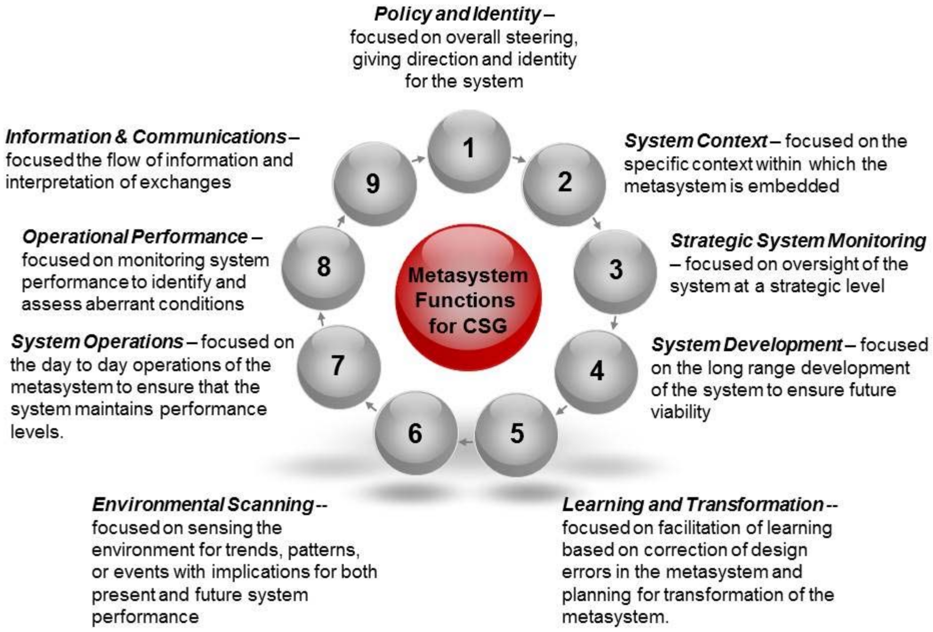
Figure 1 is drawn to indicate the realities that the practitioner in the modern enterprise must contend with in the complex problem domain. Arguably, these conditions have existed since the dawn of man and are not likely to subside in the future as technologies, social structures, and societies continue to increase in complexity (Thissen and Herder, 2003). However, the present state of the complex problem domain suggests the time is ripe for innovative approaches to lessen the burden.

Figure 1 Nature of the complex system problem domain (see online version for colours)

This is the domain where CSG is being postured to impact practitioner effectiveness. Once again, CSG is primarily based in systems theory (Skyttner, 2005; von Bertalanffy, 1956, 1968; Adams et al., 2014) and management cybernetics (Beer, 1979, 1981, 1985) and has been built upon their philosophical, theoretical, and methodological underpinnings. CSG has been previously defined as the "design, execution, and evolution of the metasystem functions necessary to provide control, communication, coordination, and integration of a complex system" [Keating et al., (2014), p.274]. The metasystem is an essential element CSG and has been previously described (Keating et al., 2014). Figure 2 provides the nine metasystem functions that must be performed to maintain viability (continued existence) for a complex system.

The execution of these functions provide a complex system with *control* (minimal constraints necessary to ensure consistent performance and future system trajectory), *communications* (flow and processing of information necessary to support consistent decision, action, and interpretation across the system), *coordination* (providing for effective interaction among different critical entities, including multiple and diverse stakeholders, within and external to the system, to prevent unnecessary oscillations), and *integration* (achieving system unity with common goals, accountability, and balance between autonomy of individual elements interests and system level interests). In essence, effectiveness in execution of the nine 'metasystem governance' functions determines the level of system performance and is the primary focus of CSG.

Figure 2 Nine metasystem functions of GSG (see online version for colours)



CSG has a direct relationship to SoSE. SoSE is concerned with means of attaining capabilities, missions, and outcomes beyond of those individual systems (Sousa-Poza et al., 2008). In systems of systems, the concern is not the capabilities, missions, and outcomes of individual systems. Rather emphasis is placed on integration of individual systems and their coordination to enable delivery of "significantly greater capability" [USAF SAB, (2005), p.24]. In prior work, SoSE has been defined as "The design, deployment, operation, and transformation of metasystems that must function as an integrated complex system to produce desirable results" (Keating et al., (2003), p.40]. In that work the metasystem was identified as not just existing beyond 'meta' to the systems that were being integrated into the system of systems, but also inclusive of the systems being integrated. The current CSG perspective of the metasystem has evolved from this initial perspective in several important ways, including:

1 the metasystem is considered as logically 'separate' from the systems that it seeks to integrate (this is consistent with Beer's articulation of the metasystem in relationship to the autonomous systems that it seeks to integrate)

2 Beer's (1979) original articulation of the metasystem, although not specifically expressed in the early SoSE work, has been expanded from Beer's original five functions to nine functions

3 the metasystem exists beyond and seeks to integrate the multiple constituent systems into a productive system of systems.

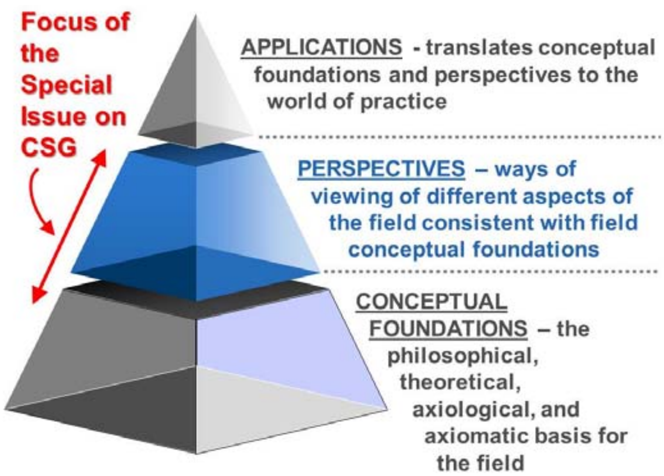
Therefore, CSG is certainly related to, and offers an extension of, SoSE as it relates to integration of multiple complex systems through the functions of the metasystem.

3 Focus of the special issue

This special issue is focused on providing a set of foundational perspectives for the emerging CSG field as well as some of the conceptual underpinnings that inform those perspectives. The CSG field is in the earliest stages of development. However, as we have established, it lies at the intersection, and draws upon the rich heritage, of systems theory, governance, and management cybernetics. Therefore, the CSG field is well served by establishing some critical foundations that are put forth in this special issue. In all, the nine articles contribute to our foundational perspectives in governance of complex systems.

These perspectives give an important set of different viewpoints that contribute to the development of the CSG field. At the most foundational level we suggest *conceptual foundations*. These foundations provide the basis for the *philosophical* (i.e., worldview that provides the values and beliefs that inform decision, action, and interpretation), *theoretical* (i.e., explanation of phenomena related to the field), *axiomatic* (i.e., the principles that define the function of systems within the field), *axiological* (i.e., values, value judgements, and beliefs held dominant for the field), *methodological* (i.e., generalised frameworks that guide applications in the field), and *methods* (i.e., the supporting processes, technologies, standards, and tools the inform applications within the field). At a next level, we project *perspectives*. Perspectives offer essential viewpoints of different aspects of the emerging CSG field. The different perspectives provide a variety of views that lie in the space between conceptual and application. While this set of perspectives in the special issue makes no claim to be either exhaustive or complete, the articles do provide a robust foundation for accelerating understanding and development of the field. In particular, they offer an excellent transition for bridging from conceptual underpinnings to the world of practical applications for CSG.

Figure 3 Role of perspectives for the special issue (see online version for colours)



Application is the final element in the triad presented for the CSG field. The perspectives in this special issue offer some unique insights and challenges to push the CSG field forward in the transition from the conceptual realm to the world of the practitioner. Ultimately, the applications related to CSG are where the benefits of the field are experienced. To establish the relationship between these different perspectives, Figure 3 is drawn to show these perspectives relative to one another. Although the figure presents the three different levels (*conceptual foundations, perspectives, and applications*) as independent, their separation is for discussion convenience only. In reality, these perspectives are not mutually exclusive or independent of one another in their development or application.

4 The contents of the special issue

The papers of this special issue on CSG are targeted to provide multiple perspectives on the emerging field. While the systems theory paper provides a conceptual foundation serving to ground the emerging field, for the most part the collection offers different aspects and ways of looking at critical elements in the emerging CSG field. While it would be easy to view each of the papers in isolation, this would be shortsighted. In actuality, the set of papers represent an interrelated set of perspectives on the emerging field. Thus, we suggest that:

1 systems theory serves as a common basis for each of the different perspectives provided

2 each of the perspectives might be considered to exist in relationship to the other perspectives, influencing the other perspectives while simultaneously being influenced by the other perspectives

3 the different perspectives also have implications for the conceptual basis for the field

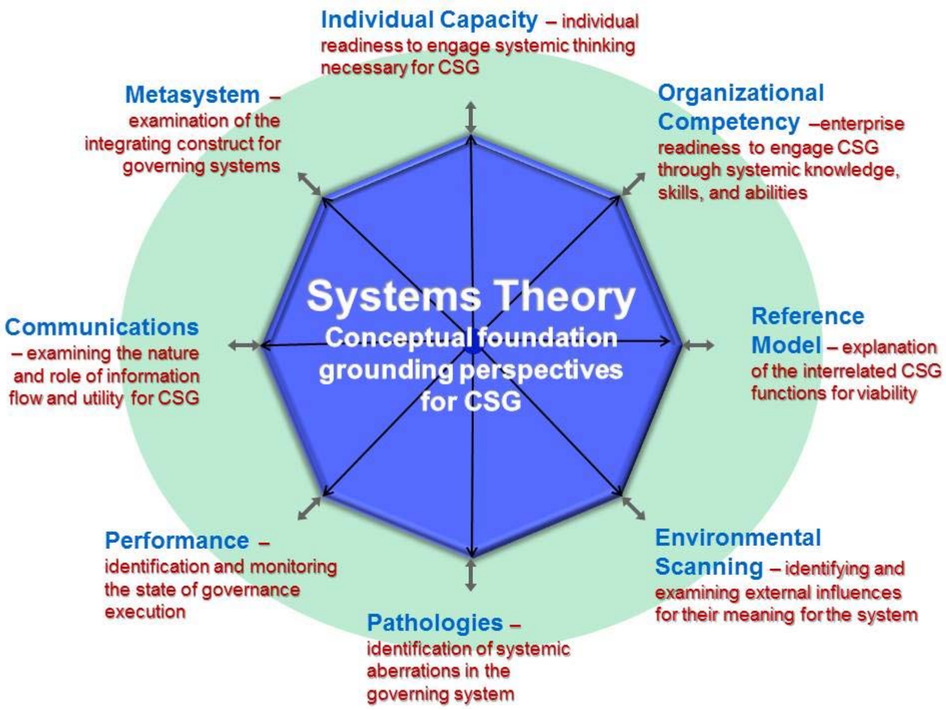
4 the perspectives are certainly not mutually exclusive of one another or serve as an exhaustive set defining the emerging CSG field.

Instead, they offer an invitation to inquiry and bridge between the conceptual foundations and applications of the field.

Figure 4 is drawn to indicate the interrelationship among papers in this special issue. Although the papers are not presented as a complete set of perspectives for CSG, they are important in establishing relationship between the base conceptual foundations and the level of application as indicated in Figure 3.

This special issue includes nine relevant perspectives essential for developing the emerging CSG field. The first paper of the issue, written by Kaitlynn Whitney, Joseph Bradley, Dale Baugh, and Charles Chesterman Jr., focuses on systems theory as a foundation for CSG. Systems theory is taken as the essential conceptual foundation for CSG. In this paper, the authors draw on the traditional concepts of 'systems' to enhance application of systems theory to CSG – especially propositions and axioms that can be used to better understand complex systems. Using discoverer's inductive method, the authors (re)defined systems theory, associated axioms, and propositions and offer their role in governance of complex systems. This paper offers the conceptual 'heart' for CSG, providing a solid reference point against which other subsequent work in the field might draw upon as a common grounding platform.

Figure 4 Perspective papers in the special issue, grounded in systems theory (see online version for colours)



In the second paper, by Charles Keating and Joseph Bradley, a first articulation of a CSG reference model is explored. This paper provides a model of nine essential metasystem functions for CSG that must be performed if the system is to remain viable. It provides an essential perspective of what must be accomplished in order to provide CSG. The reference model offers a perspective which can provide a transition to applications of CSG for a targeted enhanced CSG performance.

Undoubtedly, systems theory is vital in governance of complex systems. However, to bring about the systemic change sought by real world applications of CSG perspectives, policy-makers, researchers, and complex system owners will be limited by the individual capacity they have engaging in 'systemic thinking'. The level of system performance improvement will be limited/enhanced by the degree to which individuals fully understand and appreciate the nature of complex systems (i.e., their capacity to engage in systemic thinking). This is the message of Ra'ed Jaradat's article. He provides an assessment tool that can be used evaluate the level of systemic thinking for a workforce that must engage in efforts to address complex systems issues.

While individual capacity for systems thinking is necessary, alone it does not guarantee sufficiency for success with CSG improvement endeavours. One aspect of sufficiency is the level of organisational competence that exists for implementing CSG. The forth paper, by Joseph Bradley, Resit Unal, C. Ariel Pinto, and Edward Cavin, suggests a need to evolve contemporary competencies to address the challenges of the complex system problem domain. In this paper, the authors provide weaknesses associated with current competency models and suggest a need for (re)evaluation of such models. This is especially appropriate based on the current nature of complex system problems and the emerging field of CSG. The authors develop a framework that can be used to asses and create competency models capable of matching complexity generated by the complex landscape faced by modern enterprises. The level of organisational competence is a critical perspective for advancing the promise of CSG for improving system performance.

A key feature of CSG is the 'metasystem'. A metasystem operates at a higher logical level than the constituent systems it seeks to integrate and govern. In the fifth paper, Bry Carter defines metasystem from the perspective of management cybernetics. He articulates functions associated with a metasystem along with relevant and associated systems theory propositions. The paper includes metasystem implications for governance of complex systems in relation to viability. The metasystem offers a critical perspective in the emerging field of CSG.

Another key aspect of CSG is communication between a system and its environment and within the system. Therefore, the communication aspect offers a critical perspective for CSG. In the sixth paper, Charles Chesterman, David Walters, and Kevin Adams focus on the role of communication in a metasystem. They explore the nature of information and mechanisms for conveying that information. The paper also includes implications for having deficient communication channels, especially for CSG.

We believe a critical aspect of CSG involves the means for establishing expectations and monitoring performance of complex systems. This can be used to support many aspects of complex system development, ranging through design, analysis, maintenance, and evolution. Walt Akers paper suggests that monitoring can be done using available tools and techniques. In this paper, an alternative approach to performance monitoring is offered. The presented approach is concerned with holistic understanding of resource allocation using visualisation provided by temporal heat maps. The approach is applied in a large organisation. Challenges associated with implementation of this approach are provided.

In systems theory, the environment is defined as that which is "outside of the direct control of the system and [is] any phenomenon influencing the processes and behaviour of the system" [Skyttner, (2005), p.63]. While complex systems operate as interdependent systems, they are often managed as specific systems of interest. The interdependent systems form part of what is the environment, outside the boundaries of the particular system of interest. However, there is an essential need in CSG to understand the nature of the environment and its influence on a system of interest. This necessarily involves 'sensing' the environment for potential impacts and perturbations on a system of interest. Dale Baugh's paper explores the concept of environmental scanning from different perspectives and then from systems theory. In this paper, the importance of environmental scanning for governance and viability of complex systems is expounded.

Another important element of CSG is identification of issues affecting governance, particularly as part of problem formulation in systems-based approaches. This includes *framing* (articulation of the particular metasystem structural configuration, performance of the metasystem functions, and metasystem issues) and *relevant context* (circumstances, factors, conditions, or patterns) within which the metasystem and constituent systems are embedded. Both framing and context are critical to CSG development, since they influence “the subsequent course of action” [Mintzberg et al., (1976), p.274]. In the final paper, Polinpapilinho Katina seeks to use systems theory as the basis for enhancing problem formulation. Specifically, his paper is focused on identifying pathological factors that act to limit system viability and are thus likely to reduce expected performance of complex systems. This paper provides a systems theory-based construct for identifying pathologies that exist in a metasystem.

While not absolute, or necessarily complete, this limited set of papers provides an excellent grounding set of perspectives for the emerging field of CSG. Certainly, this does not preclude expansion of these perspectives through rigorous research, especially as further developments in the field are sure to provide new insights and fruitful directions for research and practice related to CSG. In the following section, we project our view of developmental directions for the field.

5 Conclusions and implications for moving forward

This is an exciting time in the development of the emerging CSG field. This special issue represents a significant step forward in the development of this field. We have intentionally tried to cast a ‘wide net’ to gather what are considered important perspectives for a field in the early stages of maturation. The hope is to avoid narrowing the field too early in the beginning stages of field formulation. Premature narrowing is a precursor to potentially excluding fruitful discoveries, novel insights, and unconventional developmental directions for the field. Therefore, we certainly expect challenges, additions, extensions and insights as the field continues to evolve. This includes continued maturation of the perspectives developed in this special issue. It is intellectual arrogant and naïve to think that the knowledge of the field will remain static and not change as new knowledge continues to evolve.

As the CSG field continues to evolve, the following significant directions for development are suggested. These are consistent with earlier works suggesting development of CSG (Keating et al., 2014; Keating, 2014).

- *Holistic field development* – continued development of CSG will be well-served by research and practice being simultaneously developed. Research must be directed at pursuit of *philosophical* (worldviews), *theoretical* (explanations concerning phenomena), *methodological* (high level guiding frameworks), *axiological* (values, value judgments, and beliefs), and *axiomatic* (underlying principles) advances
- *Practice and practitioner emphasis* – the field should not lose sight of the drive to improve practices related to dealing with ill-behaving underperforming systems and their issues. In addition, practitioners are tasked with being able to confront the uncertainty, complexity, ambiguity, and emergence of modern system domains. CSG development should not forget the front line practitioners and their need for *methods, tools, and techniques* with proven capability for addressing their issues through demonstrated *applications*
- *Emphasise ‘local system revolutionary’ improvement with ‘global field evolutionary’ development* – the local applications of CSG should decidedly take a near term high impact perspective. This should emphasise system improvements through application of CSG thinking, methods, and tools to produce focused, priority, and *feasible*

system improvements. In contrast, development of the CSG field should focus on long-term evolutionary development such that the field remains sustainable. The field should not be subjected to a ‘faddish’ development. Care must be taken such that the field does not create expectations that are unrealistic for the current stage of development. Unrealistic expectations at best will cause disappointment amid initial fanfare. This will either result in the field being minimised at best, or suffering an early demise at worst

- *Theoretical grounding for field sustainability* – if CSG is to maintain coherence in continued development, it will be necessary to ground the field in a strong conceptual base. We have initially built this conceptual base around systems theory, governance, and management cybernetics. However, while this offers a cogent starting point, the further development must remain open to conversations that can invite dialog beyond the current grounding and the artificial boundaries that grounding imposes. Ultimately, as the field continues to evolve there should be areas of convergence that emerge as widely accepted across the community of interest in the CSG field

The path of development for an emerging CSG field is not without challenges and intellectual discomfort. However, the hope for the CSG field is to advance thinking, understanding, decision, and action to better govern manmade complex systems. The CSG field is certainly not portrayed as a panacea that can cure all of the ills of modern complex systems and the myriad of problems endemic to their operations. Instead, the hope is that individual capacity, organisational capability, and compatible infrastructures can be improved by the future contributions sought from the CSG field. This special issue offers an initial set of contributions on the path of development for the CSG field.

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