Wicked Problem Territory and the Design Strategy

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The center of the problem is that none of them knew the center of the problem.

Nassim Nicholas Taleb 2010

Wicked problems are human problems and the difficulty in solving these intractable challenges is not necessarily the problems themselves, but the dysfunctional incoherence of the people trying to solve them!

Alan Watkins and Ken Wilber, 2015

Introduction

Wicked Problems, a concept developed by Rittel and Webber (1973), has found resonance in many disciplines: public policy (*e.g*. Australian Public Service, 2012; Head and Alford, 2015; Newman and Head, 2017), public management (*e.g*. Head, 2008; Head and Alford, 2015), business (e.g. Camillus, 2008; Fahey,2016), and applied sciences (*e.g*. Batie, 2008; Pryshlakivsky and Searcy, 2013). As defined by Rittel and Webber (1973) wicked problems are ill-defined social problems that "are never solved" but at best "only re-solved—over and over again" (p. 160). They: have no definitive formulation; no stopping rules; are essentially unique; can be considered to be symptoms of other problems; and are explained in numerous ways that determine the problem's resolution. Solutions to wicked problems: are not true or false, but better or worse; have no immediate or ultimate test; are one-shot operations with no opportunity to learn by trial and error since every attempt to solve a problem counts significantly; have no describable set of potential solutions; and make planners liable for the actions they generate since they have no right to be wrong.

Widely accepted as a useful concept, the popularity of the term has come at some cost. Its diffusion has opened up interpretations that diverge from Rittel and Webber's original formulation. For example, there are some who claim that "wicked problems" can be tamed (Camillus, 2008) and can be solved (Australian Public Service, 2012; Kolko, 2012). These deviations from Rittel and Webber's original framework have led others to declare the term to be: "inflated and overused," "applied indiscriminately" (Alford and Head, 2017); and a "fad in contemporary policy analysis" "that is conceptually stretched" and "abused" (Peters, 2017). I believe the concept of "wicked problems" has utility. But work needs to be done to flesh out a more developed conceptual framework so we can move "wicked problems" from concept to construct. To pursue this end, three goals inform this paper.

Section one addresses the inherent contractions in the term "wicked problem." By definition, if we agree what the problem is, then the problem can't be wicked. So how do we characterize these "problems" about which we don't agree? What do we call them? Should we even call them problems? Does naming them give them more certainty than they deserve which may account for some of the indiscriminate use of the term "wicked problem" in the literature? Moreover, how do we distinguish these problems on which we don't agree from other types of problems? Rittel and Webber (1973) introduced the concept of "tame" problems to compare and contrast them with "wicked" ones—a useful conceptual technique.[1] But are there other problem types and if so, how can we distinguish them from "tame" and wicked ones?

[1] See Appendix A for a comparison between wicked and tame problems.

In answer to this question, section one also briefly summarizes different problem typologies from the literature and describes some of their limitations. It also introduces the *Roberts Typology of Problem Territories* which has evolved over the years, the objective of which is to distinguish among four problem territories and to avoid some of the conceptual traps that have limited the usefulness of other typologies.

Section two addresses the question of how to operationalize the concept of "wicked problems." I concur with the critiques of Alford and Head (2017) and Peters (2017). Clearly people have different definitions and interpretations about "wicked problems." But before we can operationalize the concept we first need finer-grain distinctions on how to define and characterize the problems that cannot be named.

Section three addresses process issues concerning time and problem-solving strategies. Time is important since we know that problems and their solutions can evolve. Take the example of tobacco (Australian Public Service, 2012). Neither a problem nor a solution but simply part of a ceremonial tradition or a means to help a smoker relax, tobacco was not originally in someone's problem matrix. Then alarms sounded about the dangers of tobacco use. Conflicts erupted over tobacco research, problem formulations, and potential solutions driving the issue of tobacco from a non-problem into what some have described as a "wicked problem." Eventually, mounting evidence convinced people that tobacco was a health problem, and the use of tobacco gradually focused on solutions—which solution should we pursue? Ban it? Control its promotion, sale, and use? Tax it? Launch an information campaign and put warnings on packages? So, depending on our ability to learn and establish agreements about what is fact and knowledge, problems and solutions can move from one quadrant to

another. Although we can assume that a "wicked problem" won't be "solved" in the short term, determining what is short or long term can be difficult given the exponential growth of information and knowledge. In the case of small pox, as we see in section three below, the long term represented centuries of problem solving before we agreed what the problem was and how to solve it. Compare that time frame with the challenge of Ebola. As evidenced by the recent creation of a vaccine, time between problem identification and solution generation has been sharply reduced to a matter of years (Rogers, 2018).

Secondly, in terms of problem-solving strategies, Rittel and Webber (1973) explicitly stated that the rational-technical strategy is not an appropriate strategy to tackle "wicked problems" although it is an appropriate strategy for tame problems. Unfortunately, by defining tame problems in terms of the rational-technical process used to solve them, they conflated a problem type with its methods of resolution. My approach is to separate the problem type from the tactics and strategies used to try to deal with them. To this end, I explore four strategies and briefly note their advantages and disadvantages. I also introduce a fifth strategy called the *design strategy*—the features of which I find particularly attractive when working in wicked problem territory.

The paper concludes with some of my personal observations when conducting field work in wicked problem territory and offers some suggestions on how to cope with the challenges and difficulties it engenders.

Roberts Typology of Problem Territories: Wicked, Complex, Simple

Naming a problem as wicked immediately introduces a contradiction. We know that a "wicked problem" is ill-defined. Its ill-defined character makes it difficult to agree on a problem frame. But if we are unable to agree on the definition of a problem, then why do we insist on naming wicked problems *e.g*., "poverty is a wicked problem" or "race relations are wicked problems" etc.? What is our justification for labeling a problem as "wicked" when we find little agreement on its definition? Are our attempts to name and label things simply assumptions that *our* names and labels are "better than" or "truer than" those of others? Insisting on these labels, are we not fanning the fires that contribute even more wickedness to the problem solving process? If so, perhaps we should stop naming and labeling problems and find another way to categorize those things on which we cannot agree.

To address this issue, I searched for different ways to conceptualize problems and found three typologies of note in the literature. To evaluate these typologies, I followed the guidelines of D. Collier, J. Laporte, and J. Seawright (2012). The authors describe typologies as "well-established analytic tools in the social sciences" that can be useful in "forming concepts, refining measures, exploring dimensionality, and organizing explanatory claims." They challenge critics who follow "the norms of quantitative measurement" and consider typologies as "old-fashioned and unsophisticated." In their view, research on typologies can and should proceed as long as it employs the high standards of rigor summarized in their guidelines. There are, for example, important differences between conceptual categories that describe types and explanatory typologies that explicate relationships among the types or their variables. The typology types serve different purposes and should not be combined in one matrix. As we see

below, these guidelines are not always followed. Problem types are confounded with the strategies to deal with them and/or with a problem's determinants and/or its consequences.

For example, the *Heifetz Typology of Problem Situations in Organizations* (Heifetz, 1994) expanded Rittel and Webber (1973) typology of tame and wicked problems and proposed three problem types: 1). work situations comparable to tame problems when experts are engaged in technical work and problem definitions and solutions are clear; 2). work situations when the problem definition is clear and agreed to, but the solutions aren't and adaptive learning is required due to the difficulties in sorting out the relevant cause-and-effect relationships among problems and solutions; 3). and work situations comparable to wicked problems when extensive, adaptive learning is required by all since both the problem definitions and the solutions are unclear and lack agreement. Although this three-fold typology broadened the range of problem types, it confounded the problem type with the recommended strategy and its techniques (adaptive learning) to address the problem. Rather than assume there is only one strategy to deal with wicked problems, it is best to keep open the question of strategy independent of problem types. Moreover, adaptive learning, a central feature of Heifetz's typology, is embedded in what I call the design strategy, a topic more fully addressed in section three.

Another example is the Hoppe and Hisschemöller's *Typology of Policy Problems* (1995) that employed two dimensions to derive four types of policy problems: structured; moderately structured (ends); moderately structured (means); and unstructured. 1). A *structured problem* has a high degree of consensus about the problem situation, the ways of converting it to a more desirable situation, and the relevant values. 2). A *moderately structured problem (ends)*

has a high degree of consensus on relevant values but there is uncertainty or dissent on what the problem situation is and what the relevant knowledge is to convert it a more desirable situation. 3). A *moderately structured problems (means)* has a consensus on the knowledge of the problem situation and the ways to convert it to a more desirable situation, but there is ongoing dissent about the relevant values at stake. 4). And finally, an *unstructured problem* has no consensus on relevant values, the problem situation, or ways to convert problems to a more desirable situation despite the widespread discomfort with the status quo. This typology expands the types of policy problems to four and identifies different strategies to deal with each problem type: a *learning strategy* for unstructured problems, a *negotiation strategy* for a moderately structured problems (ends), an *accommodation strategy* for a moderately structured problems (means), and a *rule-based strategy* for structured problems. Unfortunately, the typology conflates problem situations (problem) with the knowledge it requires address the problem (the solution). Furthermore, each problem type is directly linked to a particular strategy; there is no opportunity for strategy choice beyond the strategy affiliated with each problem type. In addition, norms or value consensus should be treated as a third dimension but instead is embedded in the two major dimensions.

Alford and Head's (2017) *Alternative Types of Complex Problems* adds additional complexity in the problem map, but also some complications. Its two dimensions are *complexity of problems and stakeholder relationships. 1). Complexity of problems* range from: problem and solutions are clear; problem is clear, solution is not clear; and neither problem nor solution is clear). 2). Difficulty of *stakeholders* range from co-operative or indifferent relationships; multiple parties each with only some relevant knowledge; and multiple parties,

conflicting in values and interests. The two dimensions produce nine different problem spaces: tame problem; analytically complex problem; complex problem; communicatively complex problem; cognitively complex problem; politically complex problem; conceptually contentious problem; politically turbulent problem; and very wicked problem. Aside from the challenges of distinguishing among the problem types, there are conceptual difficulties concerning the second dimension—stakeholders/institutions. The "dimension" is at least three dimensions (the level of cooperation/indifference in relationships, distributions of knowledge among stakeholders, and conflicts in values and interest) that are collapsed into one dimension. The end result is a typology that confounds: problems with people's strategies of dealing with them (cooperation or conflict); three dimensions confounded as one dimension; problem characteristics (the nine problem spaces) confounded with potential determinants or possibly their consequences *e.g*. value conflicts, interests, and "relevant knowledge."

To avoid some of these limitations, I offer a conceptual framework that differentiates *territories* of problem solving (Roberts, forthcoming). It builds on the assumption that people, through their interactions and relationships with problems and solutions, create "problem spaces or territories"[2] that describe *varying levels of conflict* about problems and solutions. As illustrated in Figure 1, levels of conflict concerning problem definitions vary from low to high on the vertical dimension; and levels of conflict concerning solutions vary from low to high on the horizontal dimension. These two dimensions generate four problem spaces: *simple problem territory in the lower-left quadrant* where there is agreement on a problem and its solution;

[2] My concept of space or territory draws from Allen Newell and Herbert Simon's problem-space theory in their 1972 book on Human Problem Solving. They theorize that people solve problems by searching in a problem space which consists of the current state, the goal state, and all possible states in between.

complex problem territory in the lower-right quadrant where there is agreement on a problem and disagreement on a solution; *complex problem territory* in the upper-left quadrant where there is disagreement about a problem but agreement on a solution; and *wicked problem territory (WPT)* in the upper-right quadrant where conflict is the defining characteristic, both about problems and solutions. It is in this quadrant we would expect to find the ten characteristics of "wicked problems" as described by Rittel and Webber (1973).

Insert Figure 1 About Here

S*imple Problem Territory*. In simple problem territory in the lower left-hand quadrant, there is a low level of conflict over a problem and its solution. Thus in this configuration, we find a direct connection (shown as a solid line) between a problem (*P*) and a solution (*S*). Simple problems are technically well-defined and structured, and can be solved by "experts" using standard techniques and procedures. My bicycle chain breaks. I take it to the bicycle repair shop and the technician activates a routine to fix it; he replaces the chain. An engineer has a math problem. She solves the equation correctly. A short-order cook has 20 people to feed. He decides on a menu, follows a standard procedure of buying, preparing, cooking, and serving the food.

Complex Problem Territory. Complex is something that is "composed of two or more separable or analyzable items parts, or constituents" (Webster's, 1971, p. 465). There is general agreement that complex problem solving has a number of dimensions, but two of these are most relevant for our purposes: complexity arises when people propose multiple definitions of "the problem" and complexity arises when people

pursue different goals embedded in solutions they advocate (Fisher, *et.al*., 2012; Frensch and Funke, 1995; Dorner, 1996). Thus, complex problem territory lands us in two quadrants.

In the ***complex problem territory in the lower right-hand quadrant***, people agree on the problem (*P*), but they disagree on the solutions (*S*). Hence the configuration between the problem (*P*) and the solutions (*S*) are not well connected and are shown as dotted lines. One example is the San Clemente dam project in Carmel Valley, California. The community had a general agreement about the problem: the dam on the Carmel Valley River was failing and something needed to be done about it. Conflict ensued over the solutions: shore up the dam; bypass the dam; build another dam. (The decision was to forge a new channel in the river and bypass the dam and eventually eliminate it). While the problem solving process involved years of in-depth study and problem analysis, stakeholder deliberations and conflicts centered on the solutions not on experts' well-specified technical problems with the dam.

We find another example in President Kennedy's address to Congress about urgent national needs on May 25, 1961 (NASA, nd). He challenged Americans to commit to the goal of landing a man on the moon within the decade and returning him safely to earth. The Soviet Union had launched Sputnik almost four years earlier and successfully sent cosmonaut Yuri Gagarin in space in April 1961. The problem, as President Kenned framed it on September 12, 1962 to a crowd of 35,000 people at Rice University, was that the United States was losing and the Soviet Union was winning the space race. Space superiority translated into military superiority and hence the urgent need. "Whether it will become a force for good or ill depends on man, and only if the United States occupies a position of pre-eminence can we help decide

whether this new ocean will be a sea of peace or a new terrifying theater of war." Thus, said Kennedy, "we choose to go to the Moon in this decade … not because (it is) easy, but because (it is) hard; because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one we intend to win" (Kennedy, 1962).

A consensus on the problem quickly emerged –America's lack of space superiority vis-à-vis the Soviet Union. The debate then shifted to the scientific and technical solutions needed to close the gap to get us to the moon and back:

1. *Direct ascent* called for the construction of a huge booster to launch the spacecraft and send it on a direct course to the moon, land a large vehicle, and send parts of it back to earth;
2. *Earth-Orbit Rendezvous* called for the launch of various modules required for the Moon trip into an orbit above the Earth, where they would rendezvous, be assembled on a space station into a single system, refueled, and sent to the Moon;
3. *Lunar-Orbit Rendezvous* called for sending the entire lunar spacecraft up in one launch, head to the moon, enter its orbit, and dispatch a small vehicle to land on the lunar surface.
4. *Lunar Surface Rendezvous* called for the launch of two spacecraft in succession. The first to land would be an automated vehicle carrying propellant for the return to Earth. The manned vehicle would land some time later. Propellant then would be transferred from the automated vehicle to the manned vehicle.

The debates on these four options were contentions, but in an all-day meeting on 7 June 1962 at Marshall, the advocates of the lunar-orbit rendezvous won out. Settling on a technical solution was just beginning, however. There were layers of complexity in the NASA project. Debates continued over its funding and the distribution of resources; the integration of disparate government organizations (*e.g*. research centers, laboratories, flight centers, vehicle assembly and test facilities) and private-sector organizations (*e.g*. universities, research institutions, and businesses and contractors in the emerging aerospace industry) into a single unified path; the management of programs and their three interrelated constraints (cost, schedule, and reliability); different values and perspectives between engineers who usually worked in teams to build hardware and scientists who engaged in pure research and who were more concerned with designing experiments that would expand scientific knowledge about the moon (Brook *et.al*. 1979; NASA, nd).

The U.S. achieved its goal and landed Neil Armstrong and Edwin "Buzz" Aldrin on the moon on 20 July 1969 and returned them, along with the command module pilot Michael Collins, safely back to earth on 24 July 1969. Other achievements were noted in *Science:*

> in terms of numbers of dollars or of men, NASA has not been our largest national undertaking, but in terms of complexity, rate of growth, and technological sophistication it has been unique…. It may turn out that [the space program's] most valuable spin-off of all will be human rather than technological: better knowledge of how to plan, coordinate, and monitor the multitudinous and varied activities of the organizations required to accomplish great social undertakings (Wolfle, 1968).

James E. Webb, the NASA Administrator from 1961-1968 concurred with this assessment. He contended that the project to send men to the moon was much more a management challenge to ensure technological skills were properly employed, political battles to acquire and manage resources were won, and good program management was followed to integrate complex organizations and their tasks to achieve the goal (Wolfle, 1968).

In the ***complex problem territory in the upper-left quadrant***, people disagree about the problem (*P*), but they agree on its solution (*S*). The configuration is shown with dotted lines moving "backwards" from the agreed upon solution to multiple problem formulations (*P*). This type of problem solving space is more difficult to understand. How is it possible to agree on a solution but disagree on the problem? At first glance the quadrant appears to be illogical. And indeed it doesn't make sense if one assumes a linear process of problem solving where to be "rational" one is advised to identify a problem first, then search for solutions and select one that is "optimum" based on well-chosen criteria. However, when I ask people to describe the decision making process in the U.S Congress, they grudgingly admit this solution-in-search of a problem does exist. Congressional representatives may differ on the problems facing the nation, but most will agree that spending money in their home districts is the solution. Coalitions also are formed on this same basis. Countries agree on how to deal with an aggressor, but they don't necessarily agree on the problem the aggressor presents. Madeline Albright, the Secretary of State under President Clinton, provided an example when she challenged Joint Chiefs Chairman Colin Powell during a 1993 meeting:[3] "What's the point of having this superb military that you're always talking about if we can't use it?" (Isaacson, 1999).

[3] My thanks to Professor John Arquilla for suggesting this example.

As General Powell later recalled, he "thought (he) would have an aneurysm" so alien was her problem solving approach (Isaacson, 1999). Rather than a solution in search of a problem, he advocated the rational-analytic approach as expressed in Powell Doctrine: the US should only use military force after a clear political goal has been set. Only if we know the problem, then and only then can we set explicit military goals (solutions) to solve it.

In these cases, and others, problem solvers start with their preferred solution and back-engineer the problem solving process by attaching their preferred solution to whatever problems are handy or make the most sense to them. Hence we end up identifying different problems to which we attach our preferred solution. Rather than the "rational," linear logic of the traditional problem solving process, there is a different logic that some have dubbed "the garbage can model of decision making" (Cohen, *et. al.*, 1972).

Wicked Problem Territory. The space in the *upper right hand quadrant* is populated with high levels of conflict surrounding problems *(P*) and solutions (*S*). The configuration is represented with many different *Ps* and *Ss without* any connections. A rule of thumb to distinguish "wicked" from simple or complex ones is the level of discord on the topic. If there are many people angrily debating on the problem and the solutions, such as issues around the world's climate, then it is a good guess you have ventured into some space within wicked problem territory.

I have had some experiences in wicked problem territory, some by accident and others by choice. I first "stumbled" and "fell" into the territory when working for the United Nations on an Afghanistan project in the late 1990s when the Taliban was expected to "win" the war and take control of the country. The UN asked how could the different stakeholders—the

Taliban, countries and their militaries involved in Afghanistan, the United Nations and its various agencies, international organizations, and the NGOs come to some agreement on how to reconstruct the country? I have documented my experiences in this project elsewhere (Roberts, 2000; 2001) so I won't repeat them here. Suffice it to say that by anyone's definition, Afghanistan at the strategic level was and continues to be in wicked problem territory with high levels of conflict about problems and their solutions.

In the ensuing years, having recognized the challenges and difficulties of working in wicked problem territory, I deliberately sought out projects in which there were high levels of conflict about problems and their solutions. My goal was to explore different problem solving strategies that might provide some traction in moving us into some space that was less "wicked." I have learned a great deal from these explorations some of which I describe in section three and the conclusion.

Moving from Concept to Construct

The placement of problems (*Ps*) and solutions (*Ss*) *within* wicked problem territory are meant to indicate the variations of problem-solution conflicts. Not all problems and solutions have the same levels of conflict intensity attached to them, even in wicked problem territory. Evidence of some of this variation comes from the introduction of the term "super wicked problems" (Lazarus, 2009; Levin, *et. al*., 2012).

Richard Lazarus identifies climate change as a "super wicked problem" and adds three characteristics to those identified by Rittel and Webber (1973). First, "time is not costless." We need to act quickly because the longer we take to tackle a wicked problem, the greater the

challenge it will present in the future, *e.g*. climate change can cause serious economic disruption that will slow the global growth rate and make it harder to deal with it. Second, those who are in the best position to address wicked problems are the ones who likely caused it and the ones with the least immediate incentive to act within a shorter time frame. People are caught in a "massive social trap." If they can't imagine the future, they can't prepare for it. If they discount future utility, they put off long-term investments in favor of short-term returns. Thus, short-term returns trump the realization of benefits decades and sometimes centuries in the future. And third, we lack an existing institutional framework of government empowered to develop, implement, and maintain the laws necessary to address a super wicked problem like climate change. Thus, super wicked problems have vast spatial and temporal scope. New laws and careful oversight of their implementation and updates are necessary to build this institutional framework.

Kelly Levin and coauthors[4] go one step further. The lack of interest in super wicked problems is not the issue from their perspective. It is the tendency of our institutions and our individual proclivities as consumers and voters to make choices that give weight to our immediate interests and delay making changes in our behavior and institutions that are clearly in our own long-term best interests. In addition to the three characteristics cited by Lazarus, they emphasize a fourth—the hyperbolic discounting that push solutions and policies to irrationally discount the future. They posit that the current "super wicked problem of climate

[4] The authors first identified, defined, and presented the term "super wicked problems" at the International Studies Association Convention Chicago, February 28th – March 3, 2007. Other versions of this paper were presented at the Climate Change: Global Risks, Challenges and Decisions Congress, 10 - 12 March 2009, Copenhagen, Denmark. My comments are based on the 2012 published article.

change" is driven in part, by policies, technologies and discourse that have created "a path-dependent reliance" on ''high carbon'' fossil fuels. Countervailing policies to trigger path-dependent "low carbon" trajectories are needed in the future. According to the authors, our first challenge is to identify the causal logics of path-dependent processes. Then we need to create forward-reasoning strategies and interventions that might "stick," gain "durability," expand to larger populations, and change behavior through largely unexplored and progressively small changes. Taken together these small incremental changes pursued along a path-dependent trajectory have potential to trigger large transformative efforts. "One-shot," ''big bang'' policies often fail to garner adequate support, or worse, produce "shocks" that hamper implementation and compliance and ultimately derail policy no matter how well designed. Alternatively, the researchers believe that ratcheted up, path-dependent policies, especially those that bind us to our collective selves, have a greater chance of creating behavioral change.

These additional characteristics of "super wicked problems" point to substantive variation within wicked problem territory. Following from this line of reasoning, we should expect variation in problem-solution conflicts among the other problem territories as well. One way to represent this variation is shown on the one-dimensional space in Figure 2. Conflict levels could range from the lowest levels in simple problem territory to the highest at the apex of wicked problem territory. As indicated by the // marks, it then would be theoretically possible to identify "cut scores" between the different problem territories to mark the shift from one problem space to another. A major advantage of a one-dimensional conceptual map is that we not only would be able to compare and contrast the problem-solution conflicts

within wicked problem territory, or any problem territory, but we would also be able to compare and contrast the level of problem-solution conflicts across all problem territories.

Insert Figure 2 about here

Whatever conceptualizations we use to describe wicked problem territory, operationalizing the concepts still present difficulties. When we attempt to identify a problem as "wicked" based on Rittel and Webber's characterization, we violate the indeterminacy of wicked problems. Defining a wicked problem *is* the problem, so too is any attempt to operationalize and measure a concept we can't collectively define. We however can develop metrics to measure the levels of problem-solution conflicts and Rittel and Webber's (1973) ten characteristics, including the additional four that Lazarus (2009) and Levin et.al.(2012) propose. (Appendix B provides a list of other characterizations of wicked problems from which we could derive metrics).

To summarize our journey into wicked problem territory thus far, we find problems we have difficulty defining and operationalizing. If we accept a common definition of a problem as a perceived gap between an existing state and a desired state and a solution is whatever closes the gap,[5] then *a wicked problem can be defined as the inability to conceptualize a gap due to high levels of conflict surrounding the existing state (the problem definition) and the desired state (the goals we pursue*) *and the inability to close the gap due to high levels of conflict over solutions*. One observer of the US 2016 primary season describes what it looks like on the

[5] See "Cognitive Psychology, Problem Solving." http://cognitivepsychology.wikidot.com/cognition:problem-solving accessed on 3 February 2016. See also Newell and Simon, 1972. Newell and Simon define problem solving as the successful search for an operation or a series of operations to transform the actual state of a system into the goal state.

ground during a presidential campaign: the two parties "can't agree on the problems let alone their solutions" (Rucker, 2016). So when venturing into wicked problem territory, be prepared to find it full of multiple stakeholders who hold competing values and views and vigorously defend their versions of the 'truth' by making different claims about problems, their causes, solutions, and potential consequences.

Process Issues in Wicked Problem Territory

The ultimate aim in WPT is to move "a problem" and/or "its solution" from WPT to either complex or simple problem territory. Any movement from one problem territory to another raises issues of process, especially those concerning time and strategy.

Issue of time. Thanks to our ability to learn, adapt, and change, problems and solution are not permanently affixed in one problem-solving quadrant. Take the example of small pox—the scourge of humanity for centuries—although people did not know what it was or what caused it or how to prevent it (World Health Organization, 1979). Evidence of its existence was found on the mummified body of Pharaoh Ramses V of Egypt (1150 BC) and historical records over millennia documented its lethal worldwide transmission. It was estimated to have caused the deaths of 300-500 million people in the 20th century alone. Even when the problem was well defined (small pox) and the solution (a vaccination) was well researched and accepted in the 1950s, over 50 million cases were estimated to be occurring each year throughout the world. As late as 1967, despite the successful vaccination campaigns that had been underway throughout the 19th and 20th centuries, the World Health Organization estimated that 15 million people had contracted the disease and two million had died. But by December of 1979, the

World Health organization certified the eradication of smallpox, the only human infectious disease to have been completely eradicated. It had taken centuries, arguably killed well over a billion people, but the pathogen had been identified and solutions had been discovered, tested, proven successful and implemented. Thus, progress is possible but it begs the question what problem solving strategies can help us manoeuver problems and solutions into complex, or even simple problem territories?

Issue of strategy. Strategy addresses the "how" of problem solving rather than the "what" (the purpose and goals), the "who" (people involved), and the "why" (the vision for the future). It offers a roadmap and the means (*e.g.*, guidelines, techniques, tactics) that a problem solver uses to achieve her ends. I have described six generic strategies—competitive, authority, rational-analytic, taming, collaborative, and design in greater detail elsewhere (Roberts, 2001; 2017; forthcoming) so I will only make brief mention of them here. Table 1 summarizes how they address conflicts as well as their advantages and disadvantages in wicked problem territory.

Insert Table 1 About Here

The *competitive strategy* has a long history in warfare, markets, and public policy. Those who pursue it play a zero-sum game. Zero-sum can best be explained by thinking of a pie that I want to divide into six pieces. If I want to increase the size of my serving, then I have to take from someone else's share. So in terms of wicked problem territory, if my problem solving strategy is competitive and my opponent wins the right to frame the problem and choose his preferred solution, then I lose. If I win then I have the power and right to define problems and

choose solutions the ways that suit me. The advantage of a competitive strategy is that we can identify clear "winners" and "losers." And following the rules of competitive engagement, the "winners" get to decide how to define the problems and solutions. The disadvantage of the competitive strategy is that the "losers" often wait in the wings for their chance to get even and resume the conflict*, e.g*. the Afghanistan War.

The *authority strategy* in WPT is a reliance on people in positions of power who have the formal authority to frame problems and generate solutions. By virtue of their leadership and offices, we entrust them to be our surrogates in the problem solving process. The advantage of an authority strategy is that someone takes charge of problem solving in the messy and contentious "wicked problem" world and relieves us of the responsibility**.** Ultimately, problems and solutions exist in wicked problem territory because our leaders say they do and our compliance signals agreement with their assessments and solutions. The disadvantage is that authorities can be and have been wrong—wrong about the problems and wrong about their solutions *e.g*. the war in Iraq its consequences which pushed the U.S. and the world deeper into wicked problem territory in the Middle East.

The *rational-analytic strategy* describes the expert's approach to problem solving. Experts come from wide-ranging disciplines and professions. What is common to all is that they derive their power from the rational-analytic process they use to solve problems and recommend action. The generic rational-analytic model follows eight basic steps. The problem solver: begins by stating the problem; identifies the goal or result to be achieved; specifies the criteria to assess whether the goal or result has been achieved; identifies the total of range of solutions to address the problem or goal; estimates the consequences for each solution; selects

the optimal solution to the problem based on the established criteria and the expected consequences; implements the solution; and seeks feedback on the effectiveness of the implementation. The advantage to the rational-analytic strategy is the well-defined path for problem solving. The assumption is that we can be "rational" if we follow the basic steps of the problem solving process. The disadvantages are many such as our cognitive biases (Kahneman, 2011) that predispose us to be less than rational problem solvers and our inability to anticipate what the consequences of our solutions might be to inform our selection of the "optimum" or any solution for that matter. But most importantly, without agreements on a problem, we are unable to activate the eight-step rational-analytic process and thus be deemed a "rational" problem solver.

The *taming strategy*[6] bounds the problem space and/or the solution space to make it less "wicked." Building on Rittel and Webber's (1973) critique of the rational-analytic model and its inability to deal with "wicked problems," the taming strategy simplifies *some of the stringent requirements of the rational-analytic process in order to make it more usable and a better "fit" in WPT.* There are at least five options to create this "fit." We can: bound the problem space into smaller bit-size pieces to reduce the conflicts over problem identification; simplify our goals to make them less ambitious and easier to achieve; restrict the solution space by reducing the solution options and controlling the criteria by which a preferred solution is selected; make the problem solving process more manageable by excluding those who would

[6] The taming strategy is different from a "tame" problem. A tame problem has agreement on the problem and its solution. The taming strategy attempts to use the a less restrictive rational-analytic model of problem solving as well as to simplify and domesticate WPT so problems are bit-sized, constrained and manageable.

disagree with us and limiting the time and resources needed to support the problem solving process; and choosing less stringent models of problem solving and decision making like Simon's model of bounded rationality (Simon, 1957) or Cohen, March, and Olsen's (1972), garbage can model of decision making. The advantage of the taming strategy is that it simplifies the problem solving process and reduces the complexity, uncertainty, and ambiguity. The disadvantage is that this simplification limits our ability to understand, appreciate, and deal with the wickedness of the problem-solution space as a whole, often opting for easier problems that we can solve rather than deal with the ones we can't. So if a lake is polluted, we post signs to warn people not to eat the fish rather than deal with the wicked issues of pollution.

The collaborative strategy is a process of working together, a definition that derives from the French verb *collaborer (col* means "together," and *laborare* means "work in combination with … especially at literary or artistic (or scientific) production" (Fowler & Fowler, 1964, p. 234). Working together has two general interpretations. From a classic liberalism perspective, we work to achieve our own self-interests and goals by bargaining and negotiating with others who bargain and negotiate with us to achieve their self-interested goals. If successful, the "collaboration becomes an aggregation of private preferences into collective choices" (Thomson and Perry, 2006, p. 20). In other words, through bargaining and trading, we find the points of overlap among our self-interests on which we all can agree, what some have described as the search for the lowest common denominator solution. In contrast, civic republicanism views collaboration as integrative (Thomson and Perry, 2006, p.20); it is the pursuit of something larger than our individual self-interests. At its core, it is the constructive exploration of differences that goes beyond each person's "limited vision of what is possible"

(Gray, 1989 p. 5). When we pursue integrative rather than self-interested collaboration, we join forces and work together to achieve what each of us is unable to do on our own. When the whole becomes greater than the sum of its parts, the integrative approach of the collaborative strategy moves us beyond self-interested trades and zero-sum bargaining. Power is then pursued *with* others for mutual gain rather than attempting to establish power *over* others in the pursuit of individual self-interests. The advantage to a collaborative strategy is the buy-in and support it receives when participants agree on problems and their solutions. The disadvantages of a collaborative strategy are the time and resources needed to gain agreement (Huxham & Vangen, 2005) and the problems of *scale*, especially in wicked problem territory. Although people have created ingenious large-group problem solving techniques (*e.g.*, Lukensmeyer & Brigham, 2005), we still are left with the question: how do we get everyone concerned about a "wicked problem" in the "room" and still get something done? How big does that room have to be?

The *design strategy* is "intentional change in an unpredictable world." As formulated by Harold Nelson and Eric Stolterman (2012) in *The Design Way*, design assists humans in reshaping their world by creating new products, technologies, processes, services, organizations, policies, and systems. Central to all design activity, regardless of the types of designs one creates, is the "ability to imagine that-which-does-not yet exist, to make it appear in concrete form as a new, purposeful addition to the real world" (p. 12). Thus, the designer, as change agent and innovator, creatively develops new designs to make or reshape the real world into what she or he wants it to be. Design differs from the other strategies in some major ways:

- Design is a legitimate form of inquiry and represents a third tradition on par with the traditions of science and art (Nelson & Stolterman, 2012). Although both the discoveries of science and insights from art can and do inform the design process, the purpose of science is to describe what is, the purpose of art is to expresses our personal images and sense of the world, and the purpose of design is to invent a world that could be.
- Design is contextual and situational—it focuses on certain challenges/issues that are specific to stakeholders in a particular context, at a particular point in time.
- Design follows a process of problem solving often referred to as Design Thinking. A design challenge launches the process with a question *e.g.* How should we reconstruct Afghanistan? The design team then attempts to answer the question following an *iterative* five-stage process: discovery; problem framing; ideation; prototyping; and testing.[7] During discovery the design team does a "deep dive" to explore and understand the context. From this exploration, it surfaces and frames problems it believes are central to the reconstruction. Identifying what it believes is a central problem, the team then generates new, creative ideas to address it. Prototyping follows which means embodying the idea in some physical form. Testing with stakeholders then provides feedback on whether the prototype merits further development. If the prototype survives the testing process, it is implemented into practice.

[7] Other designers offer variants of the design process (e.g. Liedka & Ogilvie, 2011), but for this brief overview, I focus on the Stanford D School's Design Thinking approach which has informed my design work. See the Stanford D School Website for additional details.

- The advantage of a design strategy in wicked problem territory is its emphasis on the future and the learning, experimentation, creativity and innovation that it generates to forge that future. But having some success with new ideas and solutions at a "local" level, we have no guarantee that the prototypes will be successful at a global level. The disadvantage is that ideas and solutions in one context may not transfer well to other contexts.

Implications for Those Venturing into Wicked Problem Territory

Dealing with High Levels of Conflict. High levels of conflict alert us to wicked problem territory, especially when people are more intensely focused on their disagreements rather than searching for some areas of agreement. Sometimes the issues are so threatening and heated that people can't be in the same room together. Diplomats and mediators have developed a technique to deal with these extreme situations—they refer to it as "shuttle diplomacy." A third party serves as an intermediary who shuttles back and forth between or among principals in a dispute without any direct principal-to-principal contact. The term was first applied to Secretary of State, Henry Kissinger's efforts to facilitate the cessation of the hostilities that followed the Arab-Israeli War in 1973.

My personal test of wicked problem territory is what it feels like to be caught in it.[8] For me it is the churning in the pit of my stomach when I realize that there is no way out and whichever way I turn there I likely to be more conflict and confusion. My first instinct to engage in some mind-numbing activity to help me forget the whole damn mess. My second reaction is to fight the inclination to blame someone or some "thing" for the discomfort I feel. What I have learned is that each person has to be

[8] I have used the design strategy in projects to forge Norway's Special Operations Command (Berg-Knutsen and Roberts, 2015), craft strategy for various Special Operations commands (Roberts, 2017), and currently I am engaged in the redesign the Palestinian Authority Security Forces. See also Arquilla and Roberts (1917) on the topic the *Design of Warfare*, and our forthcoming monograph on *Designing Grand Strategy*.

prepared to handle the uncertainty, ambiguity, and sense of helplessness these problems engender. If your territory is truly "wicked," your life and the lives of others may depend on your ability to say calm and centered despite the conflict and chaos that surrounds you.

Social Construction of Problems and Solutions. Problems and their solutions are socially constructed (Wittgenstein, 1958). They depend on our values, beliefs and preferences. We label things; we define what problem and solutions are and aren't. So the USSR was a US *partner* against Hitler's Nazi Germany in WWII. The USSR was a US *enemy* in the Cold War. And when the USSR officially ceased to exist on 31 December 1991, Russia and the US became *bilateral collaborators* on a host of economic, commercial, regional, and security issues. After Russia's support for separatists fighting in Ukraine, its invasion, occupation, and annexation of Crimea, its backing of Bashar al-Assad of Syria, and its meddling in the US election, Russia and the U.S. are now _____ (fill in the blank).

Thus, solving problems in wicked problem territory first requires our interpretation, structuring, and labeling of people, things, and events. There are no "givens" to define problems or their solutions. And, as suggested above, people can tolerate different levels of ambiguity and uncertainty in problem solving. When the levels of discomfort, frustration, and anxiety rise beyond one's comfort zone, some prematurely use language and actions to lock down and bound problems and their solutions. What is wicked is reframed as complex or preferably simple to minimize the time and resources "wicked problems" require and to avoid the aggravation and dis-ease they engender. Locked-downs also give us false assurance that we are "in control" of ourselves and the world around us.

Lack of Conflict Doesn't Mean We Have the "Facts." A lack of conflict about a problem should not be confounded with an understanding of the "facts." Suppose we all agree that the earth is the center of our solar system, and at one point in history most of us did. There were few problems with that position at least until Nicolaus Copernicus published *De Revolutonibus* in 1543 which contained his

heliocentric model of the universe. Although Copernicus managed to escape the wrath of the Catholic Church, Galileo who followed him didn't (Shea and Artigas, 2005). Describing his observations made with his new telescope, Galileo began promoting Copernicus' heliocentric theory. When he published *his Sidereus Nuncius* (*Starry Messenger*) in 1610, describing his observations and discoveries that the sun was the center of our world and the earth moved around it, he prompted strong opposition from within the Catholic Church. His first rebuke in 1616 resulted a ban of his book and an order to abandon the heliocentric idea and to abstain from teaching, defending, or discussing his ideas either orally or in writing. When he continued to write--*Dialogue Concerning the Two Chief World Systems—he* was he was ordered to stand trial in 1633. Galileo was interrogated, threatened with physical torture, tried, found guilty of heresy, and sentenced to indefinite imprisonment. His sentence was commuted to house arrest which he served until his death in 1642. His offending book was banned and publication of his past and future work forbidden. There are many ironies in this short narrative the least of which is that neither the earth, nor the sun are the center of our world, and now we are not even sure how many worlds and universes do exist. Although many think science moves us beyond wicked problem territory in "rational" discussions of our physical world, others remind us that conflict over the earth still generates a great deal of heat. Many of our problems are due to our own ignorance. Often we simply do not know what the "facts" are the worst part is that we do not know that we do not know. The unknown unknowns should make us all less contentious and argumentative and more thoughtful and humble, certainly when venturing into WPT.

Separating Complex Problems from Complicated Ones. In the complex problem territory as defined above we find conflicts over problems or their solutions. But even though we may reach a consensus about a problem or its solution, complications do occur as the small pox case illustrates. The eradication of small pox was complicated; it involved many different people, organizations, and countries and required the application of well-established, standard operating procedures to deal with

the disease. In 1972 a major European outbreak occurred in Kosovo, Yugoslavia. A pilgrim returning from Mecca via Iraq, spread the virus to 175 friends, relatives and hospital personnel killing 35. When the virus reached Belgrade, Tito's Communist government declared martial law, enforced quarantine, enlisted the help of WHO and launched a vaccination campaign to prevent the epidemic's spread outside Kosovo. All public events were forbidden, including weddings. No one was permitted in or out of the area unless vaccinated. The work was exhausting, with no time off including holidays or Sundays. "In the end almost the entire Yugoslavian population of 18 million people was vaccinated" (Flight, 2010). Although the causes and solutions to combat small pox were known and understood, it still was complicated to quarantine a large number of people in a large geographic area in a short period of time to avert a pandemic. Routines and protocols continued to improve over the years with D.A. Henderson's more targeted strategy of containment and surveillance (Flight, 2010). When an outbreak would occur, a World Health Organization team arrived, vaccinated and isolated those were ill, and then traced and vaccinated all their contacts. The idea was to "fence" the virus and prevent it from moving to others outside the fence. The team also travelled with a "recognition card" to show what the disease looked like and offered rewards to encourage people to report any cases. The entire eradication process became less complicated and more medically efficient than vaccinating a whole country.

Be Wary of Those Offering Quick Fixes to "Wicked Problems." "Wicked problems" are *au courant*. It may be that the growing references to them in the academic and popular press reflect their actual increase. If so, then we need to explore what seems to be driving our world more and more into wicked problem territory, a subject certainly worthy of exploration. (Appendix B may be a starting point to identify some potential causes or determinants). On the other hand, the label of "wicked problem" may be simply an attention-grabbing device that is used without concern for conceptual clarity or its application. When people tell me they can "tame," "manage," or "solve" our "wicked problems" and offer "quick fixes" then I question whether the problems they are dealing are truly "wicked." Baring

miracles or some yet-to-be-invented technology, these types of problems will not be tamed, managed, or solved, certainly not in the short term. I don't mean to say we should stop trying to tackle them. Indeed, the primary goal in my research has been to find problem solving strategies that may serve us better than the ones we currently employ. It just means we need to be realistic in what we are up against and prepared to deal with the dis-ease and frustrations in dealing with problems we can't seem to define and solutions that defy our best attempts at resolution.

Insert Figure 1

Roberts' Problem Territory Matrix

Levels of Conflict about the Solution

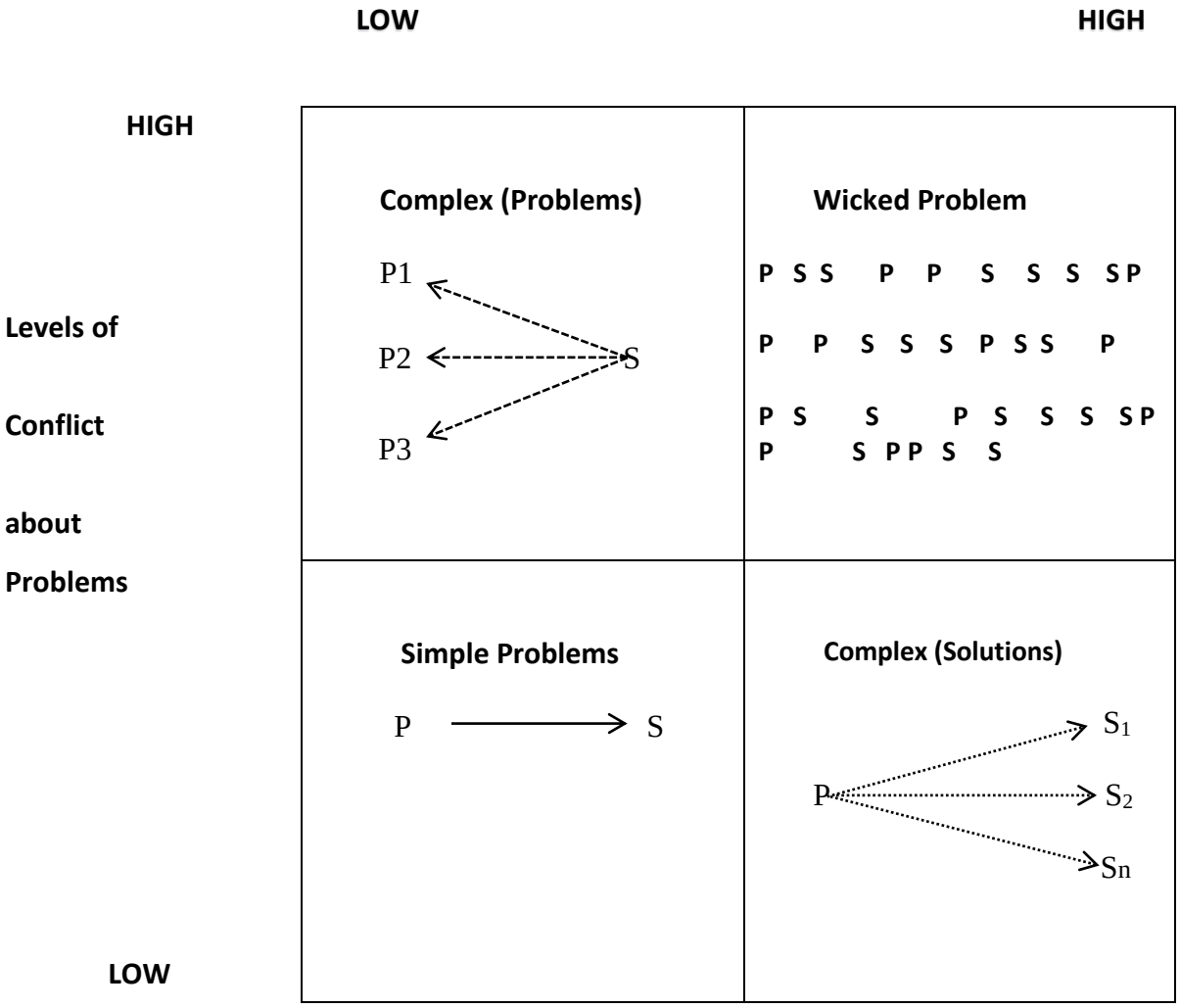
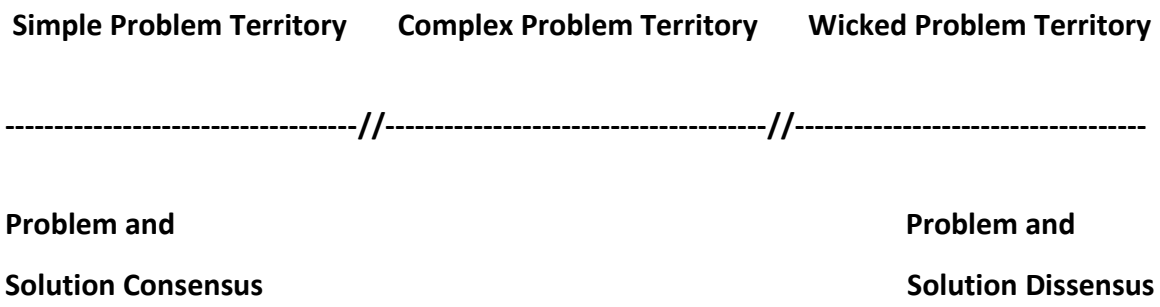


Figure 2

Problem Solving Dimension



***** The hash-marks denotes the potential location of "cut scores" that might differentiate problem territories.

Table 1: Major Strategies in Wicked Problem Territory

Strategy	How conflicts end	Advantage	Disadvantage
Competitive	By winning	Conflict "finished"	Spawns more conflict
Authority	By leaders	Someone in charge	Can be wrong
Rational-Analytic	Rational process	Logical steps	No problem agreement
Taming	Chunking; Bounding	Easier to tackle	Limits seeing the whole
Collaboration	Win-Win	Get buy-in	Large numbers
Design	Design Thinking	Creative Learning	"Local" innovation

Appendix A

Rittel and Webber's Comparison between Tame and Wicked Problems

Problem Elements	Tame Problems	Wicked Problems
Problem Solving	Problems can be bounded and well specified.	Problems are difficult to bound. Every problem can be considered to be a symptom of another problem—a system of interconnected problems.
	Root causes of problems can be identified.	There are no identifiable root causes.
	Problems can be addressed in a linear and standardized way.	Every problem is unique. There is no agreed upon routine or standard procedures to deal with them.
Problem Definition	The problem can be clearly defined.	The problem is difficult to define. People perceive the problem differently.
	There is agreement on the problem statement.	There are many different problem statements.
Problem Solutions	Solutions can be identified.	The search for solutions stops when people run out of time, resources, and political will.
	Criteria used to select a solution are well defined.	No single set of criteria exists to select a solution. Criteria selected depend on problem solvers' preferences.
	Criteria are accepted by all.	Criteria are not accepted by all.
	Criteria are applied and solutions are eliminated until the "best" solution is found.	Solutions are reviewed and selected based on selective judgements--which are "better than" or "worse than" others.
	There is agreement on the "best" solution.	There is no agreement on a solution, or a "best" one.
Consequences	Are well specified and understood; the problem solver knows when she has succeeded or failed.	Problems do not have an end point. In the worst case, there are unintended consequences that make the problem worse.
	Problem solving process can be repeated and get the same solution.	Each problem is a one-shot operation. Once a solution is attempted, you can't undo it.

Appendix B

Summary of Some Wicked Problem Characteristics

Source	Problem Definition	Solution Generation and Selection
Rittel & Webber (1973)	1. Wicked problems have no definitive formulation.	1. There are no definitive solution formulations, or an enumerable or exhaustively describable set of potential solutions, or “classes” of solutions to apply to a wicked problem.
	2. Every wicked problem can be considered a symptom of another problem.	2. Solutions to wicked problems are not true-or-false but good-bad.
	3. The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem resolution.	3. There is no immediate and ultimate test of a solution to a wicked problem.
	4. Every wicked problem is essentially unique.	4. Wicked problems have no stopping rule.
		5. Every solution to a wicked problem is a "one-shot operation." Because there is no opportunity to learn by trial-and-error, every attempt counts significantly.
		6. Planners have no right to be wrong.
Ackoff (1974)	5. Messes-- every problem interacts with other problems and produces a set or system of interrelated problems.	
Horn & Webber (2007)	6. Competing views of the problem; value conflicts	7. Value conflicts produce contradictory solutions
	7. Data about the problem/s are uncertain or missing.	8. Data about the solution/s are uncertain or missing.

	8. Problems are constrained ideologically, politically, economically	9. Solutions are constrained: ideologically, politically, economically
	9. Problem framing involves a-logical or illogical or multi-valued thinking	10. Solutions involve a-logical or illogical or multi-valued thinking
	10. Considerable complexity, uncertainty, ambiguity	11. Solutions can involve numerous possible intervention points in a system
		12. Problem solver(s) are out of contact with the problem s and potential solutions
		13. Solutions face great resistance to resolution.
Australian Public Service Commission (APSC 2007)	11. Responsibility for problems stretch across many organizations.	14. Solutions require but lack coordinated action by a range of stakeholders, including government at all levels, nonprofits, and private businesses and individuals.
	12. Problems have many interdependencies and are often multi-causal.	15. Solutions lack holistic, non-linear thinking; flexible approaches, toleration of ambiguity, long-term focus.
	13. Problems are not stable; they often are a moving target	16. Traditional solutions (levers to change behavior) do not work; they lack innovative, personalized approaches that citizens may use to generate their own solutions.
	14. Problems are intractable	17. Solutions have failed
Lazarus, (2009)	15.Time is running out to address super wicked problems	18. Solutions are time sensitive; the longer we wait the more difficult the solutions will be.
	16. Those seeking to solve super wicked problems are also causing them.	19. Short-term interests and solutions trump long-term need and gains.
	17. People have cognitive tendencies and limitations that make it difficult to identify problems and their causes.	20. Solutions lack institutional frameworks to develop, implement, and maintain laws to deal with wicked problems.
	18. Super wicked problems have tremendous spatial and temporal scope.	

Levin *et. al.* (2012)	19. We lack analytical tools to deal with wicked problems.	21. There is hyperbolic discounting in solutions: a preference for rewards/solutions that are received sooner rather than later and irrationally discount the future.
	20. We lack applied-forward reasoning about wicked problems.	22. Solutions lack path-dependent, incremental policy interventions to ‘‘constrain our future collective selves.”
Ansell & Bartenberger (2017)	21. Unruly problems are highly variable.	23. Difficult to develop a standardized strategy of response and when we do the results may themselves be highly variable.
	22. Unruly problems are perceived as *inconsistent*. They often create simultaneous demands that raise vexing tradeoffs in an atmosphere of time compression and urgency.	24. Decision makers under these conditions can produce outputs that amplify inconsistencies.
	23 Unruly problems are often *unexpected*. We learn about such problems abruptly, when we are least prepared to address them and thus they are unsettling and produce confusion.	25. Solutions produce unintended consequences.
	24. Unruly problems are *unpredictable*. We may expect the problem but be unable to predict how or where it will manifest itself.	26. When we intervene to solve an unruly problem, are unable to predict how upstream conditions will affect downstream conditions.

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