PROBLEM STRUCTURING IN PUBLIC POLICY ANALYSIS

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INTRODUCTION

The primary focus of this article is problem structuring in public policy analysis. Problem structuring refers to the use of systematic procedures for structuring as well as solving problems that are ill-defined, ill-structured, or wicked. In this article, these procedures are presented as part of a suite of problem solving methods used in public policy analysis. Drawn from multiple disciplines, methods of policy analysis are designed to assist policymakers in making better decisions. This article focuses on methods of policy analysis designed to structure policy problems--hence, methods of *problem structuring*. Other important methods of policy analysis are treated secondarily, as illustrations of the important connections between problem structuring, on one hand, and policy forecasting, policy prescription, policy monitoring, and policy evaluation. As will become apparent in the course of this article, problem structuring in the central guidance system of policy analysis.[1]

The article addresses six aspects of problem structuring:

- The Process of Problem Structuring
- Problem Structuring in Policy Analysis
- Types of Policy Problems
- The Congruence Principle
- Methods for Second-Order Problems
- Evidence-Based Problem Structuring

[1] The field of policy design is also committed to assist policymakers make better decisions. Although policy design will be addressed only indirectly, this article incorporates and addresses works on policy design including Dryzek (1983); Linder and Peters (1985); Miller (1985); Bobrow and Dryzek (1987); Howlett (2011); and Peters and Rava (2017).

THE PROCESS OF PROBLEM STRUCTURING

A central aspect of problem structuring is what John Dewey called a *problem situation,* by which he meant an indeterminate set of conditions that may give rise to the formulation of a problem. In public policy, the indeterminacy of problem situations is characterized by Rein and White (1977: 262) as "diffuse worries and inchoate signs of stress."[2] An example of a problem situation is the diffuse worry that the height of water in the canals traversing the state of Florida are rising faster than anticipated, creating stress among residents and business owners. However, problem situations are not problems; problems are products of thought interacting with problem situations. "Problems are elements of problem situations that have been abstracted from these situations through analysis" (Ackoff 1974: 21). Problems are not "out there" in the world, disembodied and waiting to be discovered, like Columbus discovering America.

Of pivotal significance is that problems do not exist apart from the humans who sense and analyze them. Returning to the example of the Florida canals, the problem is a product of the disagreement over the extent to which sea levels are rising; some citizens are unwilling to pay for the spillways that siphon the canal water into holding pools, where the water is converted into potable form. There are also disagreements over the level of water purity required to qualify as "potable." However, the formulation of the problem may ignore the disagreements, structuring the problem in terms of relations among three physical properties. It might then be transformed into a linear equation, where Y = the height of the water above sea level, $_{X}b_1$ is the number of spillways of a given volume, and $_{X}b_2$ is the level of water in the holding pools. Presented in this way, it appears to be a well-structured problem. But it neglects the fact that the problem is formulated in different ways by the stakeholders, making it an ill-structured problem that is unlikely to be resolved by conventional methods such as regression analysis.

To bring clarity to the process of problem structuring, it may be represented as a flow chart. Figure 1 shows that the process of problem structuring does not ordinarily begin with problems, but with problem situations. For John Dewey and other pragmatists, problem

[2] Dewey, aware of the logical trap of relativism, was no epistemological relativist. However, wary of dogmatic uses of the term "truth," he redefined the concept, critically and reflectively, as "warranted assertibility." Pragmatists such as Abraham Kaplan (1968: xx), in stressing the pragmatist rejection of dualities, uses Dewey's term "objective relativism."

situations are composed of unsettled beliefs, or doubts, followed by processes of "fixing beliefs," beliefs in which there is sufficient trust to become instruments of action.

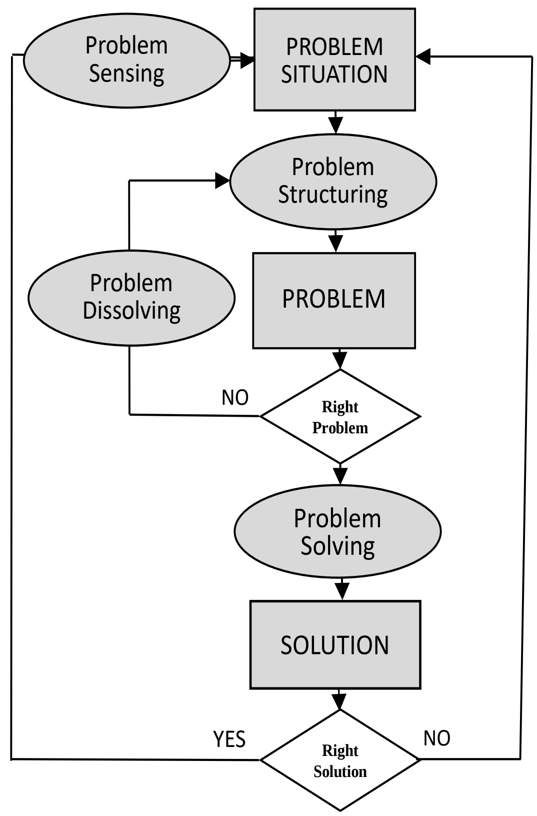


Figure 1: The Process of Problem Structuring
Source: Adapted from Dunn, "Methods of the Second Type: Coping with the Wilderness of Conventional Policy Analysis," *Policy Studies Review* 7, 4 (1988): 720–37.

Problems do not stay solved; they may be *resolved, unsolved,* or *dissolved,* as shown in Figure 1. The terms problem resolving, problem unsolving, and problem dissolving designate three types of error correction.[3] Although the three terms come from the same root (L. *solvere,* to solve or dissolve), the error-correcting processes to which they refer are different. *Problem resolving* involves the reanalysis of a correctly structured problem to reduce calibrational errors. *Problem unsolving,* by contrast, involves the abandonment of a solution based on the wrong formulation of a problem and a return to problem structuring in an attempt to

[3] Russell L. Ackoff, "Beyond Problem Solving," *General Systems* 19 (1974): 237–39.

formulate the right problem. Finally, *problem dissolving* involves the abandonment of an incorrectly formulated problem and a return to problem structuring, thus starting the process anew. Finally, because problems do not stay solved, identifying the right problem may later mean a return to problem sensing and the detection of new worries and signs of stress.

Problem structuring methods provide a methodological complement to theories of policy design. Arguably, structuring a problem is a prerequisite of designing solutions for that problem.[4] In this context, problem structuring methods are *metamethods.* They are "about" and "come before" processes of policy design and other forms of problem solving.

PROBLEM STRUCTURING IN POLICY ANALYSIS

Problem structuring is designed to improve the informational content of problems. One framework for depicting this aim is Figure 2, which shows the role of problem structuring in producing different types of information.

Policy Problems

Policy problems are abstractions from problem situations. Information about which problem to solve often requires information about the antecedent conditions of a problem (e.g., rising water levels in canals) and information about the values that drive solutions of the problem (e.g., potable water). Information about policy problems typically includes alternative solutions and, if available, the probabilities that each alternative solution is likely to lead to a solution. If these requirements are met, the problem is usually described as a well-structured problem that might be stated in the form of a regression equation. Information about policy problems plays a critical role in policy analysis, because the way a problem is structured governs the identification of solutions. Inadequate or faulty information may result in serious or even fatal errors, errors that Raiffa (1968: 264), Mitroff and Featheringham (1974), and Mitroff and Mason (2012) have described as *formulating the wrong problem*, which they distinguish from statistical errors resulting from setting the confidence limits too high or too low in testing the null hypothesis (Type I and Type II errors). Formulating the wrong problem (Type III error) is conceptual rather than statistical or mathematical.

[4] Peters and Rava (2017: xx) observe that xxxx

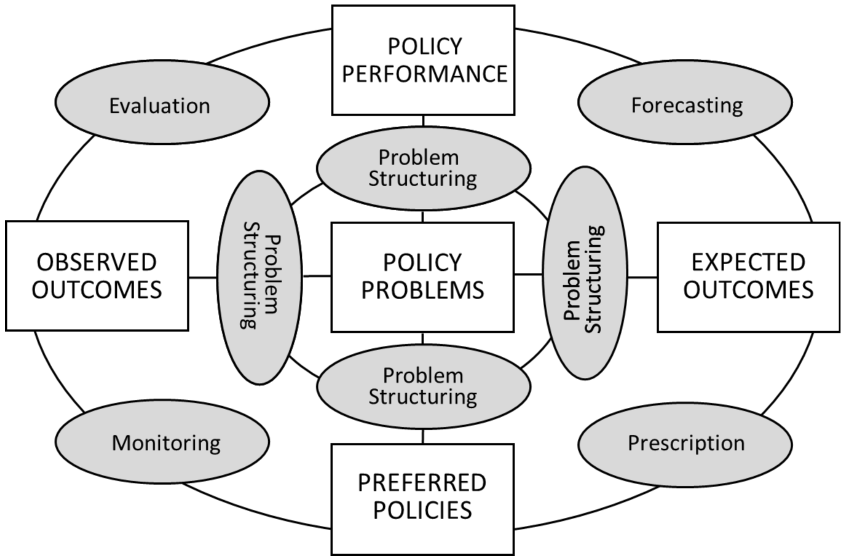


Figure 2
Problem Structuring Produces Different Types of Information
SOURCE: Adapted from Dunn (2018), p. 6.

Expected Policy Outcomes

Expected policy outcomes are likely consequences of two or more policy alternatives designed to solve a problem. Information about expected policy outcomes, which is generated through methods of forecasting and modified by problem structuring, is also susceptible to Type III errors. Information about expected policy outcomes may be errorful because the past does not repeat itself, because the values that shape behavior may change in future, and because some outcomes may by omitted from a forecast. In his study of forecasting errors Ascher (1978) has shown that errors in forecasting energy demand, employment, and other expected policy outcomes are created by unrecognized assumptions that he calls "assumption drag," assumptions that pull forecasts in unexpected and errorful directions. Ascher's findings show that information generated by means of forecasting methods is not "given" by the existing situation. For this reason, problem structuring is an important potential corrective.[5]

[5] Successful problem structuring may require creativity, insight, and the use of tacit knowledge. Books that address creativity, insight, and tacit knowledge are Yehezkel Dror, *Ventures in Policy Sciences: Concepts and Applications* (New York: American Elsevier Publishing, 1971); Sir Geoffrey Vickers, *The Art of Judgment: A Study of Policy Making* (New York: Basic Books, 1965); and C. West Churchman, *The Design of Inquiring Systems; Basic Concepts of Systems and Organization* (New York: Basic Books, 1971. The concept of tacit knowledge is attributed to Michael Polanyi, *Personal Knowledge* (Chicago: University of Chicago Press, 1958).

Preferred Policies

A preferred policy is a potential solution for a problem. To select a preferred policy, it is necessary to have information about expected policy outcomes as well as information about the value of those outcomes. Stated another way, factual as well as value premises are required for any prescription. That one policy is more effective than another does not alone justify its choice. Factual premises must be joined with values such as enlightenment, wealth, equality, efficiency, security, or democracy. One of the more difficult tasks of problem structuring is identifying potential solutions for problems. Preferred policies for mitigating global warming, for example, are economic, political, institutional, cultural, biological, ethical, and all of these. They are not well-structured problems.

Observed Policy Outcome

An observed policy outcome is a present or past consequence of implementing a preferred policy. It is sometimes unclear whether an outcome is actually an effect of a policy. Some effects are not *policy* outcomes, because many outcomes are the result of extra-policy factors. It is important to recognize that the consequences of action cannot be fully stated or known in advance, which means that many observed outcomes are unintended. Information about observed policy outcomes is produced by a combination of monitoring and problem structuring after policies have been implemented. Here the problem is to identify observed policy outcomes after they occur.

Policy Performance

Policy Performance is the degree to which an observed policy outcome contributes to the solution of a problem. In practice, policy performance is always imperfect. Problems are rarely "solved;" more often they are resolved, dissolved, or unsolved (Figure 1).[6] To know whether a problem has been solved requires information about observed policy outcomes, as well as information about values. A combination of methods of evaluation and problem structuring help create information about the extent to which policy outcomes contribute to the achievement of values that gave rise to a problem.

[6] Russell L. Ackoff, "Beyond Problem Solving," *General Systems* 19 (1974): 237–39.

Informational Transformations

In Figure 2, the solid lines connecting each pair of informational components (outer circle) represent *informational transformations*, where one type of information is changed into another. The creation of information at any point depends on information produced in an adjacent phase. Information about policy performance, for example, depends on the transformation of prior information about observed policy outcomes. The reason for this dependence is that any evaluation of how well a policy achieves its objectives assumes that we already have reliable information about the outcomes of that policy. Note that types of information are connected with solid lines, rather than arrows, in order to show that information can be transformed in a backward as well as forward direction. Hence, the process of transformation is rarely linear; more often it is a complex process of adaptation to newly created information, which becomes the basis for a new transformation cycle.

Information about policy problems is a special case, because it is related to other types of information. Problem structuring may result in the inclusion of some types of information—for example, information about preferred policies or observed policy outcomes—while other information is excluded. What is included or excluded in structuring a problem affects which policies are eventually prescribed, which values are chosen to assess policy performance, and which expected outcomes warrant or do not warrant attention. Critical elements of a problem situation may lie outside the boundaries of a given problem representation; what is unrecognized and unknown cannot be understood or anticipated. Inadequately trained technicians at nuclear power facilities may endanger millions of citizens by searching for air leaks with candles (Fischhoff, 1977), warnings placed on cigarette packages may exclude other opportunities to deal with significant public health problems such as nicotine addiction (Sieber, 1981), and the institutionalization of pretrial release without systematic analysis of causal relations actually may increase the jail population (Nagel and Neef 1976). A fatal error in problem structuring is a Type III error: Formulating the wrong problem.[7]

A Case of Successful Problem Structuring

[7] Type I and Type II errors are also known as false positives and false negatives. Other sources on Type III errors include A. W. Kimball, "Errors of the Third Kind in Statistical Consulting," *Journal of the American Statistical Association* 52 (1957): 133–42; and Ian I. Mitroff, *The Subjective Side of Science* (New York: Elsevier, 1974).

The following story illustrates successful problem structuring and the mitigation of a Type III error. Imagine an office building that has insufficient elevator service for a growing number of employees and tenants.[8] The manager had been receiving a growing number of complaints about the elevator service, which was producing long waiting times. She attributed the problem to conversations initiated by a few unhappy employees. When tenants threatened to move out, and the performance of employees was being compromised, a solution had to be found.

The manager called on a group of consulting engineers who specialized in the design and construction of elevators. After structuring the problem, the engineers identified three options: add more elevators; replace the existing elevators with faster ones; or add a computerized control system so that elevator service could be optimally routed for faster service. After the manager looked at the costs of each option, she found that the cost of any of the three alternatives was not justified by the income generated by renting the building. None of the alternatives was acceptable.

The manager called an urgent meeting of her staff and presented the problem situation in a *brainstorming* session, which is a popular and widely used method of problem structuring. Many suggestions were made and then discarded. During a break a young assistant in the human resources department, who had been quiet to this point, made a suggestion which was eventually accepted by everyone. Full length mirrors were installed on the walls of the elevator lobbies on each floor. Subsequently, the waiting times seemed short, because the complaints had come from the boredom of waiting for the elevators. Yet the time only seemed long. Employees now had opportunities to look at themselves and others in the mirror, often without appearing to do so.

A system of problem representations created by a manager, consulting engineers, disgruntled employees and tenants, and a young staff member was complex because multiple stakeholders interacted to produce different representations of the problem. Yet the consulting engineers, the employees, the tenants, and the manager had committed Type III errors. Although each problem representation was well-structured by the stakeholders, they had formulated the

[8] Adapted from Russell Ackoff, *The Art of Problem Solving* (New York: Wiley-Interscience, 1978), “Fable 3.2 An Ups-and-Downs Story,” pp. 53-4.

wrong problem. Consequently, they also concluded, falsely, that there was no solution.[9] When assessed against the original problem situation, one of these formulations--the installation of mirrors--was correct. The others were Type III errors.

Purposeful Systems

Situations such as the "elevator problem" may be regarded as purposeful (teleological) systems (Mitroff and Blankenship 1973: 341-42). What makes purposeful systems complex are the multiple problem formulations of stakeholders with different experiences, information, assumptions, and goals. For example, an apparently well-structured and soluble problem—whether the government should impose air quality standards on industry—is actually a system of conflicting representations of a problem:[10]

1. Pollution is a natural consequence of capitalism, an economic system where the owners of industry seek to increase profits from their investments. Some damage to the environment is a necessary price to pay for a healthy capitalist economy.
2. Pollution is a result of the need for power and prestige among industrial managers who seek promotions in career-oriented bureaucracies. Pollution has been just as severe in socialist systems, where there are career-oriented bureaucracies but no profit-seeking private owners.
3. Pollution is a consequence of consumer preferences in high mass-consumption society. In order to ensure corporate survival, owners and managers must satisfy consumer demand for high-performance engines and automobile and air travel.

Policy problems are subjectively meaningful representations of problem situations; they are not discrete material or mechanical entities. Most stakeholders are not identical in all or even any of their subjectively meaningful problem representations or acts; the problem representations and acts of each stakeholder have an effect on the representations and acts of the system as a whole; the representations and acts of each stakeholder, and the way each affects the system as a whole, depend on the representations and acts of at least one other

[9] Another example of a prototypical Type III error is the aphorism popularized by Aaron Wildavsky: "No solution, no problem." See Wildavsky's Preface to *Speaking Truth to Power: The Art and Craft of Policy Analysis* (Boston, MA: Little Brown, 1979).

[10] See Ritchie P. Lowry, *Social Problems: A Critical Analysis of Theories and Public Policy* (Lexington, MA: D. C. Heath and Company, 1974), pp. 23–25.

stakeholder; and all possible subgroups of similar stakeholders have a non-independent effect on the system as a whole (Mitroff and Blankenship, p. 341). In short, problems are complex because multiple policy stakeholders hold different formulations of the "same" problem situation. Aspects of the external environment that constitute the problem situation intersect with multiple representations of that problem situation.

TYPES OF POLICY PROBLEMS

Three types of policy problems have been identified in the literature of problem structuring.[11] These problem types have been placed on continua with two poles[12] defined according to the relative simplicity or complexity of the system of problem formulations of which they are a part.

Ill-Defined versus Well-Defined Problems

The oldest classification of problems in planning, management, and public policy is that of Walter Reitman (1964: 282-315). Reitman used the term *ill-defined*, which was subsequently replaced by the term *ill-structured* by Herbert Simon (1973: 181-201). The distinction between ill-defined and ill-structured is of methodological importance, as the terms *defined* and *structured* correspond to *delineated* and *arranged*. To define or delineate a problem is to identify the elements or properties that constitute that problem, that is, belong within its problem space or problem boundaries. By contrast, to structure a problem is to arrange or regulate the elements within that space or boundary in a particular way. The example of a pyramid is instructive. A pyramid is a pile of stones and a specific kind of architectural structure. In the case of the pile of stones, problem structuring refers to the delineation or definition of elements, while in the second the elements have been arranged or structured in the form of a pyramid. The first is a necessary condition of the latter. David Dery (1974) makes a similar distinction between constitutive and regulative problem structuring procedures (Dery uses the term defining). Of interest is the extent to which these terms are a part of the "culture" of problem structuring, as found in the world literature published in (American) English between 1965 and 2008. Shown as a Google n-gram in Figure 3, the frequency of use for the word ill-structured problem is

[11] Schwenk and Schon (1987) also identify what they call problems of the "swamp" and the "high ground."
[12] Mitroff and his colleagues also identify problems that lie somewhere close to the midpoint of the continuum. These are called moderately structured problems.

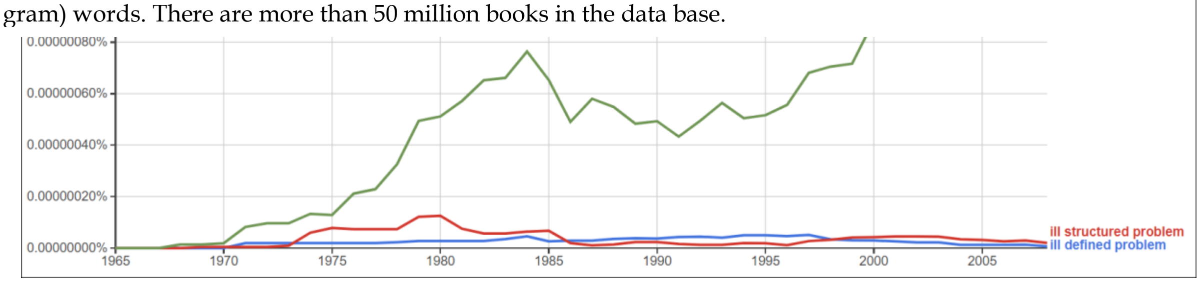
roughly the same as the word ill-defined problem. The frequency of use of the term "wicked

Figure 3: Frequency of Use of Terms Designating Three Types of Problems, 1965-2008

problem" is far greater in this period.

SOURCE: Jean-Baptiste Michel et al., "Quantitative Analysis of Culture Using Millions of Digitized Books." www.sciencemag.org/content/early/2010/12/15/science.1199644

NOTE: Google N-gram is an online search engine that charts frequencies of any set of words found in sources printed between 1500 and 2008. Words found in 40 or more books are then plotted on a graph. The relative frequencies on the vertical axis show the words "wicked problem," "ill-defined problem," and "ill-structured problem" as a percentage, or relative frequency, of all words in the data base with two (bi-gram) or three (tri-gram) words. There are more than 50 million books in the data base.



Wicked Versus Tame Problems

The second oldest classification is that of Churchman (1967), who designated such problems as *wicked* at one end of a continuum and *tame* at the other.[13] Rittel built on Churchman's concept shortly thereafter (see Kaburskis 2008) and Rittel and Melvin Weber (1973) then expanded on

[13] A search of Google N-gram uncovered the use of the term "wicked problem" in 1897 by Ernest Edward Kellett in a book of verse titled *Jetsam* (Cambridge: E. Johnson, 1897). Kellett used the term to describe examination questions at Cambridge which were unanswerable because of their complexity and the fact that there were no readings available to find the answer.

these concepts by identifying ten characteristics of wicked problems. Although the term "wicked" has the ethical connotation of something that is bad or evil, this was not Churchman's meaning of the word wicked, which he employed to call attention to the responsibility of consultants to inform clients that it is unlikely or impossible that such problems can be solved, at least with conventional quantitative methods available to the planning and operations research communities. Rittel and Weber (1973) used "wicked" in a similar sense to stress that planners and policy analysts may not be politically and morally responsible for their actions when commissioned to solve such problems. By contrast, at the other end of the continuum, "tame" was equated with actions that are "satisficing" or "good enough." Robert Horn (2007) has also described wicked problems in terms of the characteristics of wicked problems listed by Rittel and Weber (1973). Horn recommends visual analytics--for example, murals, wall displays, and computer graphics-- to structure wicked problems which, following Ackoff, he also calls "messes." Visual analytics are used with interactive groups of stakeholders tasked with structuring wicked problems.

Ill-structured versus Well-structured Problems

The term ill-structured problem is placed at one end of the continuum on the basis of the relative complexity of the system of problem formulations that have been advanced, or that remain undiscovered and latent, among stakeholders. The chronology of ill-structured problems begins with Herbert Simon (1973), Francisco Sagasti (1973), Ian Mitroff (1974), and Mitroff and Featheringham (1974). Figure 3 shows that the frequency of use of the concept between 1965 and 2008 is roughly equal to that of the ill-defined problem, but far less than the term wicked problem. A prototypical ill-structured problem in artificial intelligence is Herbert Simon's story the architect who has been commissioned to build a custom home for which there are no standard plans. The architect must develop an appropriate floor plan, decide on how many floors the home will have, which building materials to use (woods, plastics, tile, slate, marble), all the while communicating with his client to see if his formulation of the problem conforms to their definition of a "custom" home. Simon stresses that ill-structured problems such as this become well-structured in the course of their solution, arguing that there is no reason to suppose that new and unknown methods are needed to solve ill-structured problems.

Ill-structured problems are not confined to technical domains such as artificial intelligence. Simon also sees no need for special methods to solve ill-structured problems in real-world policy contexts such as designing and building a new battleship for the British Navy. Here, there are many stakeholders, ranging from the First Sea Lord, the Director of Naval Construction, the Controller, the Director of Naval Ordinance, the Director of Torpedoes, the Director of Electrical Engineering, and so forth, all of whom work on relatively well-structured problems within their domain of responsibility. The overall problem of designing and building the ship, however, is an ill-structured or wicked problem. The process of structuring the problem is based on setting rules for coordinating the actions and communications of the various units, accessing each of their long-term memories of past ships that had been constructed and engaging in recurring meetings to share information. Initially, the overall problem was ill-structured, because it was composed of competing well-structured problems involving different goals, objectives, processes, and materials. Collaboration over time under the direction of the First Sea Lord gradually transformed the ill-structured problem into a well-structured problem whose solution took the specific form of a new battleship commissioned by the British Admiralty. This example holds important lessons for problem structuring, as well as policy design, under conditions represented as ill-structured problems of public policy.

Well-Structured Problems in Decision Analysis

The literature on the definition of well-structured and ill-structured problems is sometimes ambiguous. A clear definition of a well-structured problem has been advanced in the domain of decision analysis. This simplifies the effort to define an ill-structured problem as a residual entity. Mitroff (1974) and Mitroff and Blankenship 1973) define a well-structured decision problem in terms of decision makers, preferences, alternatives, outcomes, and states of nature. In this context, states of nature refer to probabilities of events over which the decision maker has no control. A well-structured decision problem is one where relations among a decision maker (Di), preferences or utilities (Uij), alternatives (Ai), outcomes (Oj), and states of nature (Sj) are certain (deterministic), probabilistic (based on empirical frequencies), or uncertain (based on Bayesian subjective probabilities). Well-structured problems "are problems about which enough is known … that problems can be formulated in ways that are susceptible to precise analytic methods of attack" (Mitroff, 1974, p. 224). In principle, problems in applied economics can be structured according to transitive preferences among individuals. If alternative A_1 is preferred to alternative A_2, and alternative A_2 is preferred to alternative A_3, then alternative A_1 is preferred to alternative A_3. Of course, preferences may be cyclical rather than transitive, which is a characteristic of an ill-structured or wicked problem. Batie (2008), an agricultural economist, even asks whether applied economics can survive, thrive, and maintain relevancy if it neglects wicked problems.

A Conceptual Framework for Ill-Structured Problems

Ill-structured problems also may be viewed less technically, in terms of a conceptual framework that focuses on policymaking processes (Harmon and King, 1985, p. 28).

Policy Goals

The goals of policy are ambiguous or unknown, so that determining what goals to achieve is part of the problem. "Our problem is not to do what is right," stated Lyndon Johnson. "Our *problem is to know what is right" (quoted by Wood, 1968, p. v).*

Policy Phases

The phases through which goals are to be achieved are indeterminate. Since linkages among phases involve feed-back and feed-forward loops that may occur at any time, the pattern of phases is more like a tangled river network (Beer, 1981, p. 30) than an assembly line, tree, or cycle. There is no assurance that success at one phase will lead to success at another, for example, that adopting an optimal policy alternative will lead to its successful implementation.

Policy Instruments

The policy instruments required to achieve goals are ambiguous or unknown. Information about what policy instruments work best under which conditions is often rudimentary or simply unavailable (Linder and Peters, 1985, 1987). Even when analysts use advanced decision technologies (e.g., computer-designed event and fault trees) they may overlook instruments which are critical to the success of policies. For example, nuclear near-disasters such as the Brown's Ferry fire "was started by a technician checking for an air leak with a candle, in direct violation of standard operation procedures" (Fischhoff, 1977' p. 181).

Policy Problem Domain

The domain of potentially relevant goals, phase patterns, and instruments is unbounded. No exhaustive or even approximate set of goals, phases, and instruments is available. The problem domain appears to be unmanageably huge, with analysts engaged in what Dery (1984, p. 6) calls "a never-ending discourse with reality."

lll-structured problems are not uncommon; they are pervasive (Simon, 1973, p. 186). Their pervasiveness is a consequence of the fact that conflicting representations of problems are continuously created, maintained, and changed by stakeholders who affect and are affected by the problems of modern governments. Analysts expend large amounts of time and energy investigating the conflicting problem definitions of large numbers of policy stakeholders. Such is the case with many health and educational polices, which Sieber (1981) characterizes as "fatal remedies" that arise due to faulty problem structuring. The process of problems representation occurs throughout the policy-making process; it involves legislators and executives as well as street-level bureaucrats (Lipsky, 1971) and ordinary citizens situated at the "periphery" of the policy-making process (Sabatier and Mazmanian, 1983, pp. 149-151). Just as problem structuring procedures are relevant to all types of information (Figure 1), competing problem formulations are distributed throughout the policy-making process. The bulk of studies of individual and group decision making show that policymaking involves bargaining, competition, and conflict. [14] It is seldom possible to identify the broad range of alternative solutions for a problem, in part because of constraints on the acquisition of information, but also because it is difficult to know when we have collected enough information to find a solution. Public organizations (Braybrooke and Lindblom 1963; Lindblom 1959; Lindblom and Woodhouse 1993) as well as corporations (Camillus 2009) typically face ill-structured problems that are not amenable to standard methods of analysis such as those contained in leading texts on policy analysis (e.g., Stokey and Zeckhauser (1979).

[14] See, for example, Thomas R. Dye, *Understanding Public Policy*, 3d ed. (Englewood Cliffs, NJ: Prentice Hall, 1978), pp. 30–31; Richard O. Mason and Ian I. Mitroff, *Creating a Dialectical Social Science* (Dordrecht, The Netherlands: D. Reidel, 1981); and James G. March and Johan P. Olsen, “The New Institutionalism: Organizational Factors in Political Life,” *American Political Science Review* 78, no. 3 (1984): 739–49. Earlier work making many the same points include Herbert A. Simon, “A Behavioral Model of Rational Choice." *The Quarterly Journal of Economics* (1955): 99-118; and David Braybrooke and Charles E. Lindblom. *A Strategy of Decision: Policy Evaluation as a Social Process*. New York: Free Press of Glencoe, 1963.

As already noted, ill-structured problems are residual categories defined in terms of their well-structured counterparts; ill-structured problems are what well-structured problems are not. This is evident when we examine some of the characteristics of wicked problems put forward by (Rittel and Weber 1973). Because the ill-structured or wicked problem is what is left over after considering the deficiencies of well-structured or tame problems, the residue is prone to ambiguity. It appears that one of the advantages of the term "wicked problem," a term that is used with increasing frequency (Figure 3), is its rhetorical power. A wicked problem is one whose solution is urgent, unusually important, impossible to solve accurately, or at all, and perhaps evil or malevolent. By contrast, sixty years ago, in 1967, the term wicked was intended to call attention to the ethical obligations of planning and policy professionals when faced with problems for which there appears to be no solution. At that time, a prime example was the Watts riots in Los Angeles, which provided a worrisome and stressful problem situation for urban planners.

Five characteristics of wicked problems presented by Rittel and Weber (1973) are listed below. Significantly, the characteristics of wicked or ill-structured problems are opposites of tame, or well-structured, problems. Wicked or ill-structured problems, typically created as residual concepts by showing that they are unlike well-structured problems, are especially difficult to define, because they may refer only to what well-dtructured problems are not, but without stating much more than that they are negations.

Tame. There is a definitive solution to a problem.
Wicked Residual. No definitive solutions are known.

Tame. There are criteria for knowing when a problem has been solved.
Wicked Residual. Criteria are unknown.

Tame. There is a stop-rule specifying when to stop collecting information.
Wicked Residual. There is no stop-rule prescribing when to stop collecting information.

Tame. One or a few decision makers are known to have transitive preferences.
Wicked Residual. Transitive preferences are unknown or non-existent.

Tame: Shared values are available to assess outcomes.
Wicked Residual: There is no consensus on values.

Tame. Analysts specify decision makers, alternatives, outcomes, values, and probabilities.
Wicked Residual. Stakeholders arrive at their own specifications through unknown processes.

THE CONGRUENCE PRINCIPLE

Practicing analysts typically face a complex system of problem representations. In effect, they are faced with what Dror has called a metaproblem (Dror, 1971), a problem-of-problems that is ill-structured or wicked because the number of problem representations is large and unmanageably huge. The problem structurer's task is to structure a problem-of-problems, a second-order entity that is the class of all first-order problems, which are its members. Unless the difference between these two levels is recognized and kept analytically distinct, the problem structurer will conflate member and class, ignoring a basic logical rule stated in *Principia Mathematica* by Whitehead and Russell (1910: 37) and applied to the process of problem structuring by Watzlawick, Weakland, and Fisch (1974: 6): "Whatever involves all of a collection must not be one of the collection."

The distinction between member and class is equivalent to the difference between first-order and second-order problems, each of which requires its own methods. Although Simon contended that no special concepts and methods were required to solve ill-structured problems, his close collaborator, Alan Newell, suggested methods of a second type. Newell identified a special class of what Simon called "weak methods" (Simon 1973: 182), by which Newell meant heuristic and qualitative methods, rather than methods that are algorithmic and quantitative (Newell 1969). This distinction permits an assessment of the extent to which particular methods of problem structuring--for example, the method of brainstorming used to structure and solve the elevator problem presented in the last section--are congruent with the level of problem under consideration. The congruence principle has also been advanced by Brewer and DeLeon (1983: 125) in their discussion of a principle stated by mathematician and chaos theorist Leften Zadeh: Conventional scientific methodologies are incompatible with social problems that have exceeded a given threshold of complexity.

The bulk of methods available today are methods of the first type, M1s, that are appropriate for well-structured or tame problems. These first-order methods are well-known to most analysts: input-output analysis, linear programming, microeconomic modeling, land-use analysis, game theory, and some forms of systems analysis (Greenberger, Crenson, and Crissey, 1976). The congruence principle asserts that these first-order methods, M1s, are appropriate and useful for solving first-order problems, but inappropriate for structuring second-order problems that are ill-structured or wicked. Another example of a method of the first type, cost-benefit analysis, is an appropriate and useful first-order method that facilitates the analysis of opportunity costs and tradeoffs by calculating discounted costs and benefits for two or more alternatives. However, cost-benefit analysis is not a second-order method, M2. The generation of policy goals, phases, instruments, and causally relevant variables for inclusion within the problem space is a second-order task that cannot be accomplished with methods of the first type, M1s, which are designed for first-order problems.

When many second-order methods, M2s, are presented for application, however, it is often doubtful whether the accompanying methodological advice is more than a set of general recipes, for example, "the analyst should prepare a menu of policy alternatives that cover a range of appropriate, possible, and feasible solutions to the problem" (Brewer and de Leon 1983: 65). Recipes of this kind, as Linder and Peters (1985: 240) caution, represent "advice on what not to do and what pitfalls to avoid in applying one's intuitions … an interactive and creative process with few rules and guidelines."

The congruence principle is designed to remove ambiguities surrounding the definition of Type III errors. For instance, a Type III error is usually defined in vague, nonspecific, and general terms as solving the "wrong" or "less appropriate" problem (Mitroff and Featheringham 1976; Raiffa 1968: 264). By drawing on the distinction between member and class, and first-order, M1, and second-order, M2, methods, we can formulate a more concrete definition of a Type III error: Solving the wrong problem by employing a method that is incongruent with the level of the problem representation under investigation.

In summary, methods appropriate and effective at one level are inappropriate at the next. Issues of appropriateness and effectiveness cannot be resolved without considering the level of the problem to which a method is applied. When the principle of methodological congruence is violated, we are likely to solve the wrong problem and commit a Type III error.

METHODS FOR SECOND-ORDER PROBLEMS

Almost fifty years ago Newell (1969) suggested and Simon (1973: 182) conceded that methods of a second type may be needed to solve ill-structured problems. A nearly identical recommendation has been made by members of the operations research community in Europe and the United States (Rosenhead 2013: 1166-67).[15] In this context, "methods which are designed to be effective in handling tame problems are likely to be largely irrelevant for wicked ones. (And vice versa of course.) For the latter type of problem situation, methods which assist argumentation, promote negotiation or generate mutual understanding are needed, rather than those which … identify an optimum. Methods which can only start once there is an agreed problem (but have no methods for reaching that agreement) are liable to ignore or dismiss alternative perspectives …." (Rosenhead 2013: 1165). Today, a reasonably large number of appropriate methods is available to perform problem structuring in policy analysis. These methods are scattered among different professional communities, including applied psychology, applied anthropology, business strategy, operations research, management science, systems theory, applied philosophy, and intelligence analysis. Following 9/11 and the 2004 Intelligence Reform and Terrorism Protection Act, a handbook of problem structuring methods was published for the use of the intelligence community (Heuer and Pherson 2010). These and other problem structuring methods are not confined to a single type or phase of policy analysis, but are systematically related to procedures for structuring problems associated with monitoring observed policy outcomes, evaluating policy performance, forecasting expected policy outcomes, and prescribing preferred policies (Figure 2).

PROBLEM TYPE

	1ST ORDER (WELL-STRUCTURED)	**2ND ORDER (ILL-STRUCTURED)**

[15] Interestingly, Rosenhead (2013) notes that interest in and publishing on problem structuring methods in the United States has declined markedly. The development of PSMs has been virtually ignored by the operations research/management science community in the United States. This was pointed out in a letter to the journal *ORMS Today* (Ackermann et al, 2009). The letter was signed by 45 academics from 11 countries and 4 continents. The strongest contributory factor appears to have been the systematic exclusion of papers in this area by the editors and boards of U.S.-based academic journals.

METHODS OF THE 1st TYPE	Choosing the wrong level of alpha (α) or beta (δ) in testing H_o (EI or EII)	Formulating the wrong problem (EIII)
METHODS OF THE 2ND TYPE	Formulating the wrong problem (EIII)	Choosing the wrong level of alpha (α) or beta (δ) in testing H_o (EI or EII)

Figure 5. Congruence and Incongruence of Problems and Methods: Errors of the First, Second, and Third Type

Methods for second-order problems, M2, may be conceptualized at two levels: methods for delineating a problem space by acquiring from stakeholders an approximately complete set of problem formulations; and methods for working within this delineated space to analyze these problem formulations by means of qualitative and quantitative methods. This two-level solution is based on the experience of fields that have specialized in determining the elements of systems with unknown boundaries: sociolinguistics, sociometric sampling, systems theory, petroleum exploration, and ethnography. In each field, the methodology of boundary estimation works on the principle of a cumulative frequency function (ogive) such as that governing the distribution of household income under a Lorenz curve or the distribution of words in a language. Various distributions can also be expressed in terms of a number of applicable power laws, including Zipf's Law, Lotka's Law, Bradford's Law, de Solla Price's Law, the Hirschman-Hilferding Law, the Law of Cumulative Advantage, and others. This family of power laws produces robust estimates of a problem representations within a problem space. Several of the most readily accessible applications may be found in Simon (1978) and Dunn (2002).

Methods of the second type (M2s) are different than methods of the first type (M1s), which are appropriate for solving well-structured or tame problems. M2s may be sorted into four categories formed by the intersection of the purpose of the method (constitutive versus regulative) and its level of replicability (low versus high).

In one category are M²s designed for constituting a problem space by delineating the problem representations within that space. The process is analogous to identifying, but not analyzing, variables in a regression model. Although important as a means of generating policy goals, alternatives, outcomes, and hypothesized causes of outcomes, many M2s tend to be so ambiguous and general that they cannot be replicated. M2s such as brainstorming (Osborn 1948), continuous decision seminars (Lasswell 1960), multiple perspective analysis (Linstone et al. 1981), and visual analytics or infographics (Horn and Weber 2007) appear to fall in this category.

In a second category are M2s that, while they have low replicability, are designed to regulate, order, or relate problem representations within the boundaries of a problem space. If the problem representations are hypothesized causes of traffic fatalities, these hypothesized causes can be regulated, ordered, or related by, say, processes presented as physical and biological metaphors and analogies. Traffic flows, traffic jams, abrupt stops, and crashes, and so on, might be represented in terms of biological metaphors such as rolling or raging rivers, cascades, and waterfalls, or with physical representations such as electric currents, surges, short circuits and other metaphors (see Schon 1993). In public health, a well-known biological metaphor is that opioid use is like an infectious disease. Although M2s of this kind can be sources of creativity and insight about the mechanisms that govern problem representations, they have limited replicability. Methods of synectics (Gordon, 1961) and other forms of analogical reasoning (see, e.g., Rein, 1976; Schon, 1983) appear to belong to this second category of M2s. While useful in conceptualizing a problem and analyzing its related elements, they tend to be imprecise, ambiguous, and general. They are difficult to replicate with the confidence that two or more analysts can produce the system of problem representations.

A third category of M2s includes procedures designed to estimate the boundaries of a system of problem representations, or problem space, in a replicable and reliable fashion. These methods are replicable by virtue of their relative specificity, precision, and comprehensiveness. Presently, there is a dearth of methods in this category, which means that the process of identifying problem representations resembles what Dery (1984, pp. 6-7) characterizes as "a never-ending discourse with reality, to discover yet more facets, more dimensions of action, more opportunities for improvement." Apart from the EPSEM rule of random sampling (Every element has an equal probability of being selected.), which is inappropriate with second-order problems, the absence of boundary-approximating rules makes it impossible to know with confidence that we have captured all possible problem representations. This is a limitation of M2s such as the analytic hierarchy process (AHP) and strategic assumption surfacing and testing (SAST), a limitation that has been acknowledged by the authors of these methods (Saaty 1980, p. 14; Mitroff and Mason, 1981b, pp. 73-86). However, there are other boundary-approximating rules that are used in sociolinguistics, the demography of large city populations, the sizes of scientific communities, the number of topics in library holdings, and the number of causally relevant constructs in a policy system (see Zipf 1949; Simon 1978; and Dunn and Ginsberg 1986). These M2s are replicable procedures for estimating the boundaries of systems of problem representations.

In the fourth category are M2s that aim at estimating patterns believed to regulate relations between previously defined elements, for example, patterns of conflict and cohesiveness, distance and proximity, or consistency and inconsistency among problem representations. In this category are replicable methods that include policy capturing (Adelman, Stewart, and Hammond 1975), interpretive structural modeling (Warfield 1976), Q-methodology (Brown, 1980), the analytic hierarchy process (Saaty 1980), and strategic assumption surfacing and testing (Mason and Mitroff, 1981). Singly and in combination, these methods appear to provide a powerful medium for creating spatial, geometric, and quantitative representations of the structure of problems. In addition to their replicability, these methods provide tests for estimating the ecological validity (Adelman, Stewart, and Hammond, 1975), consistency (Saaty, 1980), and plausibility (Mason and Mitroff, 1981) of patterns believed to represent the structure of policy problems.

In summary, M2s, when they are congruent with second-order problems, are likely to reduce or eliminate Type III errors. Although M2s are generally available to the policy analysis community, they are seldom included as an integral part of training in applied social research, including applied economics (Batie 2008). With the exception of Dunn (1981, 2017) and Brewer and DeLeon (1985), there are virtually no textbooks, manuals, and handbooks of methods of the second type (M2s) in public policy. A parallel literature in policy design has grown far faster than literature on problem structuring, but it is rarely included in policy analysis programs. There are occasional references to what have been called methods of the second type (M2s) in authoritative sources such as *Encyclopedia of Policy Studies* (Nagel, 1983) and the *Handbook of Policy Analysis* (2007), but there is scant attention to synectics (Gordon 1961), policy capturing (Hammond 1980), the analytic-hierarchy process (Saaty 1980), interpretive structural modeling (Warfield 1976), multiple perspective analysis (Linstone et al. 1981), strategic assumption surfacing and testing (Mason and Mitroff 1981), and morphological analysis (Ritchey 2011).

Bounding the Problem Space: An Application to Highway Safety

An essential task of problem structuring is determining whether a system of problem representations is approximately complete. As we saw with Rittel and Weber's (1973) characterization of wicked problems, analysts typically have no "stop-rule" to tell them when to stop searching for problem representations. A solution to this apparent dilemma is to turn to fields that have specialized in determining the elements of systems with unknown boundaries: sociometric sampling, systems analysis, petroleum exploration, and ethnography. In each field, the methodology of boundary estimation works on the principle of a cumulative frequency function (ogive) such at that governing the distribution of household income under a Lorenz curve or the distribution of words in a language.

Much of the literature on problem structuring fails to recognize that policy problems--ill-structured or well well-structured, wicked or tame--are not "given" entities that exist apart from the subjective understandings of problem solvers. To return again to Ackoff (1974: 21): "Problems are elements of problem situations that have been abstracted from these situations through analysis." To initiate the process of problem structuring, it is important to conduct a boundary analysis of the perimeters of a problem space. Methods of problem structuring that presuppose that the problem has already been structured,[16] do not themselves provide a way to know whether a set of problem formulations is relatively complete. Although there are several ways to estimate the completeness of a set of problem representations, typically there are three steps (Dunn 1988: 720-37).

Saturation Sampling

The first step is drawing a saturation (or snowball) sample of stakeholders. Stakeholders in this initial set may be contacted, face-to-face or by telephone or computer, or by accessing their written descriptions of a problem. Two additional stakeholders are contacted, one who agrees most and one least with the arguments of the other. The process is continued until no new stakeholders are named. There is no error or sampling variance, because all members of the working universe of stakeholders in a specific area (e.g., health care reform) are contacted.[17]

Elicitation of Problem Representations

In the second step analysts elicit alternative problem representations from the bounded system of stakeholders. These are the problem representations that Heclo (1976: 253-54) describes as "ideas, basic paradigms, dominant metaphors, standard operating procedures, or whatever else we choose to call the systems of interpretation by which we attach meaning to events." The information required to document these problem representations may be obtained from face-to-face interviews or, given the time constraints facing most analysts, from telephone and computer communications or from available documents.

Boundary Estimation

The third step is to estimate the boundaries of the system. A cumulative frequency distribution is constructed to display stakeholders on the horizontal axis and the number of *new* problem formulations, which may be assumptions, ideas, objectives, policies, or causes. These are plotted on the vertical axis. As the new (i.e., non-duplicative) problem representations of each stakeholder are plotted on the vertical axis, the slope of the resultant cumulative frequency

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[16] These other methods include the analytic hierarchy process, interpretive structural modeling, policy capturing, and Q-methodology. See, respectively, Thomas L. Saaty, *The Analytic Hierarchy Process* (New York: McGraw-Hill, 1980); John N. Warfield, *Societal Systems: Planning, Policy, and Complexity* (New York: Wiley, 1976); Kenneth R. Hammond, *Judgment and Decision in Public Policy Formation* (Boulder, CO: Westview Press, 1977); and Stephen R. Brown, *Political Subjectivity: Applications of Q-Methodology in Political Science* (New Haven, CT: Yale University Press, 1980). Computer software is available for applications of these methods.

[17] On these points as they apply to sociometric and saturation sampling in general, see Seymour Sudman, *Applied Sampling* (New York: Academic Press, 1976). Although there is no sampling variance it is always possible, but improbable, that some stakeholders are not in the sample.

curve changes. An initial slope will indicate a large change in new representations for every unit change on the horizontal axis. The stagnation or saturation of new representations will be reached within a small (15-25) number of stakeholders. This is the point at which the curve becomes flat. After this point, the collection of additional information is unlikely to improve the completeness of the problem space.

These estimation procedures were used to structure an ill-structured or wicked problem in the area of highway safety. A boundary analysis was conducted with documents prepared by thirty-eight state officials responsible for reporting on the effects of an original 55 mph and later 65 mph speed limit at the state level in the United States. There were sharp disagreements among many of the thirty-eight stakeholders. Some states were tenaciously committed to the hypothesis that speed limits are causally related to fatalities (e.g., Pennsylvania and New Jersey), a position supported by *The New York Times* and the Clinton Administration. Others were just as firmly opposed (e.g., Illinois, Washington, Idaho), a position supported by the American Truckers Association. Of direct importance to boundary estimation is that 718 plausible rival hypotheses were used by thirty-eight stakeholders to affirm or dispute the effectiveness of the 55 mph speed limit in saving lives. Of this total, 109 hypotheses were unique, in that they did not duplicate hypotheses advanced by any other stakeholder.

Here it is important to note that, from the standpoint of communications theory and language, the information-content of a hypothesis tends to be negatively related to its relative frequency or probability of occurrence. Hypotheses that are mentioned more frequently—those on which there is greater consensus—have less probative value than rarely mentioned hypotheses, because highly probable or predictable hypotheses do not challenge accepted knowledge claims.

The rival hypotheses were analyzed according the cumulative frequency of *unique* (nonduplicate) causal hypotheses. As Figure 4 shows, the cumulative frequency curve of unique rival hypotheses flattens out after the twenty-second stakeholder. Although the *total* number of rival hypotheses continues to increase without apparent limit, the boundary of *unique* rival hypotheses is reached within a small and affordable number of observations. This indicates that a satisfactory definition of the boundaries of the problem space has probably been achieved. Indeed, of the 109 unique rival hypotheses, several variables related to the state of the economy—unemployment, the international price of oil, industrial production—explain the rise and fall of traffic fatalities better than average highway speeds and the 55 mph speed limit.

Applications of similar procedures in other areas—for example, estimates of the boundaries of scientific literature, library holdings, languages, literary works, consumer preferences—suggest lawful regularities in the distribution of elements that populate a problem space. The Pareto chart summarizes the growth of individual problem representations. Individual problem representations are almost always well-structured or tame problems; it is when these tame problems form a system of problem representations, a second-order problem, that the problem becomes ill-structured or wicked. The use of a simple method, the cumulative frequency distribution and curve, successfully delineated the problem space and also identified causally relevant variables that, once inserted in a regression model, explained over 80 percent of the variance in fatalities. The speed limit explained approximately 15 percent of the variance (Dunn 1999, 2007). The solution to the originally ill-structured or wicked problem, which became a well-structured or tame problem in the course of problem structuring, was that the speed limit was relatively ineffective in saving lives. It was subsequently abandoned for a variety of reasons.

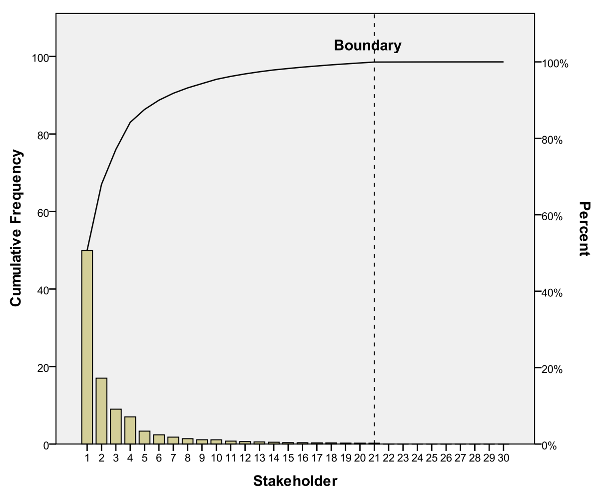

Figure 4. Pareto Chart—Estimated Boundary of System of Problem Representations with Tame or Well-structured Problems Within the Problem Space

SOURCE: Dunn "A pragmatic strategy for discovering and testing threats to the validity of sociotechnical experiments." *Simulation Modelling Practice and Theory* 10.3 (2002): 169-194.

. EVIDENCE-BASED PROBLEM STRUCTURING

A conspicuous gap in problem structuring research, and in public policy research generally, is the paucity of efforts to test the efficacy of problem structuring methods. Among the hypotheses that might be advanced to explain the lack of attention to these methods in public policy analysis, at least in the United States, several appear plausible. One is that major journals in public policy are both unfamiliar with the process (and term) of problem structuring and reluctant to publish articles in an area unknown to editors and editorial boards. This is one of the explanations advanced by Rosenhead (2013) for the poor diffusion of concepts and methods of problem structuring in operations research and management science. Significantly, operations research and management science are two of the disciplines that have most influence on the development of policy analysis since World War II.

A second plausible explanation is that those who write most about methods of policy analysis have had fewer opportunities to work in complex, real-life contexts than faculty subject to the relatively closed boundaries and incentive systems of academic institutions, where publishing in the same journals that seem reluctant to publish articles on problem structuring is a sine qua non of academic tenure. Those who write books and journal articles on policy analysis simply may be unaware that, in fact, practicing policy analysts as well as many policy makers spend much of their time dealing with what we have called ill-structured or wicked problems, not with solutions to problems that are simple enough that analysts know the key variables in advance. Consequently, there is a considerable time lag between the emergence of ill-structured or wicked problems and efforts to address them with appropriate problem structuring methods.

Third is the vague or equivocal nature of many of the problem structuring methods. The creative use of metaphors and analogies, or the analysis of problems from multiple perspectives, are in fact untested: We do not know whether their use is efficacious in producing solutions, in large part because the requirements of a solution are unknown and unspecified. This may be feeding a vicious cycle of claims that "wicked problems" do not have a solution, followed by efforts to engage again in problem structuring, but without known and specified solutions, or at least best practices that are backed by experience.

Another explanation is again related to the vague and ambiguous character of problem structuring methods. Although analysts are trained to recognize that competing perspectives of a problem are likely to assist in the discovery of otherwise hidden aspects of problem representations, problem structuring methods such as brainstorming (Osborn 1948), continuous decision seminars (Lasswell 1960), or multiple perspective analysis (Linstone et al. 1981) are general heuristics that cannot be easily replicated or evaluated, although some progress has been made in performing research syntheses of the efficacy of problem structuring methods in intelligence analysis, an area replete with ill-structured and wicked problems (Coulthart 2017). Even when these methods are well specified and replicable, as is the case with policy capturing (Adelman, Stewart, and Hammond 1975), the analytic hierarchy process (Saaty, 1980), and strategic assumption surfacing and testing (Mason and Mitroff, 1981), standards for evaluating the extent to which an analyst has performed well in structuring a problem are ambiguous or unavailable. As Mitroff and Mason acknowledge (1981: 73-86), there is no test that guarantees the completeness of a set of problem representations. Saaty (1980: 14) makes much the same point when he acknowledges that "there is no set procedure for generating objectives, criteria, and activities to be included in a hierarchy or even a more general system." The ambiguity or absence of performance criteria is closely related to problems of interpreting the results of laboratory and field research on the efficacy of these methods. Understandably, research on the performance of these methods in producing improved problem representations has yielded equivocal or conflicting findings (see, e.g., Cosier 1978, 1981; Cosier, Ruble, and Aplin 1978; Mason, Barabba, and Kilmann 1977; Mitroff and Mason 1981; Schwenk and Cosier 1980).

The further development and application of methods of the second type presuppose the identification of explicit criteria for assessing the performance of analysts in structuring problems. A first step in this process is to recognize that methods of the second type aim both at the discovery of elements that define a problem space and with methods that identify patterns and relations among those elements. Hence, methods of the second type perform functions that are constitutive and regulative. Methods designed to discover the elements that define a problem are constitutive, since they answer the question: What elements constitute the problem? Regulative methods, by contrast, aim at the discovery of patterns or relations among these elements. Here the question is: How are the elements that define the problem regulated? The distinction also punctuates the fact that the process of structuring policy problems requires that we test our explanation or comprehension of the patterns believed to regulate a problem (regulative rules) as well as our definition of its constituent elements (constitutive rules).

Methods of the second type also differ in terms of their replicability. Methods with low replicability involve general and vague guidelines, while methods with high replicability involve specific and readily comprehensible prescriptions for carrying out a defined sequence of operations. As instruments of discovery, replicable methods have been characterized by Landa (1984: 39) as algorithmic-heuristics and contrasted with non-algorithmic heuristics that are based on imprecise and vague methodological prescriptions, for example, the prescription to examine multiple perspectives of a problem in order to discover its true nature and potential solutions.

CONCLUSIONS

The appropriateness of a particular type of method is a function of its congruence with the type of problem under investigation. Conventional methods of the first type, M1s, are appropriate and useful for solving first-order problems that are relatively well-structured and tame. Contexts of practice, however, are pervaded by second-order problems that, variously described as ill structured, or wicked, are a class of all first-order problems. However, it is methods of the second type, M2s, that are congruent with the complexity of second-order problems. Available evidence suggests that a failures to observe the principle of methodological congruence is likely to result in formulating the wrong problem (Type III Error).

Methods of the second type, M2s, delineate the problem space of ill-structured and wicked problems, most of which appear, when considered individually, as well-structured and tame. Other second-order methods, M2s, are regulative: These M2s are designed for analyzing relational structures, patterns, and configurations composed of first-order problems. M2s include anything from tabular displays to causal models, decision trees, and policy networks. By contrast, the fate of M1s such as linear programming, cost-benefit analysis, and applied microeconomics is to solve problems without structuring them, failing to delineate the boundaries of problem representations with a problem space and courting Type III errors., However, assessing the performance of problem structuring methods is a question of evidence-based problem structuring, and of policy analysis generally. We may ask what works? To date, there is little research that answers this question.

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