Problem 'structure' and policy 'design' as verbs: Implications for the governance of wicked problems

Vanessa Schweizer, Christina Comeau, Natalya Siddhantakar, Naresh Singh

Table of Contents

Problem 'structure' and policy 'design' as verbs: Implications for the governance of wicked problems

Vanessa Schweizer[1], Christina Comeau[2], Natalya Siddhantakar[3], Naresh Singh[4]

[1]University of Waterloo, Dept. of Knowledge Integration, Canada

[2]Royal Roads University, School of Leadership Studies, Canada

[3]University of Waterloo; School of Environment, Enterprise and Development; Canada

[4]Jindal School of Government and Public Policy; Centre for Complexity Economics, Applied Spirituality and Public Policy; India

Abstract

This paper addresses the structural characteristics of wicked problems and their attendant demands on leadership, policy design, and implementation for effective resolution and governance. We focus on the multi-faceted (i.e. complex) nature of wicked problems as well as the reality of decision making under uncertainty. For many complex policy problems (especially those that are long lived), multi-facetedness and uncertainty should be considered as structural characteristics rather than quirks or 'flaws'. The implication of such characteristics is that policymaking for wicked problems must be more than management; leaders and institutions must create and foster spaces for governance that are complex-adaptive and problem-based (CAPB). Further implications of CAPB governance are that policy *design* should be understood as a verb (i.e. creative process) rather than noun (i.e. product). The field of *design thinking* systematizes how designers solve problems (e.g. Ulrich 2011), and this paper discusses its implications for policy design and governance when applied to wicked problems. Design thinking can be contrasted to linear thinking, which relies heavily on expertise for top-down planning and execution (Chang 2019). Instead, design thinking employs an amalgamation of evidence and vision (Berger 2009) to explore-test-iterate multiple generations of possible implementations before adopting any particular implementation longer-term (Ulrich 2011, Chang 2019). In design thinking, *problem structure* is both noun and verb: An initial characterization of the problem is made to kick-start problem solving. However, first impressions are not presumed to be sufficiently accurate, and the design-thinking process -- which includes regular consultation with stakeholders on the desired outcomes of policy or governance -- feeds back into making sense of what the problem truly is. Such iterative feedback to understand problem structure is a necessity when one aims to do more good than harm with policy interventions on complex systems. Furthermore, human-centred design

(Brown 2009) calls on designers to ground their problem-solving in empathy for stakeholders (see also Chang 2019). We argue further that the empathic core of human-centred design has implications for the problem-solving process itself. To truly be human-centered, design thinking must engage a larger matrix of human capacity for problem solving (e.g. policy co-design with stakeholders). However, too often, policy is treated as a sequence of predetermined steps (Brown & Wyatt 2010). We conclude that problem structure matters for achieving desired policy outcomes. However, for wicked problems, problem structure may be multi-faceted or hidden. Under such conditions, what is equally important to problem structure is the problem-solving process of policy analysts, policymakers, and those who govern implementation. In the context of wicked and/or complex problems, linear thinking is likely to lead to sub-optimal policy or outright failure due to underdeveloped (or simply incorrect) problem structuring. Wicked problems should be approached with humility, and leaders must be committed to learning, which will be most effective when a diversity of human perspectives are leveraged. In order to address wicked problems effectively, leaders must become adept at convening and leveraging a diversity of human relationships within a system of interactions committed to sustained problem-based learning.

Keywords: Wicked problems, complexity, Cynefin framework, design thinking, bureaucracy theory, Human Learning Systems

1. Introduction

This paper addresses the structural characteristics of wicked problems and their attendant demands on leadership, policy design, and implementation for effective resolution and governance. We focus on the multi-faceted (i.e. complex) nature of wicked problems as well as the reality of decision making under uncertainty. For many complex policy problems (especially those that are long lived), multi-facetedness and uncertainty should be considered structural characteristics rather than quirks or 'flaws'. A major implication of wicked problems is that dominant approaches to problem-solving -- which are linear -- are too inflexible and update too slowly to achieve desired outcomes. This paper summarizes the tenets of design thinking as *verbs*, or *processes*, that would be appropriate to adopt in a governance context. The structure of the paper is as follows. Section 2, "Background", clarifies the meaning of key terms including wicked problems, complexity, and uncertainty. Section 3, "Design Thinking", clarifies that this paper focuses on design thinking as a *process* rather than artifacts that might

be associated with it (e.g. concept maps). Section 3 also provides a summary of phases of design thinking. Section 4, "Implications for Governance", has three subsections. Section 4.1 contrasts two key approaches that policymakers and administrators might take to deal with wicked problems: controlling them versus influencing elements of the system (such as stakeholders or other policy actors) toward more desirable outcomes. Section 4.2 discusses implications for evaluation processes when governing for influence rather than control. Section 4.3 provides a case study of applying complexity principles and elements of design thinking: the 2010 "Modelling Birmingham" project in the UK. Section 5, "Conclusion", summarizes the full paper.

2. Background

Wicked problems are the undesired emergent outcomes of *complex social* systems that cannot be understood or addressed in isolation (Head and Alford, 2015). Climate change, systemic racism, poverty, global security, and similar social justice and environment issues occur from the local to global levels and are examples of wicked problems. While much of society feels morally compelled to address wicked problems, discourse varies on designing and implementing systemic interventions that lead to meaningful resolution. Unlike other types of problems that if solved once, can be solved again, every wicked problem is unique. This makes sense given that wicked problems are rooted in the multiplicity of political, social, economic and environmental systems that describe our daily lives (Duffy, 2017). In short, wicked problems are subject to the ebb and flow of the complex systems from which they arise.

Complex systems are a class of systems that are more than the sum of their parts. They are characterized by internal interdependencies that give rise to nonlinear (i.e. unexpected) behaviour. This dynamic, and the insufficient results of conventional problem-solving techniques, suggest that linear (cause-and-effect) models of policy planning are evidently obsolete (Mainzer, 2004).

Cause-and-effect models play a significant role in ordering information that helps humans make sense of the world. When such models are insufficient, certitude falls by the wayside. **Uncertainty** is generally recognized as having at least three key dimensions. First, there is aleatory uncertainty, which refers to the characteristic of

outcomes being indeterminate. Aleatory uncertainty is often expressed through measures such as probabilities. Second, there is epistemic uncertainty, which refers to limits to what is known. Limits in knowledge could be due to limitations in data, experience, or cognitive biases that produce blindspots. Third, there is ambiguity, which may be due to linguistic imprecision (e.g. the incomplete representation of reality afforded by language).

Those seeking to catalyze solutions in the midst of such uncertainty can be confused and frustrated by short periods of perceived stability followed by unexpected sudden changes (Frelin, 2016, p. 232). Consequently, when it comes to wicked problems, there is little or no ability to test the effectiveness of a potential solution in a system that is not only changing but also changed by the very intervention intended to stabilize it. To compound the dilemma further for policymakers, Rittel and Webber (1973) argued that social planners facing wicked problems are held liable for the consequences of their actions (p. 166). They have no right to be wrong. Churchman (1967) agreed, saying that "whoever attempts to tame a part of a wicked problem, but not the whole, is morally wrong".

Importantly, we recognize that governance itself is a complex task. As Dietz et al. (2003) noted, "Governance conveys the difficulty of control, the need to proceed in the face of substantial uncertainty, and the importance of dealing with diversity and reconciling conflict among people and groups who differ in values, interests, perspectives, power, and the kinds of information they bring to situations" (p.1911). Herein lie two key roles for governance: control vs. influence. Control speaks to the public need for governments to act authoritatively, while influence involves soft skills such as facilitation and negotiation. In Section 4, we explore the balance of these roles when policymakers work to understand the structure of wicked problems and engage in policy design.

Due to the complexity underlying wicked problems and the uncertainty in how well we understand the problem and its most-promising solutions, policymaking (i.e. policy design) for wicked problems must be more than simply tactical management (whether of resources, crises, etc.). Interventions in complex systems may be in the form of policy, programs, or unique innovations. Given the unpredictable dynamic of

complex systems, policy-based interventions must be adaptive if they are to remain relevant. The change-cycle of governance instruments such as rules, regulations, and laws are each progressively longer and more difficult. Such realities mean that policy interventions to solve wicked problems, at least initially, should not be anchored in rigid frameworks. Prototyping small-scale trial interventions with the intent to learn before moving to 'pilot' solutions can be a hands-on way to improve outcomes and mitigate risk (Clark, 2002). Propitiously, *design thinking* provides principles for exercising adaptive policy leadership in a complex world.

3. Design Thinking

The field of *design thinking* systematizes how designers solve problems (e.g. Ulrich, 2011), and this paper discusses its implications for policy design and governance when applied to wicked problems. Section 3.1 begins with clarifying design thinking as a *process*, which should not be confused with artifacts that might be employed while performing design thinking. The section then contrasts design thinking with problem-solving approaches in governance that are dominant, namely linear problem-solving. Section 3.2 summarizes the process of design thinking and points out some implications for the governance of wicked problems, which are discussed further in Section 4.

3.1 What design thinking is not

In the influential book *Change by Design*, Tim Brown introduced the label "human-centred design" for problem-solving processes that centre the needs of users while developing a designed product/service. In some contexts, human-centred design is considered an example of a systems thinking method alongside other techniques such as social network analysis, scenario analysis, cognitive mapping, participatory systems mapping, and so forth. However, that is not the position of this paper. Instead, such systems thinking methods would be considered techniques that may be applied while *doing*, or *enacting*, design thinking (see e.g. Martin and Hanington, 2012). In other words, methods such as social network analysis produce particular outputs (such as a network map) that might be an artifact generated *while engaging* in problem solving. Instead, this paper focuses on the larger arc of the *process* of design thinking as an

approach to solving policy problems rather than some distinctive artifacts often employed in human-centred design (e.g. user/stakeholder personas, empathy maps). To elucidate further the focus of this paper, it may be helpful to contrast what design thinking is not. As summarized by Brown & Wyatt (2010):

> *Time and again, [social intervention] initiatives falter because they are not based on the client's or customer's needs and* **have never been prototyped to solicit feedback**. *Even when people do go into the field, they may enter with* **preconceived notions of what the needs and solutions are**. *This flawed approach remains the norm in both the business and social sectors* (p. 32, emphasis added).

Other authors have given names to the dominant problem-solving method, which proceeds in a largely linear fashion after a problem has been defined (or structured) and a plan has been set. Names include plan-execute (Chang, 2019) or the waterfall model (Ulrich 2011). Weisert (2003) explains that the latter gets its name from "the inability of water to flow uphill. Once you've passed a given point [in the project cycle or decision sequence], there's no going back". The reason why the plan-execute approach for problem solving is pervasive is that it is effective for many problems, but not wicked problems.

How might one know when they are facing a problem that is unlikely to be solved through linear problem-solving? Kurtz, Snowden, and Boone (Kurtz and Snowden, 2003; Snowden and Boone, 2007) developed the influential Cynefin sensemaking framework, which categorizes decision contexts into four major types. The authors pointed out that *simple* contexts (e.g. completing items on a checklist) as well as *complicated* contexts (e.g. managing a well-defined project with a fixed deadline employing the efforts of multiple departments) can be addressed effectively through linear problem-solving. What the simple and complicated contexts have in common is that cause-effect relationships in the decision context are noncontroversial.[1] Snowden and Boone (2007) label the simple and complicated contexts as "ordered" decision contexts. The authors also noted that leaders often mistake *complex* contexts for being

---

[1] In the complicated context, relevant cause-effect relationships may simply need further expertise in order to be interpreted. Example: Enlisting the help of a mechanic to diagnose a problem in a malfunctioning car.

more manageable than they are (i.e. mistaking complex contexts for complicated contexts). During times of crisis (i.e. *chaotic* contexts), authority figures, which often include policymakers, will be the first ones called upon to respond. What complex and chaotic contexts have in common is that cause-effect relationships are *not* straightforward and may even be in flux. Such contexts are characteristic of wicked problems and are considered by Snowden and Boone (2007) to be "unordered". The authors noted that problem-solving in both complex and chaotic contexts will fall short if it is too linear. Snowden and Boone (2007) explained:

> *Of primary concern [in the complex context] is the* **temptation to fall back into traditional command-and-control management styles—to demand fail-safe business plans with defined outcomes**. *Leaders who don't recognize that* **a complex domain requires a more experimental mode of management** *may become impatient when they don't seem to be achieving the results they were aiming for. They may also find it difficult to tolerate failure, which is an essential aspect of experimental understanding. If they try to overcontrol the organization, they will preempt the opportunity for informative patterns to emerge.* **Leaders who try to impose order in a complex context will fail, but those who set the stage, step back a bit, allow patterns to emerge, and determine which ones are desirable will succeed.** *... They will discern many opportunities for innovation, creativity, and new business models* (emphasis added).

Design thinking is the experimental mode of management needed for addressing wicked problems in complex contexts characterized by uncertainty. Design thinking is also an antidote to the temptation for leaders to "impose order" prematurely on unordered contexts.

3.2 Summary of design thinking

Brown (2009) warns that those unfamiliar with design thinking who see it up-close for the first time could mistake it for being "no process" at all. This perception may be due to the unflinching commitment of design thinking to *learning* rather than following a plan. In fact, if there are indications that the existing plan may have limitations, such limitations aim to be fixed immediately rather than letting the plan run its course, documenting all limitations, and recommending possible amendments to address them. The regular doubling-back of efforts (which is seen as a feature of design thinking rather than flaw) leads Brown to characterize it as moving through "overlapping spaces" of

activity. Importantly, proponents of human-centred design advocate that stakeholders or target users also be engaged in the activities of each of the spaces; effective design thinking is done *with* stakeholders rather than applied *to* them. Different authors have given these spaces different names, but they generally include:

Space (1): Observing, detecting, or acknowledging that there is a problem. Relevant activities are rooted in the objective of fact-finding and include ethnography, shadowing, or recording a diary, all undertaken within the problem context. Dominant questions in this space are *what, when, where,* and *who*.

Space (2): Defining what the problem is as well as what some indications might be that an implemented solution is ameliorating said problem. Activities in this space include, first, articulating ***problem structure***, and the dominant question addressed at this stage is *why*. A second activity in this space is envisioning desirable goals for change. When articulating criteria for success, relevant questions include *how* and *what*, e.g., "How will we know that we are solving the problem?" and "What does success look like?" Relevant activities might include visioning (Berger, 2009).

Space (3): Exploring alternative ideas for how the problem might be solved. Space (3) is an ideation space, where the dominant question is, "How might we …?" When there is a wicked problem to solve, it means that at least one new idea needs to be found.[2] It has been well established in studies of creative thinking and machine learning that the odds of *finding a useful, new idea* increase when it is selected from a large number of alternative ideas (see e.g. Chan, 2017), and a way to generate more ideas is to involve more people in the process. Relevant activities are brainstorming and play (e.g. doodling, roleplay). A key mindset in Space (3) is detachment from the ideas generated, e.g., "There are no judgments here, we are just playing around with ideas".

---

[2] Problems that arise due to negligence -- i.e., where a known, accepted solution exists but simply was not executed -- might be 'solved' through activity in Space (2). Wicked problems, however, need new interventions not currently on offer in the *status quo,* so continued problem-solving activity beyond Space (2) into Space (3) would be called for.

Space (4): Experimenting with a proposed solution in order to <u>learn</u> rather than to demonstrate. Space (4) is a low-stakes testing space *outside* of the system using low- and lower-fidelity prototypes. The objective is to learn whether a candidate idea from Space (3) is feasible, not to demonstrate that it is the best idea. The distinction between an idea being feasible vs. the 'best' is important for characterizing what activities should be happening in Space (3). In design thinking, an important measure of progress is time to first prototype (Brown 2009), where prototyping should be rapid in order to learn as quickly as possible as much as possible. Low- and lower-fidelity prototypes that fail are often more informative, and therefore more valuable, than prototypes that succeed. Failed prototypes signal to the problem-solver that something fundamental was misunderstood about the candidate solution, the nature of the problem, and/or the system itself, and they redirect the problem-solver to a previous Space to revisit conclusions or assumptions and to try again. In contrast, fixation on demonstrating that an idea is the 'best' is likely to misdirect activities toward prematurely enhancing the fidelity and investment in a prototype. Investment in an idea before its feasibility has been shown can activate a sunk-cost fallacy, where problem-solvers waste resources continuing to prop up a proposed solution that will ultimately fail.

Space (5): Evaluating the effectiveness of the solution. Once a candidate solution has shown its feasibility in Space (4), the problem-solver can evaluate its effectiveness. Such evaluation may lead to refinements of the proposed solution that make it more elegant or economical to implement or are anticipated to enhance its effectiveness. Naturally, such refinements should be considered new experiments to study in Space (4). Depending on the nature of the refinements, the prototype might also begin to assume traits that are of higher fidelity and be subjected to user testing that is more realistic. In short, proposed solutions that have succeeded more than one round in Space (4) may graduate from low-stakes testing outside the system (e.g. in a 'lab' setting) to higher-stakes testing within the system (i.e. in 'the field') in the form of a pilot program before being formally adopted as new policy. Further discussion of a design-thinking perspective on policy evaluation is taken up in Section 4.

Importantly, because of the commitment in design thinking to *learning* rather than following a plan, it is expected that while occupying any of the aforementioned five spaces, one might need to fall back to a previous space (including back to Space (1)) and try again. Indeed, some lessons about the feasibility of a proposed solution or some other facet of a wicked problem may not become apparent until the latter stages of problem-solving or prototyping. Because of the dynamic relationship between the Spaces of design thinking, *problem structure* is both noun and verb: An initial characterization of the problem structure is made to kick-start problem solving. However, first impressions are not presumed to be sufficiently accurate, and refinements to problem structure (i.e. the verb of "structuring the problem") emerge from the design-thinking process. Regular consultation with (or better yet, the active participation of) stakeholders on the desired outcomes of policy or governance feeds back on the policy design process to better make sense of what the wicked problem truly is. As will be discussed further in Section 4, part of why integrative consultation (i.e. policy co-design with stakeholders) is effective for solving wicked problems is that it engages a larger and more diverse matrix of human capacity for problem solving. Such iterative feedback to understand problem structure is a necessity when one aims to do more good than harm with policy interventions on complex systems.

Design thinking is becoming fashionable in the private sector but is not yet as common in public policy. This paper makes the argument that design thinking should be utilized in policy contexts, especially for wicked problems. To shed light on the challenges for taking up design thinking in the policy sector, Section 4 examines fundamental tensions in governance between the objectives of control vs. influence. From these alternative objectives, alternative meanings and approaches also become established for policy 'interventions' and how they should be evaluated (i.e. linear vs. non-linear approaches).

4. Implications for Governance

As introduced in Section 2, complex systems have internal interdependencies that give rise to unexpected system behaviour. Such internal interdependencies might be complicated causal chains or internal feedbacks. Some complex systems seem to be

'alive' because the system itself adapts as conditions (external or internal) change. Such systems are called complex-adaptive systems (CAS). Socio-political systems are CAS, as connections and interactions among socio-political agents, social networks, bridging organizations, and institutions lead to the emergence of macroscopic patterns that then loop back on the agents in a dynamic, never-ending process. Given that social systems are ever-changing (as are other systems that social systems interface with such as natural systems, technological systems), learning about changes in system states and dynamics becomes essential for effective governance -- especially during times of crisis to transform crisis into opportunity (Preiser and Woermann, 2019). The need for learning when governing in a complex system means that governance requires feedback mechanisms to evaluate to what degree intended interventions in system behaviour are: a) occurring, b) effective, and c) sustainable. However, as also discussed in Section 2, wicked problems provide little or no ability to test the effectiveness of a potential solution in a system that is not only changing but also changed by the very intervention intended to stabilize it (i.e. the socio-political CAS). In addition, decision makers facing wicked problems will be held liable for the consequences of their actions with little forgiveness if they make the wrong decisions. What is a decision maker to do?

This section has three subsections. Section 4.1 first examines two key principles that may compel how a governing body reacts to wicked problems: controlling them vs. influencing elements of the system (such as stakeholders or other policy actors) toward more desirable outcomes. Section 4.2 then discusses implications for evaluation processes when governing for influence rather than control. Section 4.3 then provides an example of how complexity principles and elements of design thinking were applied in a real case: the 2010 "Modelling Birmingham" project in the UK.

4.1 Wicked problems and governance in a complex system: Control vs. influence
When undertaking change work, a widely held view asserts that policy or program initiatives act as 'controls' on the social system intended to drive desired outcomes. The 'control' paradigm in public administration can be traced to Max Weber (1864-1920), who was among the first to describe and analyze traditional administrative and

organizational structures. His *bureaucracy theory* founded the classic control-based paradigm in public administration, which dominated the field for most of the 20th century. In Weber's theory, the existence and effectiveness of the state and any ruling organization are continuously safeguarded by the application and threat of physical, economic, or legal coercion. In the implementation of its order, the state claims monopoly over coercion accepted by the public as legitimate (Weber, 1978). Administrative processes are one of the ways coercion is exercised.

Weberian bureaucracy theory is founded on the belief that in order to be efficient, any organization supporting the rule of the state must be highly formalized, solve problems in an orderly (i.e. linear) manner, be impersonal, and be authoritative. The 'ideal' well-functioning civil service must have a formal set of laws, rules and regulations, well-defined specialization (i.e. division) of labour, definitive hierarchy in its organizational structure, and remain impersonal when applying rules and exercising the power of coercion. Writing in the early 20th century, Weber attributed the emergence of bureaucracy to the increased complexity of problems faced by public institutions, increased population, and the rise in complexity and interconnectedness of the global community. Weber saw bureaucracy as the most efficient and rational way of managing public affairs at the time.

In linear systems, such formal structures may be helpful for maintaining order and solving problems; however, in the non-linear systems from which wicked problems emerge, such approaches fall short. Bureaucracies deal with the complexities of wicked problems by artificially reducing uncertainty through two fundamental strategies: first, a wicked problem might be re-classified as a familiar, simpler problem and dealt with accordingly. Second, a wicked problem might simply be ignored because it is considered beyond the scope of bureaucratic responsibility. Neither of these strategies actually solves the problem, and policy responses that are inappropriately applied risk making the wicked problem worse. In fact, Weber was also a critic of the rigid organizational form of bureaucracy. He saw it as a threat to individual freedoms because of its depersonalized model incapable of dealing with the nuance of individual cases (Tomo, 2018). The inability of bureaucracies to make novel decisions quickly, lack of flexibility, and lack of stakeholder representation make the bureaucratic model

incapable of addressing the complexity of the real world. Weber also admitted that bureaucratic institutional structures could alter the underlying rationality of public policy actors to produce misguided and inappropriate outcomes, the so-called "iron cage" of rule-based rational control (Geyer and Rihani, 2010). Now, the traditional administrative and bureaucratic tools of large-scale institutions are recognized as key contributors to most public policy failures (Scott, 2020).

As discussed in Section 2, wicked problems are the result of emergent outcomes from complex systems, so their resolution is unlikely through control-oriented directives. Instead, tapping into the organic actions and interactions of the elements of the socio-political CAS -- individual agents, organizations, and institutional networks, -- may be more effective for arriving at emergent or 'self-organized' outcomes (Arnaboldi et al., 2015; Lawrence and Phillips, 2019). To avoid misconception of what drives effective change in a CAS, a governance mindset of 'influence' rather than 'control' broadens considerations of what policy actions are possible and guards against missing the relevance of system details and dynamics that might otherwise be overlooked. Exerting *influence* as an enabler of complex change is the multi-dimensional work of social learning across individuals, organizations, and institutions to shape beneficial system conditions as catalysts for change (Lawrence & Philips, 2019). The dimensions of enabling work include:

- · The creation and distribution of information and experiences as narratives or text;
- · Sustaining, expanding, and diversifying a fabric of relationships; and
- · Providing the material objects that support work.

The aforementioned dimensions facilitate social learning by leader and actor groups by

> *lift[ing] the focus from simplistic beliefs in stakeholder participation or blueprint solutions such as policy instruments or economic incentives towards a deeper understanding of* ***social*** *responses and the significance of realizing that the social dimension of the problem of fit and the governance challenges of systems is a complex entity* (Boyd and Folke, 2012, p. 268, emphasis added).

Similarly, the mechanisms of complex change can inform a shift of intentionality from policy decisions for optimization, or adopting the 'best available' policy design as a permanent solution, to policy design for systemic improvements that make things 'better than before' (Holland, 2012). In the case of the latter, however, the effort and the outcome may be more subtle than what one might hope.

The paradigm shift from control to influence is enacted in the design of 'interventions' as purposeful actions by agents who create change rather than guidance or rules that constrain work (Midgley, 2015). If the intent of interventions is to motivate the actions of agents and networks, then the principle that change is best done 'with' people rather than 'to' them makes sense (Senge, 2006). Therefore, the design of systemic interventions, whether policy or program, benefits from wide-spread stakeholder participation (Midgley, 2000). Participation of a diversity of stakeholders introduces human-centered principles into multiple stages of policy management including the design, implementation, and enforcement stages of policy management. As will be shown in the case study in Section 4.3, diverse stakeholder participation also mitigates risk by increasing the breadth of reflexivity and contingency in the policy process (Bushe and Marshak, 2015).

4.2 Implications for evaluating interventions on wicked problems

Two key implications for how interventions might be evaluated is (1) whether the aim of the intervention is to influence agents who create change vs. to control what agents do and (2) whether the intervention was tested outside the system (e.g. in a 'lab' setting) vs. inside the system (i.e. in 'the field'). This section will discuss *ex ante* vs. *in situ* interventions first and then provide a summary of useful approaches for evaluating possible or real policy interventions according to the aforementioned implications.

The first issue is whether the intervention being evaluated was tested outside vs. inside the real system. Since intervention design and implementation is no more predictable than any other aspect of complex systems, the design principle of rapid prototyping discussed in Section 3 describes a quick and economical means of 'learning before doing'. Early prototypes should be tested outside the system in settings that might be characterized as a 'lab' or 'off stage'. Importantly, prototyping describes the

first arena for safe-to-fail conditions for policy design: a commitment to learning about the wicked problem and the socio-political CAS from, and with, stakeholders. When the process of structuring the wicked problem, as well as prototyping and developing its solutions, is recognized by all as a process of learning, unintended outcomes can be recast as building knowledge and experience rather than exercising poor judgement or mismanagement. In this sense, we distinguish 'prototypes' from 'pilots'. Prototypes are novel candidates for intervention tested outside the complex system that add expeditious informational value to intervention design whether they fail or succeed. In contrast, pilots are more resource intensive tests within the complex system of what is hoped, after refinement, will be operationalized.

Before a prototype might be further developed to advance to a pilot phase, it must be evaluated. In design thinking as summarized in Section 3, prototype evaluation is the process of revisiting conclusions drawn from Space (2): What did the policymakers (i.e. designers) conclude might be some indications that an implemented solution is ameliorating the problem? What were the envisioned desirable goals for change? Progress towards goals might be assessed through qualitative or quantitative benchmarks, and assessing the prototype's performance against said benchmarks is the process of evaluation. Conclusions from the evaluation determine what policy design activities should happen next: If policy designers are satisfied with the evaluation outcomes, the prototype may be refined to develop a pilot; if not, the candidate idea may be overhauled or scrapped, with corresponding revisits to early Spaces of design thinking.
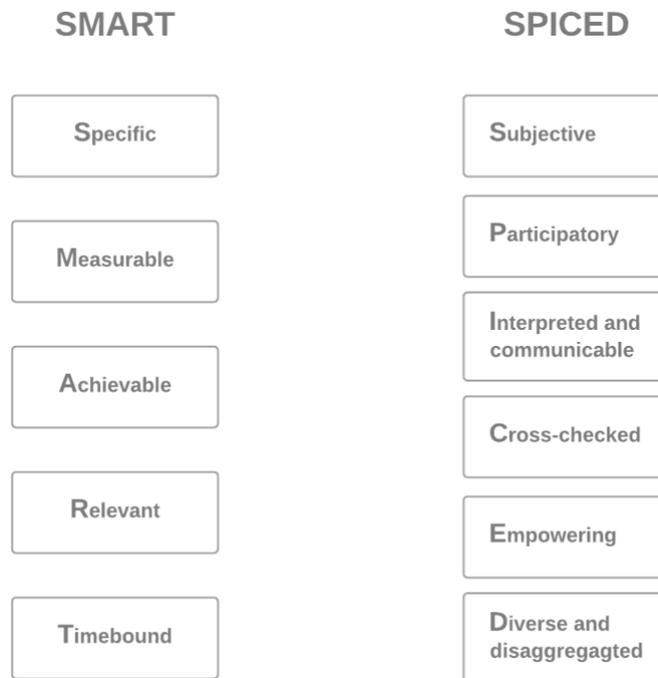
For evaluating interventions that are *in situ*, one must also then consider the second issue, i.e., whether the aim of the intervention is to influence agents who create change vs. to control what agents do. As discussed in Section 4.1, the prevailing approach to governance is to manage uncertainty by attempting to control it. The tenets of Weberian bureaucracy theory suggest that the most reliable indicators to evaluate policy interventions will be SMART, i.e. specific, measurable, achievable, relevant, and time-bound. However, as discussed in previous sections of the paper, SMART indicators presume that the relationships between policy interventions and system responses are straightforward (i.e. ordered). The Cynefin framework calls such policy

contexts "complicated"; however, under a "complex" policy context, relationships between policy interventions and system responses lack such order.[3] SMART indicators might provide a familiar framework for evaluating policy interventions; however, for a policymaking context that is complex, such indicators will provide partial information about the effectiveness of the policy intervention at best and useless information at worst. Thankfully, alternative SPICED indicators have been developed that better suit complex policy contexts, as they prioritize participatory engagement of stakeholders and provide guidance on the *practices* for indicator use, or application.

      SPICED stands for subjective, participatory, interpreted and communicable, cross-checked, empowering, diverse and disaggregated. The objective of SPICED indicators is to engage stakeholder and policymaker communities to increase awareness, information exchange, and learning. From the perspective of the Cynefin framework, such indicators provide qualitative guidance for evaluation *activities* that help policymakers develop order -- in the forms of shared information and cohesive effort -- when the policy context is unordered. Importantly, SPICED indicators work through a governance paradigm of influence rather than control.

---

[3] *Unordered* relationships are not necessarily *disordered*. In the Cynefin framework, "complex" contexts have an order that may be evolving, or expert consensus might be low about how relationships are ordered. In contrast, "chaotic" contexts might share some of the aforementioned traits of complex contexts but are changing so disruptively, rapidly, or both that the context also gives rise to disorientation (i.e. disorder, or the perception of disorder).

	SMART		SPICED
Specific		**S**ubjective	

SMART

- **S**pecific
- **M**easurable
- **A**chievable
- **R**elevant
- **T**imebound

SPICED

- **S**ubjective
- **P**articipatory
- **I**nterpreted and communicable
- **C**ross-checked
- **E**mpowering
- **D**iverse and disaggregagted

A concrete example of SPICED indicators for effective activities that design system interventions (yet are also simultaneously system intervention itself) comes from design thinking: The Agile Manifesto (Beck et al., 2001). Agile was born in the context of software development, but it was a response to problems in the field that can also be found in public policy: products (i.e. intended system interventions) would be less effective or impactful than desired, great effort would be expended in the process to develop them, and morale was often sacrificed during research and development. In writing about the history of The Agile Manifesto, Jim Highsmith explicitly criticized bureaucratic institutional norms in corporations, which altered the underlying rationality of management. Onerous and meaningless outputs from software developers were typically required:

> *The Agile movement is not anti-methodology, in fact, many of us want to restore credibility to the word methodology. We want to restore a balance. We embrace modeling, but not in order to file some diagram in a dusty corporate repository. We embrace documentation, but not hundreds of pages of never-maintained and rarely-used tomes. We plan, but recognize the limits of planning in a turbulent [business] environment.*

In short, the aforementioned corporate requirements reflect Weber's "iron cage" of rule-based rational control within bureaucracy, and it hampered (or worse, derailed) effective problem-solving among developers. Instead, Agile succinctly declares:

> *We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value:*
>
> - *Individuals and interactions over processes and tools*
> - *Working software over comprehensive documentation*
> - *Customer collaboration over contract negotiation*
> - *Responding to change over following a plan*
>
> *That is, while there is value in the items on the right, we value the items on the left more.*

Let us now consider the transferable lessons from Agile, a style of design thinking, to policy design. There are multiple methods for policy evaluation that bear similarities to Agile by shifting foci away from documentation and plans toward individuals, interactions, and collaborations. Advocates of the Human Learning Systems (HLS) approach contend that governance and decision making through performance reward and punishment mechanisms is demoralizing, slow, and wasteful (Lowe, 2021). HLS was developed through action research involving public service workers. It relies on mutually supportive management practices wherein effective and desirable outcomes for intervention designs emerge from learning and collaboration rather than through hierarchical directives. HLS focuses on the human element that roots public service in the everyday reality and complexity of people's lives. Such recognition of the inherent complexity of living systems that are also capable of reflection (Janzwood, 2021) leads to public management that recognizes the scarcity of well-defined problems that the public sector can swoop in and solve (Lowe and Eichsteller, 2021). Instead of solving problems through policy or program interventions intended to provoke a prescribed response, HLS invokes the principles within its name: *human* beings as complex systems (and elements of complex systems) who respond well to empathy and humility, *learning* as a managerial response to complex environments, and *systems* as the substrate from which outcomes emerge.

HLS aims to provide moral purpose to public service (Brogan et al., 2021). It envisions a public service that understands people through meaningful relationships

sustained through open dialogues that reveal the unique real-life context of their lives. Such relationships become the key resource for catalyzing outcomes. According to the 48 case studies used to develop its principles, HLS reveals people's needs from multiple dimensions, allows resources to be connected, and budgets to be pooled. This holistic approach to public management is said to avoid unintended consequences and contrary results, and results in better outcomes for less money.

There are also participatory methods of monitoring and evaluation that invite feedback from stakeholders who are impacted by policy designs, and they can complement the efforts of external evaluation. Such participatory methods strive to be just as useful at sustaining helpful emergent outcomes as they are at offering hindsight for insight. For example, the "Most Significant Change" approach is a 10-step process where stories of change are collected, interpreted, and filtered until the stories that represent the most important change are shared as representative pathways to success. (Lennie, 2011). Similarly, "Utilization-focused Evaluation" examines the interdependencies among those impacted by policy through feedback loops, recursive iterations, and other complex dynamics (Patton, 2012). "Outcome Mapping", which was first developed by the International Development Resource Centre (IDRC), seeks to provide a commonsense approach to learning as a primary outcome of evaluation (Earl et al., 2001). It captures qualitative impact in terms of changed behavior and practice. All of the aforementioned methods aim to understand and nurture change by identifying beneficial actions by system actors and how such actions might be sustained. SPICED indicators direct policy designers to evaluate their approaches for engaging system actors in order to uncover crucial information. By expanding who has access to the policy evaluation process, additional desirable outcomes beyond specifying indicators themselves are introduced including distributed ownership of the evaluation process, process flexibility, evaluation of higher quality, resilient evaluation capacity, and improved impact (Lennie et al., 2011).

These and other non-linear methods for evaluating policy interventions seek to inform ongoing governance actions that extend and diversify the interdependent behaviors needed across policymakers and stakeholders to sustain better outcomes in complex adaptive systems. Non-linear evaluation approaches address the need for

dynamic response to ongoing change, distribution of work, and optimal awareness across the stakeholder and policymaker communities. Overall, more work can be done by more informed people. However, Weber's bureaucracy theory – with its emphasis on linear and rigid processes within the organization and for policy evaluation -- casts a long shadow on the uptake of non-linear approaches for structuring wicked problems and designing policy interventions.

4.3 Case study: Governing Birmingham, UK as a complex system

The case study of the "Modelling Birmingham" project from 2010-11 demonstrates how a policy evaluation project can shift to incorporating complexity principles when stakeholders are part of the process. "Modelling Birmingham" was a partnership between the City Council, the University of Birmingham, and the University of Warwick. The 'design team' behind the project was a combination of research designers (i.e. academics) and policy designers (i.e. policymakers). Birmingham is a city in the West Midlands region of the UK with a population of 1.1 million people and the second largest City Council in Europe. As of 2015, its City Council budget was £3.1 billion annually with annual public spending of approximately £4 billion. Due to the financial crisis of 2008, the City Council had to achieve a 28% reduction in its revenue budget over four years, starting in 2010. Such severe constraints made the City Council receptive to a modeling project with potential to improve public policy outcomes.

At the time, the City recognized that its decision-making approach for the strategic planning of its major spending programs was not evidence-based. Such lack of evidence was a major concern affecting policy evaluations that aimed to quantify the value of outcomes with respect to money invested in order to support the development of public policy and programs. The goal of "Modelling Birmingham" was to introduce rigour through cause-and-effect mapping that would identify pathways to outcomes in key service areas and to explore alternative pathways to outcomes that would be more cost-effective. However, stakeholder consultation as part of the project revealed that in some policy contexts, cause-and-effect mapping alone would be insufficient for representing complex system dynamics (Bovaird and Kenny, 2015).

Key objectives of the Birmingham model were to better inform the City Council and its partners about the effects of their policy interventions; to highlight the areas where understanding of these effects is contested or poorly evidenced; to determine possible alternative interventions that would provide better return on outcomes; and to expand the stakeholder engagement by factoring in not-for-profit and private sector inputs. As part of the project, strategy maps were developed for a wide range of economic programs in Birmingham City Council. Such maps aimed to help city decision makers better understand the City's current resource allocation, explore future options, highlight problem areas, and structure debate about the impacts of budget reductions. Strategy maps included the City's "Succeed economically" program (Birmingham City Council, 2010), which complemented the "Health and wellbeing" and "Cleaner, greener, safer travel" programs (Birmingham City Council, 2020). These initiatives were part of the quality-of-life City program developed for Birmingham by the City Council and its partners.

Next, key relationships within specific cause-and-effect chains were quantified with evidence based on a review of research evaluations and business case reports. Such research activities were fairly straightforward and reflected a traditional, linear approach to problem definition and analysis. Specific value-for-money ratios could be identified for public-sector interventions considered during the mapping process. The project vision was to apply a whole-system approach to develop full cause-and-effect chains. From outcomes that the strategy maps identified, cause-and-effect chains would be used to backcast the current pathways to outcomes and alternative pathways that might be more cost-effective. A key focus was on finding pathways to better outcomes by reducing social and administrative costs through earlier intervention and prevention, shifting systematically towards investing in productive activities. For example, building social capital or creating jobs will require balancing supply and demand within labour and housing markets. The model was then vetted by seeking views from a wide range of stakeholders and a panel of academic experts.

The stakeholder and panel review, however, revealed that cause-and-effect pathways could not be constructed for all aspects of the outcomes identified by the city's agencies. For some outcomes, the interdependencies between the contributing

variables were so rich that the result of their interaction could not be predicted in the model. These interactions were the result of CAS (as discussed in the opening of Section 4) whose outcomes and respective time horizons for expected payoffs defy prediction. Nevertheless, some policy levers could influence the overall shape of potential outcomes, and it was possible to model them to a limited extent. The stakeholder and panel review inspired the design team to revisit its problem structuring steps (from Section 3.2, Spaces 1-3). The team considered other methods for the modeling approach that would provide more useful decision support for reconfiguring citywide mid- and long-term programs and budgets. The design team decided to apply the Cynefin framework (Snowden & Boone, 2007) for continued model development.

The Cynefin framework was useful for categorizing the evidence base for policy modeling. As discussed previously in Section 3.1, the simple and complicated domains of the framework are "ordered", where the relationships between cause and effect are well understood. A simple example from the project would be the relationships between advertising, marketing, and attracting investment, where best practices can guide policy decisions. A complicated example -- where cause-and-effect relationships are understood but require analysis and application of expert knowledge -- is the effect of infrastructural investments for business visitors on outcomes for business tourism. In complicated contexts, sufficient data and the application of good practice (i.e. appropriate analytical approaches) can project likely outcomes.

In contrast, the complex domain is "unordered", meaning that relationships between cause and effect are not well understood. There could be many reasons for unorder such as a high concentration of interconnections among system factors. Such interdependency can be a good thing for public policy, as it means that policy initiatives may affect several outcomes. At the same time, it presents a problem for predicting cause-and-effect relationships because it is hard to distinguish what is leading to what. Because of the non-linear relationships between system factors, alternative system trajectories can potentially lead to radical changes. For the Modeling Birmingham project, CAS relationships were modelled qualitatively to sense emergent system properties. Such exploratory 'soft modeling', which is often based on expert judgements, informs decision makers at a high level and does not offer explicit projections. Such

methods were not intended for giving definitive answers but rather for improving the quality of debate around the outcomes from public interventions (Bovaird & Kenny, 2015).

Qualitative policy models can provide suggestive results for decision support, but any decisions taken are really in-system experiments as discussed in Section 4.2. In complex decision contexts, policy makers must observe the effects of their interventions in order to learn more about the system. It also means that the pathways to desirable system states are uncertain. When knowledge about cause-and-effect relationships are unordered, observers may only be able to glean 'strange attractors' in the system that structure system behaviour. In the complex policy context, actual policy practice (in contrast to 'best' or 'good' practice) is used to uncover system rules that determine the shape of these attractors. According to Bovaird and Kenny (2015), the only form of predictability available for CAS is the knowledge of what those 'strange attractors' are. However, the semi-qualitative, semi-quantitative modelling approach of cross-impact balances, or CIB (Weimer-Jehle, 2006) can also help order knowledge of relevant cause-effect relationships in complex contexts. Furthermore, Kearney (2021) demonstrated that CIB could be applied to suggest opportunities for systemic interventions.

The move to incorporate qualitative modelling in the project also pushed the design team into more participatory activities akin to the Human Learning Systems approach discussed in Section 4.2. Stakeholder engagement from multiple parts of the public, private and not-for-profit sectors enabled the development of bottom-up strategy maps (and not only city agency strategy maps) that provided a deeper sense of reality. Inputs to the strategy planning process from the not-for-profit and private sectors shed light on how the whole system may evolve and improved the understanding of likely policy implications by decision makers and practitioners. The value of such an outcome-based strategy mapping approach is that it brings greater awareness of potential trade-offs and synergies amongst outcomes.

A specific example of a CAS identified in the Modeling Birmingham project is the innovation sector. Initially, the innovation program was modeled through a cause-and-effect approach similar to other elements of the economic program, where maps of

cause-and-effect relationships between different variables were identified as relevant by the different stakeholders involved. Discussion with stakeholders distinguished four separate strategies for promoting research- and invention-driven innovation in the city: enabling infrastructure, marketing Birmingham as an innovative place, business networking, and demand stimulation. At the time of the study, each of these strategies were pursued by the City independently; however, the project found that when the innovation sector was conceptualized as a CAS, the programs were more likely to be cost effective if combined in appropriate mixes and possibly varying sequences. The proposed way forward was to engage in the strategy of experimentation, using different combinations of the four existing strategies. To observe what effects policy programs might have on outputs and outcomes, it was recommended that in-system experiments be conducted in a variety of ways in different priority areas, in different priority sectors, and over time. It was recognized that the time horizon needed to assess the success or failure of an experiment might be substantial, as the effects of investments in innovation often take a considerable time to show up. Monitoring of experiments through total quality management was proposed so that the lessons from the ongoing experiments could be gleaned.

The Modeling Birmingham project revealed that in some aspects of public policy, cause-and-effect mapping tools were ineffective, and insights from complexity science were required. Some outcome pathways were too complex because the constituent variables were so interrelated that they could not be modeled through best/good practice (i.e., linear analysis). Once the project adopted qualitative systems analysis as well, it employed participatory practices akin to Human Learning Systems that were effective for identifying multiple opportunities for policy changes. Moreover, the assessment revealed that prior to the project, most policy evaluations performed by the City were based on input-output ratios without any consideration of intervening causal links. There was also little evidence to draw from in order to understand the nature of such links. Such limitations are common in policy contexts, and often policymakers employ a 'black-box' approach to policy evaluation, where internal relationships between inputs and outcomes are simply assumed rather than calibrated and tested (Wellstead et al., 2015). In the end, the project identified city services where system

nonlinearities could be leveraged to bring improvements to outcomes with relatively small increases in inputs of funds, time, or other resources. In addition, significant budget cuts that were well-targeted were anticipated to result in relatively small-scale impacts on quality-of-life outcomes for citizens. A specific example of Birmingham's economic strategy, however, that did not fit the linear, cause-and-effect approach was its innovation support program, which was better conceptualized as a CAS. At the time of the study, the findings and study approach represented a huge advance on what was available to policymakers. The project demonstrated a process that directly captured the perceptions of different stakeholders on how governance innovation could be achieved, and it ordered the different stakeholder perceptions according to the Cynefin framework.

5. Conclusion

Through our detailed discussion of the "Modelling Birmingham" case study, we conclude that problem structure matters for understanding and achieving desired policy outcomes. When cause-and-effect relationships are well understood, problem-articulation approaches such as linear cause-and-effect modelling, and policy evaluation approaches such as value-to-money cost ratios, are sensible. However, for wicked problems, problem structure may be multi-faceted or hidden. Under such conditions, what is equally important to problem structure is the problem-solving process of policy analysts, policymakers, and those who govern implementation. In other words, are policymakers thinking of 'problem structure' and 'policy design' solely as nouns (i.e. products) or also as verbs (i.e. processes)? As discussed in Section 3.1, linear thinking applied to wicked problems is likely to lead to sub-optimal policy or outright failure due to underdeveloped (or simply incorrect) problem structuring. Since wicked problems are emergent properties of complex systems, such systems should be modelled in an exploratory manner to explore ideas for how the complex system works. Wicked problems should be approached with humility, and leaders must be committed to learning, which will be most effective when a diversity of human perspectives are leveraged. Design thinking, summarized as overlapping spaces of activity in Section 3.2, provides guidelines for how policy designers can prioritize learning over making plans. In Section 4.2, the Agile framework for design and Human Learning Systems

(HLS) demonstrate how policymakers might become adept at convening and leveraging a diversity of human talent and relationships to sustain problem-based learning. Design thinking has become fashionable in the private sector but is less common in policymaking. Similarly, the HLS approach to public management is also less common. In Section 4, the anchoring influence of Weberian bureaucracy theory was discussed as a potential barrier to the effective resolution of wicked problems. As proposed by the founders of HLS (2021), future research should examine the relationship between nurturing healthy systems (including problem-solving and governance systems) and disrupting systems that create negative outcomes. How do we understand communities as complex adaptive systems, and what roles are needed to nurture a significant paradigm shift in public policy away from Weberian bureaucracy theory?

References

Arnaboldi, M., Lapsley, I., Steccolini, I., 2015. Performance Management in the Public Sector: The Ultimate Challenge. Financial accountability & management 31, 1–22. https://doi.org/10.1111/faam.12049

Beck, K., Beedle, M., van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Grenning, J., Highsmith, J., Hunt, A., Jeffries, R., Kern, J., Marick, B., Martin, R.C., Mellor, S., Schwaber, K., Sutherland, J., Thomas, D., 2001. Manifesto for Agile Software Development [WWW Document]. URL https://agilemanifesto.org/ (accessed 6.30.21).

Berger, W., 2009. Glimmer: How Design Can Transform Your Life, and Maybe Even the World. Random House Canada, Toronto, ON.

Birmingham City Council, 2020. Safer, greener, healthier travel | Birmingham City Council [WWW Document]. Birmingham City Council. URL https://www.birmingham.gov.uk/info/20163/safer_greener_healthier_travel (accessed 6.8.21).

Birmingham City Council, 2010. Brimingham: Global City, Local Plan. Birmingham Council Plan 2010+. Birmingham City Council, Birmingham, UK.

Bovaird, T., Kenny, R., 2015. Managing Complex Adaptive Systems to Improve Public Outcomes in Birmingham, UK, in: Geyer, R., Cairney, P. (Eds.), Handbook on Complexity and Public Policy. Edward Elgar Publishing, Cheltenham, UK ; Northampton, MA, USA, pp. 261–283.

Boyd, E., Folke, C., 2012. Adapting Institutions: Governance, Complexity, and Social-Ecological Resilience. Cambridge University Press, Cambridge, UK ;

Brogan, A., Eichsteller, G., Hawkins, M., Hesslegreaves, H., Jennions, B.N., Lowe, T., Plimmer, D., Terry, V., Williams, G., 2021. Human Learning Systems: Public Service for the Real World.

Brown, T., 2009. Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, First Edition. ed. HarperCollins Publishers, New York.

Brown, T., Wyatt, J., 2010. Design Thinking for Social Innovation. Stanford Social Innovation Review 8, 31–35.

Bushe, G.R., Marshak, R.J., 2015. Dialogic Organization Development: The Theory and Practice of Transformational Change, 1st edition. ed. Berrett-Koehler Publishers, Oakland, CA.

Chan, D., 2017. The AI That Has Nothing to Learn from Humans [WWW Document]. The Atlantic. URL https://www.theatlantic.com/technology/archive/2017/10/alphago-zero-the-ai-that-taught-itself-go/543450/

Chang, A.M., 2019. Lean Impact: How to Innovate for Radically Greater Social Good. John Wiley and Sons, Incorporated, Hoboken, New Jersey.

Churchman, C.W., 1967. Wicked Problems. Management Science 14, B-141-B-142. https://doi.org/10.1287/mnsc.14.4.B141

Clark, S.G., 2002. The Policy Process: A Practical Guide for Natural Resources Professionals. Yale University Press.

Dietz, T., Ostrom, E., Stern, P.C., 2003. The Struggle to Govern the Commons. Science 302, 1907–1912.

Duffy, J., 2017. Taming Wicked Problems: It's Time for a Completely New Way of Thinking [WWW Document]. ICMA.org. URL https://icma.org/articles/pm-magazine/taming-wicked-problems

Earl, S., Carden, F., Smutylo, T., 2001. Outcome Mapping: Building Learning and Reflection into Development Programs. International Development Research Centre, Ottawa, ON.

Frelin, J., 2016. Analysing Complex Conflicts: Requirements for Complexity-Aware Conflict Analysis., in: Brusset, E., Coning, C. de, Hughes, B. (Eds.), Complexity Thinking for Peacebuilding Practice and Evaluation. Palgrave Macmillan, London, U.K., pp. 207–237.

Geyer, R., Rihani, S. (Eds.), 2010. Complexity and Public Policy: A New Approach to Twenty-First Century Politics, Policy and Society. Routledge, London ;

Head, B.W., Alford, J., 2015. Wicked Problems: Implications for Public Policy and Management. Administration & society 47, 711–739. https://doi.org/10.1177/0095399713481601

Holland, J.H., 2012. Signals and Boundaries: Building Blocks for Complex Adaptive Systems. MIT Press, Cambridge, MA.

Janzwood, S., 2021. Supporting uncertain policy decisions for global catastrophic risks.

Kearney, N., 2021. Guided Cultural Evolution and Sustainable Development: Proof of Concept and Exploratory Results.

Kurtz, C.F., Snowden, D.J., 2003. The New Dynamics of Strategy: Sense-Making in a Complex and Complicated World. IBM systems journal 42, 462–483. https://doi.org/10.1147/sj.423.0462

Lawrence, T.B., Phillips, N., 2019. Constructing Organizational Life: How Social-Symbolic Work Shapes Selves, Organizations, and Institutions, First edition. ed. Oxford University Press, Oxford, UK.

Lennie, J., 2011. Equal Access Participatory Monitoring and Evaluation Toolkit. the Most Significant Change Technique: A Manual for M&E Staff and Others at Equal Access. Queensland University of Technology, University of Adelaide, Equal Access.

Lennie, J., Tacchi, J., Koirala, B., Wilmore, M., Skuse, A., 2011. Equal Access Participatory Monitoring and Evaluation Toolkit. Module 2: Setting Objectives and Indicators. Queensland University of Technology, University of Adelaide, Equal Access.

Lowe, T., 2021. Public service for the real world, in: Human Learning Systems: Public Service for the Real World. pp. 11–25.

Lowe, T., Eichsteller, G., 2021. Chapter 1 The HLS Principles: Human. Being Human: public service for real lives, in: Human Learning Systems: Public Service for the Real World. pp. 27–52.

Mainzer, K., 2004. Thinking in Complexity: The Computational Dynamics of Matter, Mind, and Mankind, 4th rev. and enl. ed. ed. Springer, Berlin ;

Martin, B., Hanington, B.M., 2012. Universal Methods of Design: 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions. Rockport Publishers, Beverly, MA.

Midgley, G., 2015. Systemic Intervention, in: Bradbury, H. (Ed.), The SAGE Handbook of Action Research., Sage Reference. SAGE Publications, London, U.K., pp. 157–166.

Midgley, G., 2000. Systemic Intervention: Philosophy, Methodology, and Practice, Contemporary systems thinking. Springer Science, New York, NY.

Patton, M.Q., 2012. Essentials of Utilization-Focused Evaluation. SAGE, Thousand Oaks, CA.

Preiser, R., Woermann, M., 2019. Complexity, Philosophy and Ethics, in: Galaz, V. (Ed.), Global Challenges, Governance, and Complexity: Applications and Frontiers. Edward Elgar Publishing, Cheltenham, UK, pp. 38–62.

Rittel, H.W.J., Webber, M.M., 1973. Dilemmas in a General Theory of Planning. Policy sciences 4, 155–169. https://doi.org/10.1007/BF01405730

Scott, J.C., 2020. Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed. Yale University Press.

Senge, P.M., 2006. The Fifth Discipline: The Art and Practice of the Learning Organization. Currency Doubleday, New York, NY.

Snowden, D.J., Boone, M.E., 2007. A Leader's Framework for Decision Making. Harvard business review 85, 68–149.

Tomo, A., 2018. Managerialism in the Public Sector: Perspectives and Prospects. Routledge, Taylor & Francis Group, New York, NY.

Ulrich, K., 2011. Design: Creation of Artifacts in Society. University of Pennsylvania, Philadelphia, PA.

Weber, M., 1978. Economy and Society: An Outline of Interpretive Sociology. University of California Press, Berkeley.

Weimer-Jehle, W., 2006. Cross-impact balances: A system-theoretical approach to cross-impact analysis. Technological Forecasting and Social Change 73, 334–361. https://doi.org/10.1016/j.techfore.2005.06.005

Weisert, C., 2003. There's No Such Thing as the Waterfall Approach! (and There Never Was) [WWW Document]. idinews.com. URL http://www.idinews.com/waterfall.html

Wellstead, A., Howlett, M., Rayner, J., 2015. How Useful Is Complexity Theory to Policy Studies? Lessons from Climate Change Adaptation Studies, in: Geyer, R., Cairney, P. (Eds.), Handbook on Complexity and Public Policy. Edward Elgar Publishing, Cheltenham, UK ; Northampton, MA, USA, pp. 399–413.