2017

Systemic Intervention for Complex System Governance Development

Charles B. Keating

Polinpapilinho F. Katina,

John C. Pyne

Ra'ed M. Jaradat

SYSTEMIC INTERVENTION FOR COMPLEX SYSTEM GOVERNANCE DEVELOPMENT

Charles B. Keating*, Ph.D.
Polinpapilinho F. Katina, Ph.D.
James C. Pyne, Ph.D., P.E.
Old Dominion University

Ra'ed M. Jaradat, Ph.D.
Mississippi State University

*ckeating@odu.edu

Abstract

This paper explores the issues related to systemic intervention for Complex System Governance (CSG) development. Systemic intervention seeks to intentionally engage a system to influence trajectory or outcomes. CSG is an emerging field focused on the design, execution, and evolution of the functions necessary to provide continued system performance (stability) in the midst of incessant turbulence and increasing complexity. Integral to this field is the necessity to 'intervene' in a complex system to enhance system behavior, structure, or performance. Arguably, system interventions have an unremarkable record of success, ranging from declared success in improving a situation (system) to abysmal failure (doing more harm than good).

However, little emphasis has been placed on a more rigorous exploration of the nature of systemic intervention as it influences our ability to more effectively enact change in complex systems. To address this sparse accounting in the literature, following an essential introduction to Complex System Governance, this paper pursues three primary objectives. First the nature of 'systemic intervention' is examined. Second, the different forms and roles in systemic intervention for complex systems are explored. Third, an approach for beginning an intervention in CSG (CSG Entry) is examined for broader implications for engaging complex systems and problems. The paper concludes with critical issues and suggests considerations for more effective systemic intervention.

Keywords

Complex System Governance, Systemic Intervention, System Development

Introduction: Complex System Governance

To achieve our introduction to Complex System Governance (CSG) we have focused on three primary objectives. First, we introduce and acknowledge the complex system problem domain that is the target for CSG. We suggest a present and continuing trajectory for the confounding landscape that must be navigated by practitiones (designers, owners, operators, maintainers, and evolvers) of complex systems. These practitioners, although having different orientations with respect to a system, all faced the same problem domain. Second, we introduce a systemic perspective that seeks to provide an explanation for our difficulties in grappling with this problem domain. This examination provides a uniquely 'systems' perspective in offering an alternative viewpoint. Third, CSG as a responsive alternative to address development of complex systems is introduced. Our focus is to provide a general overview such that the remainder of the paper will have a sufficient foundation upon which it can be built.

Landscape of the Modern Complex System Practitioner

The landscape of the modern practitioner of complex systems (organizations as well as people), might be summarized with a set of characteristics. While these characteristics are certainly not intended to present an 'absolute' depiction of the landscape, they serve as a reminder of the stark reality faced by practitioners. The domain of the complex system practitioner (Exhibit 1) appear to be intractable and are marked by conditions that have been previously established (Jaradat & Keating, 2014; Keating, Katina, & Bradley, 2015; Keating, 2014; Keating & Katina, 2011):

1. *xponential Rise in Complexity* – the availability, magnitude, and accessibility of information is beyond current capabilities to structure, order, and reasonably couple decisions, actions, and consequences. This, coupled with compression of time and the interconnectedness of 'everything' is challenging our capacity to mount effective responses.
2. *Dominance of Emergence* – the appearance of structures, behaviors, performance, or consequences that cannot be known in advance renders traditional forms of planning innocuous at best, unsuited to current realities, and potentially detrimental. Current methods are failing to provide practitioners with the necessary capabilities to engage highly emergent situations.
3. *Ambiguity in Understanding* – instabilities in understanding, shifting boundary conditions, and unstable structural patterns create a lack of clarity for decisive action.
4. *Uncertainty as a Norm* – the inability to have any measured degree of confidence in how to proceed to produce desired performance is not the exception but rather the stable state of affairs.
5. *Holistic Satisficing Solution Spaces* – the modern problem space is not limited to simple, absolute, or isolated solution forms. The spectrum of technology/technical, organizational/managerial, human/social, and political/policy are in play across special, temporal, and social dimensions.
6. *Contextual Dominance* – unique circumstances, factors, patterns, and conditions permeate all systems. They are enabling and constraining to decision, action, and interpretation.

Exhibit 1. Five Realities for Complex System Practitioners.

We offer three primary conclusions for this set of realities facing practitioners of complex systems. First, the nature of this landscape is not likely to improve in the future. More probable is that these elements will escalate in frequency and severity of their impacts. Second, our current approaches to deal with the systems characterized by these conditions are not having the desired impact. This is evidenced by the increasing number of tools, technologies, and approaches attempting to address complex systems without resolution of associated issues. This is not intended to disparage any of those tools, technologies, or approaches, but rather only recognizes that the search must continue for more effective approaches. The presented characteristics are representative of a complex system problem domain. Therefore, approaches that are not consistently developed, grounded, or applied in a manner appreciative of 'systems' are not likely to 'match' the complexity demanded by this domain. We now shift to a systemic explanation to explore ineffectiveness in addressing complex systems and their problems.

A Systemic Perspective of Current Failures in Responding to Complex Systems

From a systems perspective of dealing with complex systems and their problems, we offer five thought provoking considerations to explain continuing difficulties (Exhibit 2). These considerations provide a systemic frame of reference concerning failing strategies used to respond. However, their manifestation may take many different forms across technologies, methods, and tools used to confront complex systems problems. In relationship to CSG, overcoming these strategic deficiencies are central to the emerging field. Confronting them will require a different

level of dialog, exploration, and 'systemic' understanding. This will be essential to address our seeming inability to grapple complex systems and their problems into submission.

1. *Sprawling Complexity Exceeding Absorptive Capacity of the System* – while the external complexity facing complex systems continues to rise exponentially (e.g. information), the corresponding capacity of our systems to effectively deal with this 'complexity onslaught' has not kept pace. Unfortunately, our responses in design, operation, maintenance, and evolution of complex systems has continued to lag demands of the environment. This inability of our complex systems to 'match' the sprawling complexity of the environment places them in a continual state of re-action rather than pro-action. From a systems perspective, this suggests that the strategies related to design, execution, and evolution of our complex systems continue to produce questionable capabilities for matching complexity inherent in the environment.

Exhibit 2. Systems Explanation for Shortcomings in Addressing Complex Systems.
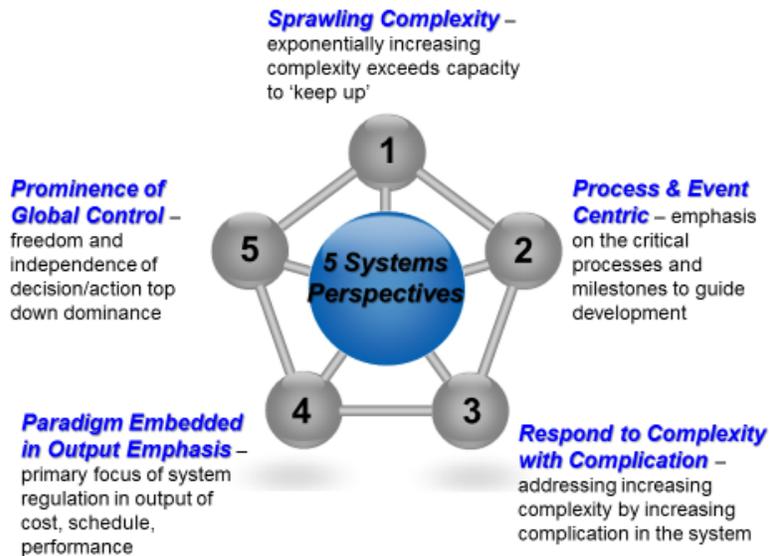
2. *Process and Event Centric Focus versus Holistic System Focus* – many of the strategies to deal with complex systems and problems are focused on process improvement or engagement in 'events' designed to improve aspects of systems and address their problems. While this is certainly capable of 'doing good' for systems, it falls short of taking a truly holistic perspective of development. Failure to focus on holistic 'systems' in lieu of fragmented pieces, processes, and events limits the capability to improve systems and address their problems from a more sophisticated systems perspective.

3. *Response to Increasing Complexity Relegated to Increasing Complication* – without doubt, there is recognition of the increasing complexity being faced by our systems and the practitioners responsible for those systems. However, in many cases our response to increasing complexity is found in unleashing strategies based on increasing complication (e.g. regulation). Complication involves such items as new processes, procedures, specifications, requirements, etc. While these are not 'bad' per se, accomplished in a piecemeal fashion, without recognition of the interrelationships to other initiatives and to the overall 'whole' system, their ultimate 'systemic' effectiveness must be questioned.

4. *Driving Paradigm Embedded in an Output Emphasis* – Outputs from a complex system are those tangible, verifiable, and objective elements that serve as products that provide value consumed external to the system. Output provides the basis for a worldview (the system of values and beliefs through which all that is sensed is processed) which translates into the design, execution, and development of many of our systems. It is hard to read a criticism of the current state of affairs for systems failures that is not targeted to such deficiencies as missing cost, schedule, and technical performance requirements. However, we suggest that these 'output' indicators are 'systemically' limited in their ability to determine the value of system performance. While these indicators (e.g. cost, schedule, performance) are necessary indicators of system performance, they alone

do not provide sufficiency as a set of judgments of the ability of a complex system to meet expectations with respect of solving problems or fulfilling needs. The question for examination of paradigm consistency must consider whether or not the 'failures' in a complex system might be more directly addressed by looking beyond superficial indicators (outputs) of performance found in such typical indicators as the cost, schedule, and technical performance triad.

5. *Prominence of Global Control* – From a systems perspective, control is about providing constraints for a system only to the degree to which is necessary to assure continued performance (Keating, et al. 2016). Excessive constraint in a system (control) wastes resources and limits local autonomy evidenced in independence for decision, action, and interpretation. The common manifestation of excessive global control is what has been described aptly in system critical literature as overregulation, bureaucracy, and excessive constraint -- without evidence of commensurate value added to the system. The near constant state of systems in reform, reorganization, or restructuring seems to support the increasing desires to initiate 'control' of systems. However, from a systems view, global control is best achieved by providing the greatest degree of local level autonomy (freedom and independence of decision, action, and interpretation) possible. Thus, achievement of systemic control is not focused on control at the global level, but rather the local level – in closer proximity to decision-action-consequence sequences.

This systems perspective provides an elaboration that offers a different (systemic) explanation of shortcomings of present approaches to deal with complex systems and their problems. Although it is not a panacea for explaining issues, it does provoke a different level of thinking.

Complex System Governance: A Different Perspective

CSG is focused on successfully navigating the conditions identified in Exhibit 1 to produce higher performing systems and ease the burden of practitioners. CSG development and application draws upon a strong conceptual base found in General Systems Theory (von Bertalanffy, 1968; Whitney, Bradley, Baugh, & Chesterman, 2015) and Management Cybernetics (Beer 1979). In essence, General Systems Theory (GST) offers the set of propositions that have been continually developed and applied over the past eight decades (Katina, 2015a; Katina, 2015b; Skyttner, 2005). The propositions have withstood the test of time and application and serve to define the structure, behavior, and performance of all systems. GST propositions are non-negotiable and have real consequences for systems and practitioners that, knowingly or unknowingly, 'violate' them. The strong influences of GST are found in the emphasis on integration and coordination for CSG.

Management Cybernetics (Beer 1979, 1981, 1985) provides a strong conceptual foundation for communication and control essential to CSG. In particular, Management Cybernetics offers CSG design cues for control through the model of a 'metasystem'. The 'metasystem' is a set of functions that stand above/beyond the particular systems/entities that it seeks to "steer" -- in the cybernetic sense of providing control. Management Cybernetics also provides a set of communication channels associated with the 'steering' functions of the metasystem.

From this conceptual grounding in GST and Management Cybernetics, CSG is formulated as the *"design, execution, and evolution of the [nine] critical metasystem functions necessary to maintain system viability [existence]"* (Keating, 2014, p. 156) (Exhibit 3).

Exhibit 3. System Functions for CSG.

A brief depiction of the nature and role of the CSG functions, identified as Metasystem functions, (Keating & Bradley, 2015, Keating, Pyne, & Bradley, 2015) is:

- *Metasystem Five (M5) – Policy and Identity* – focused on overall steering of the system, giving policy level direction, representation of the system to external constituents, and maintaining identity for system coherence.
- *Metasystem Five Star (M5*) – System Context* – focused on the specific context within which the metasystem is embedded.
- *Metasystem Five Prime (M5') – Strategic System Monitoring* – focused on oversight of the system at a strategic level.
- *Metasystem Four (M4) – System Development* – focusing on the long-range development of the system to ensure future viability.
- *Metasystem Four Star (M4*) – Learning and Transformation* -- focused on facilitation of learning based on detection and correction of design errors in the metasystem and guiding planning to support transformation of the metasystem.
- *Metasystem Four Prime (M4') – Environmental Scanning* -- focused on sensing the environment for circumstances, trends, patterns, or events with implications for both present and future system performance.
- *Metasystem Three (M3) – System Operations* – focused on the day to day operations of the metasystem to ensure that the system maintains performance levels.
- *Metasystem Three Star (M3*) – Operational Performance* – focused on monitoring system performance to identify and assess aberrant or emergent conditions in the system.
- *Metasystem Two (M2) – Information and Communications* – focused on the design for flow of information and consistent interpretation of exchanges (communication channels).

The performance of these functions, required by all existing systems, supports achievement of:

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

Ultimately, effectiveness in purposeful design, execution, and evolution of the nine 'metasystem governance' functions determines system performance.

This remainder of this paper is organized to pursue three primary objectives. First, we examine the concept and nature of systemic intervention. Second, we explore the different roles in systemic intervention for complex systems. Third, we examine an approach, CSG Entry, that serves as an initial approach to engage systemic intervention for CSG. The paper concludes with implications for systemic intervention for CSG.

The Nature of Systemic Intervention

Intervention is certainly not a new concept. At the very essence of intervention is the notion that there is (1) involvement, (2) intention to alter actions/outcomes, and (3) use of some form of leverage (force) to carry out the effort. While this depiction is helpful, systemic intervention has a different connotation. Following Midgley (2001) we describe systemic intervention as *the purposeful action by an agent, generally human for complex systems, to produce change is a system or situation*. For our perspective of systemic intervention the following elements of elaboration provide the essence of systemic intervention for purposes of our exploration:

1. *Purposeful* – engagement in intervention with the intention to achieve some desired aim. The importance of this aspect of systemic intervention is that it requires the outcome (expectations) for the intervention to be specified (known) in advance of the intervention. From a systemic perspective, this also must acknowledge that, based in emergence (unpredictable consequences) that although there are 'desirable' outcomes, latitude must be given to results and directions not necessarily conforming to desires, design, or intentions for intervention.
2. *Human Agent* – at the center of any systemic intervention are people. The design, execution, and evolution of a systemic intervention are accomplished by people. As such, people become the central driving force

behind systemic intervention. So much so that effectiveness in intervention must be a function of those who design, those who conduct, and those who play participatory roles in the intervention.

3. *Produce Change* – from a systemic perspective, change in a system include modifications is structure, behavior, or understanding/interpretation of a system/situation. This point is critically important, since it moves the notion of change beyond the narrow conception of solution as the singular objective for intervention.

4. *Systemic* – this invokes the entirety of the 'systems' perspective in intervention. In contrast to a focus on linear, reduction, or piecemeal inquiry, a systemic orientation to intervention is focused on the non-linear, holistic, and integrated inquiry into a system.

There are four primary conclusions with respect to the systemic nature of intervention identified for CSG development. First, although the notion of intervention is well known, the nature of 'systemic intervention' introduces a different level of thinking, possibility for different corresponding actions, and can invoke a different level of understanding/interpretation of a situation. Second, systemic intervention does not exist in a binary fashion of 'present' or 'not present.' Rather, it's best to recognize that systemic intervention might be achieved in 'degrees of application'. This opens the possibility of systemic intervention having a spectrum of depth in delivery. Third, the engagement in systemic intervention has real consequences for performance of a given system – introducing an entire spectrum of development possibilities. These 'change' possibilities range across the spectrum of technology, human, social, organizational, managerial, policy, and political dimensions. In addition, although 'everything' cannot change simultaneously for a given system, changes pursued can be assessed for feasibility and their specific fit to the larger landscape of systemic issues can be identified during intervention inquiry. As each system is unique, so too will be the associated systemic intervention design, execution, and development expectations. Fourth, systemic intervention must be engaged by individuals with some level of a 'systems worldview'. In effect, since intervention is undertaken by people, their worldview, and the degree that it is consistent with a systems mindset, will enable or constraint any systemic intervention effort. Thus, while systemic intervention provides an exciting and substantial movement forward for CSG development, it must be engaged with a healthy skepticism.

We now shift our focus to elaboration of the different roles and specific forms of systemic intervention. This elaboration is essential to clearly understand where individuals a placed in a systemic intervention and the particular type (form) being pursued. Both of these aspects require clarity concerning systemic intervention – hopefully at the outset of an initiative.

Roles and Forms in Systemic Intervention

In the initiation of systemic intervention, we present four primary forms of intervention and their associated role expectations. It is important to be clear on which of the forms of intervention are being pursued. In addition, each of the different forms require a specific role to be played by both the interventionist as well as those enlisting the intervention.

Exhibit 4 summarizes four basic forms of intervention. This is not to say that there might be different configurations or hybrids of the different forms. However, we suggest that these four basic forms provide an adequate definition of the landscape for intervention.

Table 4. Forms and Roles for Systemic Intervention.

Intervention Form	Nature	Roles	Accountability	Example
Additive Resources	Addition of resources to assist in performance of particular task(s). Assumes that sufficient expertise exists to supplement existing capability shortfall.	The intervention is simply to supplement existing capabilities with additional resources to complete work.	The responsibilities are for providing appropriate skill sets.	Adding temporary staff during a peak order period.
Problem Resolution	Engagement for a specific problem to be resolved by the intervention. Expertise	The expert brings specific competence not held within the system, or intended to be	Risk for proper resolution of a problem is held	Bringing on an expert to provide a technical evaluation of

	is beyond that held by the system in focus.	developed by the organization.	by the interventionist.	cyber security effectiveness.
Expert Advice	Engagement of a professional for their specific advice concerning a problematic situation for which they have recognized expertise.	The client provides data and description of a problematic situation. The interventionist provides proscriptive advice for resolution.	Interventionist has responsibility for the prescription adequacy. Client holds responsibility for implementation of recommendations.	Engaging an expert to make recommendations concerning development of a new program.
Participatory	Engaging in a shared effort to develop a system to improve performance.	The intervention design, execution, and assessment are shared between interventionist and system actors.	The responsibility for conduct and results are shared between all parties in the intervention	Engaging in a comprehensive effort to develop individuals, system, and support infrastructure.

These four forms of intervention are not intended to define the entire scope of intervention. However, they do provide a survey of the range of intervention possibilities for systems. There are three important conclusions we offer with respect to intervention implications. First, there is a range of 'intensity' and corresponding expectation for the different forms. The simple addition of resources is certainly not to the depth or expectations that would be characteristic of the participatory form. Second, there is a range of risk incurred in any intervention. As the intervention moves from 'additive resources' to 'participatory' the risk shifts from the interventionist to the client organization. Thus, for holistic intervention characteristic of the participatory form, there is a sharing of risk for success of the intervention. Third, the ability to make objective determinations with respect to 'success' of the intervention endeavor decreases as the form of intervention moves from additive resources to participatory forms. Fourth, as the depth of intervention increases (from additive to participatory) so too does the risk for failure or falling short of expectations. This is not unexpected, as the nature of problems and their scope, breadth, and depth is increasing with the different forms, with participatory representing the most comprehensive and extreme intervention case. In closing, it should be emphasized that the forms of intervention are not binary in nature. Instead, they can exist in different combinations and hybrid forms.

Now, we shift the discussion to a particular first introduction to CSG systemic intervention, CSG-Entry.

CSG Entry as an Approach to Begin Systemic Intervention

CSG-Entry has been developed as a first introduction to begin a systemic intervention effort. It represents a 'hands-on' low risk, efficient, and value adding introduction to CSG. In a nutshell, CSG has been developed as a systems-based approach that:

1. *Appreciates the 'new normal' for practitioners marked by increasing complexity in their organizations, systems, and environment.*
2. *Offers an alternative perspective and approach to better understand critical system functions directly responsible for performance,*
3. *Is based in the application of fundamental system laws that govern performance of all systems, and*
4. *Enhances capacity to more effectively deal with increasingly complex systems, environments, and problems.*

CSG has not been presented as a 'magic elixir' or 'silver bullet' that can cure all system/organizational ills. CSG development is not a 'sprint', a 'fad', 'easy', or an 'isolated' endeavor. Instead, it requires commitment to a 'long view', 'sustainable', and 'integrated' endeavor. It focuses on the very core of complex system design, execution, development, and maintenance for organizations. However, as with all systemic intervention approaches, it should be met with a healthy skepticism. It would be unrealistic to engage in a comprehensive systemic intervention without more than a 'promise' of effectiveness. Thus, *embarking on a comprehensive CSG development effort as a first step is unrealistic.* The associated risks and inherent uncertainties in a comprehensive CSG endeavor are simply too great as a first step. Therefore, we have designed a 4 Phased *CSG-Entry* (Exhibit 5) approach that offers an efficient, convenient, low-risk, and value adding introduction to CSG.

Exhibit 5. Four Phases for CSG Entry.

CSG-Entry offers a 'hands-on' first exposure to CSG that is a short term, efficient, and value adding endeavor. It can be achieved from start to finish in 4 Phases with a minimal investment of time and resources (total 90 minutes) spread out over a time period convenient to a participating organization. A summary of the 4 Phases of CSG Entry include:

1. *PHASE 1: INVITATION TO CONDUCT CSG ENTRY* – the organization agrees to engage in a CSG Entry effort and is provided a basic overview of the process and expectations. The focal entity (unit, team, organization) is identified, prospective participants are selected, and a tentative timetable for completion set.

2. *PHASE 2: OVERVIEW BRIEFING* – this briefing is designed to introduce participants to CSG and the *CSG Entry* approach. Questions are answered, expectations are set, and preparations are made to execute *CSG Entry*. In this briefing, the nature of CSG is kept to an overview level and the emphasis is on the three instruments to be completed by the participants.

3. *PHASE 3: CSG ENTRY INSTRUMENTS APPLICATION* – this phase is designed around administration of three web-based instruments that provide a set of insights for individual participants as well as the organization. The total time investment in this phase is 30 minutes per participant to take the three instruments. The results of these instruments are anonymous and only aggregate information is shown. Each instrument provides a snapshot of a different aspect related to systems thinking and the state of CSG for the focal entity (unit, team, organization). A more detailed description of the instruments is attached. In summary, the 3 instruments are:
    a. ***Systems Thinking Capacity*** – examines 7 dimensions of Systems Thinking through a 39-question web-based survey instrument. The instrument determines the relative preference for systems thinking that exist in the participating group. Each individual is provided with their personal profile for Systems Thinking preference, but only aggregates are collected and reviewed for CSG implications.
    b. ***Environment Complexity Demand*** – examines the degree of complexity that exist in the environment of the focal entity. This is captured by assessment of the 7 dimensions of Systems Thinking in relationship to the environment through a 43-question web-based survey instrument. The aggregate of participant responses are collected and mapped to the seven dimensions of systems thinking capacity.
    c. ***Diagnostic System Governance Check*** – a 45 question web-based survey that guides participants through an examination that provides a 'snapshot' of 9 essential governance functions. Participant responses are anonymous and only aggregate data are used for analysis and mapping of the results.

4. *PHASE 4: OUTBRIEF RESULTS* – After completion of the three instruments, results are compiled in a technical document provided to help guide interpretation of results. A presentation briefing is also conducted

with participants to explore the interpretations, answer questions, and suggest implications of the results for individuals and the participating entity. A more detailed description of these instruments is attachment to this CSG Entry overview.

In sum, *CSG Entry* offers an *efficient, low-risk, and value added* set of activities to introduce CSG. This approach represents a 'hands-on' demonstration of the practical utility of CSG for helping to address some of the most vexing problems facing organizations and practitioners responsible for design, execution, and development of complex systems. CSG development is not easy, fast, or achievable by following a prescriptive recipe. However, the *CSG Entry* approach outlined in this document offers an important first step for more comprehensive systemic intervention. Even if nothing is pursued beyond the CSG Entry effort, there is still significant value that can accrue.

Conclusions and Implications

In this paper, we have developed the nature of CSG, the concept of systemic intervention, and an approach for introduction of CSG. We now conclude with considerations for engaging in systemic intervention for CSG development. To provide guidance and caution for engaging in CSG systemic intervention, we have identified seven considerations that can impact effectiveness. These considerations include:

1. *Incompatibility of Dominant Worldview with Systems* – worldview is the frame of reference defines how we see everything presented to us. It defines our 'space' for decision, action, and interpretation related to everything that we encounter. The degree to which the predominant worldview is consistent with the 'systems' worldview will impact the effectiveness of any systemic intervention, including CSG.
1. *Mismatch in Expectations for Outcomes* – establishment of expectations consistency between the interventionist and participants must be aligned and realistic. Lacking this consistency is likely to result in a failed systemic intervention.
2. *Unrealistic Investment of Resources* – Inappropriate allocation of resources based on the nature of the problem system and expectations. It is unrealistic to have grand expectations for systemic intervention that exceed a commensurate investment of resources necessary to support those expectations.
3. *Lacking Sufficient Level of Systems Expertise* – systemic intervention requires a corresponding level of systems thinking capacity to be effectively engaged. Lacking this level is not likely to produce levels of improvement expected of a systemic intervention. This also suggests that comprehensive systemic intervention must also understand and address deficiencies in the level of systemic capacity required.
4. *Incompatibility of the Problem Formulation with Systemic Perspective* – there must be clear formulation of the problem/system of interest that is the focus for CSG development. This includes establishment of boundary conditions that define what is included/excluded in the scope of the development as well as definition of the system of interest.
5. *Compatibility of the Development Approach* – every system is unique, exist in a unique context, and requires an approach that is compatible. This compatibility must exist with the systemic capacity of participants, supporting infrastructure, and specific approach engaged for systemic intervention to achieve CSG development.
6. *Context Compatibility for Conducting Systemic Intervention* – context includes those circumstances, factors, conditions, trends, or patterns that enable or constrain all that a system (organization) engages. Therefore, the specific context must be supportive of a systemic intervention for CSG. Lacking this supportive context cast doubt on probability of success for systemic intervention.

While these elements are not insurmountable, they should be considered as essential for any systemic intervention. We conclude with three primary points related to systemic intervention for CSG Development. First, systemic intervention requires a particular mindset (worldview) based in 'systems'. Lacking this mindset in either the interventionist, the target (system) for intervention, or the individuals (participants) in the intervention is likely to result in failure to meet expectations for CSG development. Second, the compatibility of context, supporting infrastructure (including development of strategic tools and technologies to enable systemic intervention) , and commitment to engage in systemic intervention for CSG development must be present and continuous. Lacking this compatibility is limiting at best and at worst can produce more damage that good. Third, expectations must be consistent with commitment of resources and the 'will' to engage in deep system development. It is unlikely that true 'deep' systemic intervention for CSG development can be effectively engaged without a full commitment to comprehensive engagement. Forth, there is opportunity to related CSG to other domains including System Management.

References

Beer, S. (1979). The Heart of Enterprise. New York: John Wiley and Sons.

Beer, S. (1981). *The brain of the firm: The managerial cybernetics of organization*. Chichester, UK: Wiley.

Beer, S. (1985). *Diagnosing the system for organizations*. Oxford, UK: Oxford University Press.

Jaradat, R., M, & Keating, C. B. (2014). Fragility of oil as a critical infrastructure problem. *International Journal of Critical Infrastructure Protection*, 7(2), 86-99.

Katina, P. F. (2015a). Emerging systems theory–based pathologies for governance of complex systems. *International Journal of System of Systems Engineering*, 6(1/2), 144–159.

Katina, P. F. (2015b). *Systems theory-based construct for identifying metasystem pathologies for complex system governance* (Ph.D.). Old Dominion University, United States -- Virginia.

Keating, C. B. (2014). Governance implications for meeting challenges in the system of systems engineering field. In *2014 9th International Conference on System of Systems Engineering (SOSE)* (pp. 154–159). Adelaide, Australia.

Keating, C. B., Pyne, J. C., & Bradley, J. M. (2015). Advancing enquiry for system of systems engineering: paradox, critical thinking, and critical systems enquiry. *International Journal of System of Systems Engineering*, *6*(4), 327-354.

Keating, C. B., & Bradley, J. M. (2015). Complex system governance reference model. *International Journal of System of Systems Engineering, 6(1),* 33-52.

Keating, C. B., & Katina, P. F. (2011). Systems of systems engineering: prospects and challenges for the emerging field. *International Journal of System of Systems Engineering, 2(2/3)*, 234-256.

Keating, C. B., Katina, P. F., & Bradley, J. M. (2015). Challenges for developing Complex System Governance. In *Proceedings of the 2015 Industrial and Systems Engineering Research Conference*. Knoxville, TN: IIE.

Midgley, G. (2000). *Systemic intervention*. Boston, MA: Springer.

Skyttner, L. (2005). General systems theory: Problems, perspectives, practice (2nd ed.). Singapore, World Scientific Publishing Co. Pte. Ltd.

von Bertalanffy, L. (1968). General System Theory: Foundations, Development, Applications (Rev. ed.). New York: George Braziller.

Whitney, K., Bradley, J. M., Baugh, D. E., & Chesterman, C. W., Jr. (2015). Systems theory as a foundation for governance of complex systems. *International Journal of System of Systems Engineering, 6(1)*, 15-32.

About the Author(s)

Charles B. Keating is a Professor of Engineering management and Systems Engineering at Old Dominion University. He also serves as the Director of the National Centers for System of Systems Engineering (Norfolk, Virginia).

Polinpapilinho F. Katina is a Postdoctoral Researcher with the National Centers for System of Systems Engineering (Norfolk, Virginia). Dr. Katina is a co-author of '*Critical Infrastructures: Risk and Vulnerability Assessment in Transportation of Dangerous Goods - Transportation by Road and Rail*' (Springer, 2016).

James C. Pyne is an Associate Researcher with the National Centers for System of Systems Engineering (Norfolk, Virginia).

Raed M. Jaradat is an Assistant Professor of Industrial and Systems Engineering at Mississippi State University (Starkville, Mississippi).