she ji
[ʃə: dʒi:]

# Tame Problems, Wicked Possibilities: Interpreting the Distinction between Wicked and Tame Problems through the Cybernetic Concepts of Variety and Constraint

**Ben Sweeting**

**Keywords**
wicked
tame
cybernetics
variety
constraint

**Received**
January 13, 2024
**Accepted**
March 25, 2024

BEN SWEETING
School of Architecture, Technology and Engineering, University of Brighton, UK
r.b.sweeting@brighton.ac.uk

**Abstract**
The distinction between wicked and tame problems has been a major influence on design and numerous other fields since it was developed in the late 1960s and early 1970s by design theorist Horst Rittel and urban designer Melvin Webber. The characteristics of wicked problems continue to resonate today, helping make sense of the complexities of contemporary challenges. Wicked and tame refer to types (rather than degrees) of difficulty, but what defines these types is not simply the domains in which problems occur, as in the dichotomy between scientific and social contexts originally put forward by Rittel and Webber. To clarify the distinction between wicked and tame, I ground it in the cybernetic concepts of variety and constraint, building on Rittel's references to the cybernetician Ross Ashby. Understood in this way, wicked and tame do not refer to problems, or to the situations in which problems arise. Rather, wickedness and tameness are dynamics of possibilities (variety) in how multiple aspects of problems are perceived and responded to across the relationships in which designing (in its broadest senses) is embedded.



http://www.sciencedirect.com/journal/she-ji-the-journal-of-design-economics-and-innovation
https://doi.org/10.1016/j.sheji.2024.03.002

## Introduction

The distinction between wicked and tame problems has significantly influenced numerous disciplines, including design. It was developed during the late 1960s and early 1970s by design theorist Horst Rittel and urban designer Melvin Webber, who both held positions at University California, Berkeley. Rittel and Webber use this distinction to characterize the limitations of various problem-solving methods when applied to social domains such as urban design and planning that are "at the juncture where goal-formulation, problem-definition and equity issues meet."[1]

What Rittel means by problem is "a recognized discrepancy between what is and what ought to be."[2] By *tame* problems, Rittel and Webber refer to well-defined and unambiguous problems that can be definitively answered. They give various examples, including solving a mathematical equation or a chess puzzle; processes of scientific research such as analyzing the chemical structure of an unknown compound;[3] and the "classical systems-approach of the military and the space programs."[4] The term *wicked* refers to challenges that they argue are typical of planning and designing, characterized by incomplete, changing, and contradictory criteria. Rittel asserts that "all essential planning problems are wicked"[5] and (with Webber) that "planning problems are inherently wicked."[6] Rittel uses the terms planning and designing interchangeably to refer to the activity of devising a plan.[7] This conception of design reflects a division of labor between planning and implementation: "The outcome of designing is, not the accomplishment of the purpose, but a plan for its accomplishment. For instance, architects make plans for buildings but do not build buildings."[8] While tame problems are amenable to professional expertise and technical procedure, Rittel and Webber argue that wicked problems require political judgment.

Rittel and Webber's description of the characteristics of wicked problems remains relevant today, more than half a century after its introduction. The concept of wicked problems resonates with the complexities of contemporary systemic challenges and continues to be invoked and debated in many fields and contexts, including the discourses of planning, design, policy, and systems thinking.[9] The enduring influence of the distinction between the tame and the wicked reflects its significance and the clarity of Rittel and Webber's presentation. However, its widespread use has led to concerns that the concept of wicked problems has been overextended,[10] and to questions concerning its interpretation and premises.[11]

In a sense, Rittel and Webber's articulation of the characteristics of wicked problems is timeless, giving words to challenges that are immediately recognizable in the context of design. However, the distinction between wicked and tame is also a concept of its time. It is a response to the loss of faith in professional expertise during the 1960s and 1970s that was manifest in "the courts, the streets, and the political campaigns,"[12] as well as from professionals themselves.[13] The idea of wicked problems aligns closely with other concepts from the period, such as messes,[14] ill-structured problems,[15] continuous critical problems,[16] and the distinction between first and second-order cybernetics.[17]

1 Horst W. J. Rittel and Melvin M. Webber, "Dilemmas in a General Theory of Planning," *Policy Sciences* 4, no. 2 (1973): 156, https://www.jstor.org/stable/4531523.
2 Horst Rittel, "Some Principles for the Design of an Educational System for Design," *Journal of Architectural Education* 25, no. 1/2 (1971): 21, http://www.jstor.org/stable/1423929.
3 Rittel and Webber, "Dilemmas," 160.
4 Ibid., 162.
5 Horst Rittel, "On the Planning Crisis: Systems Analysis of the 'First and Second Generations,'" *Bedriftskonomen* 8 (1972): 392, reprinted in: Jean-Pierre Protzen and David J. Harris, eds., *The Universe of Design: Horst Rittel's Theories of Design and Planning* (London: Routledge, 2010), 151–66.
6 Rittel and Webber, "Dilemmas," 160.
7 Raymond McCall and Janet Burge, "Untangling Wicked Problems," *Artificial Intelligence for Engineering Design, Analysis and Manufacturing* 30, no. 2 (2016): 201, https://doi.org/10.1017/S089006041600007X; Jean-Pierre Protzen and David J. Harris, eds., *The Universe of Design: Horst Rittel's Theories of Design and Planning* (London: Routledge, 2010), 2.
8 Rittel, "Some Principles," 19.
9 See, for example Kate Crowley and Brian W. Head, "The Enduring Challenge of 'Wicked Problems': Revisiting Rittel and Webber," *Policy Sciences* 50, no. 4 (2017): 539–47, https://doi.org/10.1007/s11077-017-9302-4; Jeffrey Kok Hui Chan and Wei-Ning Xiang, "Fifty Years after the Wicked-Problems Conception: Its Practical and Theoretical Impacts on Planning and Design," *Socio-Ecological Practice Research* 4, no. 1 (2022): 1–6, https://doi.org/10.1007/s42532-022-00106-w; Terry Irwin, "Wicked Problems and the Relationship Triad," in *Grow Small, Think Beautiful: Ideas for a Sustainable World from Schumacher College*, ed. Stephan Harding (Edinburgh: Floris Books, 2011), chapter 18; Terry Irwin, "The Emerging Transition Design Approach," in *Design as a Catalyst for Change — DRS International Conference 2018*, ed. C. Storni et al. (Limerick, Ireland: DRS, 2018), 968–89, https://doi.org/10.21606/drs.2018.210; Danielle Lake, "Jane Addams and Wicked Problems: Putting the Pragmatic Method to Use," *The Pluralist* 9, no. 3 (2014): 77–94, https://doi.org/10.5406/pluralist.9.3.0077; Johanna Lönngren and Katrien van Poeck, "Wicked Problems: A Mapping Review of the Literature," *International Journal of Sustainable*

*Development & World Ecology* 28, no. 6 (2021): 481–502, https://doi.org/10.1080/13504509.2020.1859415; Ryan J. A. Murphy and Peter Jones, "Towards Systemic Theories of Change: High-Leverage Strategies for Managing Wicked Problems," *Design Management Journal* 16, no. 1 (2021): 49–65, https://doi.org/10.1111/dmj.12068; Ben Sweeting, Sally Sutherland, and Tom Ainsworth, "Wicked Possibilities: Alternatives to Taming," *Proceedings of Relating Systems Thinking and Design* RSD10 (2021): online, https://rsdsymposium.org/wicked-possibilities-alternatives-to-taming/; Catrien J. A. M. Termeer, Art Dewulf, and Robbert Biesbroek, "A Critical Assessment of the Wicked Problem Concept: Relevance and Usefulness for Policy Science and Practice," *Policy and Society* 38, no. 2 (2019): 167–79, https://doi.org/10.1080/14494035.2019.1617971; Niraj Verma, "The Disarming Simplicity of Wicked Problems: The Biography of an Idea," *Socio-Ecological Practice Research* 5, no. 2 (2023): 151–57, https://doi.org/10.1007/s42532-023-00143-z; Sharon Zivkovic, "Systemic Innovation Labs: A Lab for Wicked Problems," *Social Enterprise Journal* 14, no. 3 (2018): 348–66, https://doi.org/10.1108/SEJ-04-2018-0036.

10 John Alford and Brian W. Head, "Wicked and Less Wicked Problems: A Typology and a Contingency Framework," *Policy and Society* 36, no. 3 (2017): 398, https://doi.org/10.1080/14494035.2017.1361634; Janet E. Burge and Raymond McCall, "Diagnosing Wicked Problems," in *Design Computing and Cognition '14*, ed. John S. Gero and Sean Hanna (Cham: Springer, 2015), 315, https://doi.org/10.1007/978-3-319-14956-1_18; Lönngren and van Poeck, "Wicked Problems," 482; B. Guy Peters, "What Is so Wicked about Wicked Problems? A Conceptual Analysis and a Research Program," *Policy and Society* 36, no. 3 (2017): 386, https://doi.org/10.1080/14494035.2017.1361633.

11 Nick Turnbull and Robert Hoppe, "Problematizing 'Wickedness': A Critique of the Wicked Problems Concept, from Philosophy to Practice," *Policy and Society* 38, no. 2 (2018): 315–37, https://doi.org/10.1080/14494035.2018.1488796.

12 Rittel and Webber, "Dilemmas," 155.

13 Ibid., 156.

14 Russell L. Ackoff, "The Future of Operational Research Is Past," *The Journal of the Operational Research Society* 30, no. 2 (1979): 99, https://doi.org/10.2307/3009290.

15 Herbert A. Simon, "The Structure of Ill Structured Problems," *Artificial Intelligence* 4, no. 3-4 (1973): 181–201, https://doi.org/10.1016/0004-3702(73)90011-8.

Rittel first introduced the concept of wicked problems in a 1967 seminar, part of a series organized by UC Berkeley professor C. West Churchman, a foundational figure in operations research and systems thinking. Rittel presented an initial version of the differences between wicked and tame problems, and Churchman then published a summary.[18] Two publications set out the characteristics of wicked problems and the distinction between the wicked and tame: Rittel's 1972 article "On the Planning Crisis"[19] and Rittel and Webber's 1973 article "Dilemmas in a General Theory of Planning."[20]

The period between the 1967 seminar and Rittel and Webber's 1973 publication included the scientific and technological triumph of the first human landings on the moon and widespread protests on streets and campuses. Both were part of the context in which the idea of wicked problems took shape. Churchman was working at the Berkeley Space Sciences Laboratory, exploring the possible transfer of insights from the NASA space program to social contexts.[21] Rittel worked on a project with the Space Sciences Laboratory during the period 1965–1967[22] and mentioned the space program as an example of tame problems where methods such as systems analysis were successful.[23] While Rittel and Webber allude to protest only somewhat distantly,[24] it was not an abstract issue at UC Berkeley. The campus and its environs had been a center for different forms of activism and counterculture throughout the 1960s.[25] In 1969, demonstrations in support of People's Park, a community initiative for a vacant university-owned plot in Berkeley, were met with a violent response from the state.[26] People's Park was at the intersection of three issues that Rittel and Webber highlight concerning wicked problems and the loss of faith in professional expertise: education, urban renewal, and law-enforcement.[27] It exemplifies how seemingly straightforward questions in urban development and planning, even decisions over a single site, can be tangled within broader political contestations and conflicts between different interests and participants. The confrontation at People's Park—with many people wounded and one death—vividly demonstrates what can be at stake in how a wicked problem is responded to.[28]

The characteristics of wicked problems, and the challenges they present, have received much attention. What I focus on in this article is not the characteristics of wicked problems per se but the characteristics of the distinction between the wicked and the tame. Rittel and Webber's articulation of wickedness resonates with the messy entanglements of contemporary challenges. However, the distinction that Rittel and Webber draw between wicked and tame problems presents a binary framework that is at odds with the complexity described in their account of wicked problems.[29] What is it that the distinction between wicked and tame distinguishes? Is the underlying *problem* metaphor limiting?[30] To what extent do the ways in which Rittel and Webber characterize the distinction still make sense today?

Rittel and Webber regarded wicked and tame problems as corresponding to social and scientific or technical contexts that they understood as "inherently different."[31] Below I develop an alternative interpretation, conceptualizing wickedness and tameness through Rittel's references to the work of cybernetician Ross Ashby.[32] Cybernetics,[33] or at least versions of

16 Hasan Özbekhan, *The Predicament of Mankind: A Quest for Structured Responses to Growing World-Wide Complexities and Uncertainties* (proposal, Club of Rome, 1970), 13, available at https://s3.amazonaws.com/arena-attachments/644235/cda871b45cee6722e3b08ab1070adda4.pdf.

17 Heinz von Foerster, ed., *Cybernetics of Cybernetics: The Control of Control and the Communication of Communication* (Urbana, Illinois: University of Illinois, 1974), 1, available at https://digital.library.illinois.edu/items/2504bc20-2c83-0136-4d81-0050569601ca-5; Heinz von Foerster, "Cybernetics of Cybernetics," in *Communication and Control in Society*, ed. Klaus Krippendorff (New York: Gordon and Breach, 1979), 5–8.
–

18 C. West Churchman, "Guest Editorial: Wicked Problems," *Management Science* 14, no. 4 (1967): B141–42, http://www.jstor.org/stable/2628678.

19 Rittel, "On the Planning Crisis."

20 Rittel and Webber, "Dilemmas."

21 Andrejs Skaburskis, "The Origin of 'Wicked Problems,'" *Planning Theory & Practice* 9, no. 2 (2008): 277, https://doi.org/10.1080/14649350802041654; Magnus Ramage and Karen Shipp, *Systems Thinkers* (London: Springer, 2009), 134; Werner Ulrich, "In Memory of C. West Churchman (1913–2004): Reminiscences, Retrospectives, and Reflections," *Journal of Organisational Transformation & Social Change* 1, no. 2 (2004): 209, https://doi.org/10.1386/jots.1.2.199/0.

22 C. West Churchman, Jean-Pierre Protzen, and Melvin M. Webber, "In Memoriam: Horst W. J. Rittel," *Design Issues* 23, no. 1 (2007): 90, http://www.jstor.org/stable/25224093.

23 Rittel, "On the Planning Crisis," 390.

24 Rittel and Webber, "Dilemmas," 157.

25 Protzen and Harris note that "it was, of course, only months after the Science and Design seminars [given by Rittel] that, on the campus where Rittel taught, the Berkeley Free Speech Movement claimed national prominence, introducing Berkeley as a hotbed of student political action and ushering in an era of student protest." Protzen and Harris, *Universe of Design*, 236.

26 Peter Allen, "The End of Modernism?: People's Park, Urban Renewal, and Community Design," *Journal of the Society of Architectural Historians* 70, no. 3 (2011): 354–74, https://doi.org/10.1525/jsah.2011.70.3.354.

27 Rittel and Webber, "Dilemmas," 155.

28 Allen, "End of Modernism," 355.

it, had been strongly associated with what Rittel referred to as the first-generation systems approach.[34] It is only mentioned explicitly in the 1973 article in connection with the sorts of idealized approaches to planning of which the wicked problem characteristics describe the limitations.[35] However, the cybernetic concepts of feedback, variety, and constraint are a significant part of Rittel's discussions of the wicked problem characteristics,[36] and there are a number of parallels between wicked problems and ideas from cybernetics more broadly.[37] In this article, I build on these connections to develop an understanding of the distinction between wicked and tame problems that is grounded in the concept of variety, understood as a measure of the number of distinguishable possibilities within a set. While the distinction between wicked and tame has tended to focus on the characteristics of situations in which wicked problems are recognized, the interpretation I develop here leads to concerns with the dynamics underlying both wickedness and those routine difficulties that are encountered as tame. Rather than understanding wickedness and tameness as properties of problems, I locate the wicked and tame as dynamics of possibilities (variety) in how multiple aspects of problems are perceived, responded to, and reformulated.

## The Distinction between the Wicked and the Tame

Rittel and Webber's 1973 article set out the influential list of ten characteristics of wicked problems:[38]

1 "There is no definitive formulation of a wicked problem."
2 "Wicked problems have no stopping rule."
3 "Solutions to wicked problems are not true-or-false, but good-or-bad."
4 "There is no immediate and no ultimate test of a solution to a wicked problem."
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 "Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan."
7 "Every wicked problem is essentially unique."
8 "Every wicked problem can be considered to be a symptom of another problem."
9 "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's resolution."
10 "The planner has no right to be wrong."

Rittel and Webber are not explicit about whether all the wicked problem characteristics are needed for a problem to be distinguished as wicked rather than tame.[39] The list of characteristics has been invoked in different ways, with other authors putting forward clarifications[40] and proposals to condense[41] or expand[42] the number of characteristics. Rittel and Webber

leave room for expansion. They refer to there being "at least ten"[43] such properties. Rittel's 1972 article "On the Planning Crisis" sets out eleven characteristics,[44] with the 1973 publication with Webber condensing these to the now familiar ten listed above. Several contemporary authors regard the characteristics as fluidly applicable, with problems understood as wicked to different degrees or in different ways,[45] or as entry points into deeper ways of understanding a problem.[46]

The potential fluidity of the characteristics makes the distinction between wicked and tame problems ambiguous, meaning that it is unclear when and how the characteristics of wicked problems are applicable. This ambiguity matters because framing a problem as wicked or tame implies different types of design responses, different expectations for resolution, different judgments over what to include and exclude from consideration, different ways of placing value, and different attitudes to technical expertise and political debate. Rittel and Webber have distinguished something in the list of characteristics, but what exactly?

Describing a problem as wicked is often a claim that it is especially difficult, equating wickedness with more difficult problems and tameness with simpler ones. This usage aligns with Rittel and Webber's narrative about planning where the "relatively easy problems have been dealt with," but contemporary problems "are much more stubborn."[47] Using wicked in this sense can have various rhetorical effects.[48] Referring to something as a wicked problem can be a way of managing expectations or drawing attention to a problem that requires additional attention and resources. Labelling problems as wicked can also be used as a form of advocacy for particular methods. In the context of design, the merits of specific methodologies, and sometimes the discipline of design in general, can be advanced through claims about their capacity to address the challenges of wicked problems.

However, while Rittel and Webber's wicked problem characteristics concern difficulty, they describe types of difficulty, not degrees of it. Tame problems are well-defined, but this does not necessarily mean they are easy. Rittel and Webber describe tame problems as those where "the mission is clear," and it is possible to be sure "whether or not the problems have been solved."[49] Consider, for instance, a mathematical problem such as proving Fermat's last theorem. This problem was extraordinarily difficult to solve but tame nevertheless because it was well-defined and had a conclusive answer when it was solved.[50] Another example of something both tame and challenging is the NASA space program. Rittel identifies this as an example of the tame problems that can be addressed through first-generation systems approaches: "the NASA missions would not have taken place had it not been for the systems approach."[51] Landing on the moon is an extremely difficult challenge, but it has goals and boundaries that are stable and clearly defined: The "mission is clear"[52] even if the challenge is immense.

As well as there being examples of challenging tame problems, the characteristics Rittel and Webber use to describe wicked problems can be applied to many relatively mundane problems and to situations that are not necessarily problems at all. For instance, many typical professional design

29 I am grateful to Thomas Fischer for making this point during the "Wicked Possibilities" online research seminar hosted by the Radical Methodologies Research Group at the University of Brighton, July 15, 2020.

30 Raymond L. Ison, Kevin B. Collins, and Philip J. Wallis, "Institutionalising Social Learning: Towards Systemic and Adaptive Governance," *Environmental Science & Policy* 53 (November 2015): 111, https://doi.org/10.1016/j.envsci.2014.11.002; Ranulph Glanville, "A (Cybernetic) Musing: Wicked Problems," *Cybernetics and Human Knowing* 19, no. 1-2 (2011): 174, available at https://ranulphglanville.org.za/wp-content/uploads/2021/05/Wicked-Problems-final.pdf. See also Perera's association of wickedness with play. Dulmini Perera, "Wicked Problems, Wicked Play: Fun Machines as Strategy," *FormAkademisk* 13, no. 2 (2020): 1–19, https://doi.org/10.7577/formakademisk.3378; Dulmini Perera, "Wicked Problems, Wicked Humor: Fun Machines as a Method to Frame Wicked Problems in Architecture," *Proceedings of Relating Systems Thinking and Design* RSD7 (2018): 505–15, https://rsdsymposium.org/wicked-problems-wicked-humor-fun-machines-as-a-method-to-frame-wicked-problems-in-architecture/.

31 Rittel and Webber, "Dilemmas," 160.

32 Protzen and Harris, *Universe of Design*, 88, 91, 97,100, 107. See also Rittel's references to the generation and reduction of variety regarding wicked problems, which draw on Ashby without citation. Rittel, "On the Planning Crisis," 395. In this approach, I am building on the work of Thomas Fischer and Larry Richards: Thomas Fischer and Laurence D. Richards, "From Goal-Oriented to Constraint-Oriented Design: The Cybernetic Intersection of Design Theory and Systems Theory," *Leonardo Journal* 50, no. 1 (2017): 36–41, https://doi.org/10.1162/LEON_a_00862.

33 For an introduction to cybernetics in design processes, see Thomas Fischer and Christiane M. Herr, eds., *Design Cybernetics: Navigating the New* (Cham: Springer, 2019), https://doi.org/10.1007/978-3-030-18557-2.

–

34 Rittel, "On the Planning Crisis."

35 Rittel and Webber, "Dilemmas," 158–59.

36 Rittel, "Some Principles," 19, 20, 22; Rittel, "On the Planning Crisis," 395.

37 Hugh Dubberly and Paul Pangaro, "Cybernetics and Design: Conversations for Action," in *Design Cybernetics: Navigating the New*, ed. Thomas Fischer and

problems and everyday activities involve navigating conflicting goals, uncertain boundaries, and negotiations with others.[53] If tameness and wickedness are understood as different degrees of difficulty, it can seem as if the concept of wicked problems is being overextended when it is associated with readily actionable problems. Yet, many regularly solved problems do fit with the characteristics that Rittel and Webber list. Understanding wicked and tame as different types (rather than degrees) of difficulty helps clarify this. Webber asked, "how is it we can get to the moon when we can't get to the airport?"[54] The point of this question is not that designing urban transportation systems is more difficult than the moon landings but that it is a different type of difficulty with different sorts of questions to be asked and answered.

The wicked problem characteristics specify limitations on various approaches to problem-solving. Techniques such as those of operations research[55] or the form of systems analysis advocated by the RAND Corporation[56] involve exhaustively analyzing and unambiguously defining a problem. They are, therefore, of limited use when there is uncertainty or conflict over the problem—when "there is no definitive formulation"[57] of the problem, when "every wicked problem can be considered to be a symptom of another problem,"[58] and when the problem "can be explained in numerous ways."[59] If there is not "an enumerable (or exhaustively describable) set of potential solutions,"[60] it is not possible to analyze every possibility in full.

If methods such as operations research, which rely on exhaustive analysis and precise problem definition, are deemed inapplicable, one might turn to other approaches such as experimental trial and error, working from precedent, comparative evaluations of different possible options, or making incremental improvements. However, working through trial and error is limited if each attempt at implementation reformulates the problem (i.e., if it is a one-shot operation)[61] and when there is no right to be wrong.[62] Working from precedent is only partially helpful if problems are unique.[63] Choosing the better of several possibilities has limitations if there is no immediate and no ultimate test, no stopping rule, no true-or-false solutions,[64] and if judgments about what is better or worse are "likely to differ widely"[65] amongst those involved. Even incrementalism has limits if "every wicked problem can be considered to be a symptom of another problem"[66] as it could lead to addressing symptoms rather than causes.

The point is not that these various methods are worthless. Analysis can be helpful even if it is not exhaustive, providing evidence to support arguments for and against different positions. Plenty can be learned from experimentation using "techniques which support vicarious perception," even if "there is nothing like experimentation with real situations."[67] Precedents can be adapted and built on even if they are not directly repeatable. Incrementalism is valuable so long as it is treated critically and strategically. However, under the limitations of the wicked problem characteristics, none of these approaches complete the problem definitively and conclusively.

This is not to say that it is impossible to respond adequately to planning problems. When Rittel was asked what can be done if wicked problems are

Christiane M. Herr (Cham: Springer, 2019), 85–99, https://doi.org/10.1007/978-3-030-18557-2_4; Fischer and Richards, "From Goal-Oriented to Constraint-Oriented Design"; Glanville, "(Cybernetic) Musing: Wicked Problems"; Andrew Pickering, "Wicked Problems and the Cybernetic Method" (paper presented at the *Epistemic Commitments of Complexity Theories*, ENS Lyon, January 11, 2021), available at https://www.ixxi.fr/lyonpickeringcomplexitypolitics.pdf?lang=en; Chanpory Rith and Hugh Dubberly, "Why Horst W. J. Rittel Matters," *Design Issues* 23, no. 1 (2007): 72–91, https://doi.org/10.1162/desi.2007.23.1.72.

38 Rittel and Webber, "Dilemmas," 161–67.

39 Burge and McCall, "Diagnosing Wicked Problems," 315; Jeffrey K. H. Chan, "The Ethics of Wicked Problems: An Exegesis," *Socio-Ecological Practice Research* 5, no. 1 (2023): 38, https://doi.org/10.1007/s42532-022-00137-3.

40 McCall and Burge, "Untangling Wicked Problems."

41 Jeffrey Conklin, *Dialogue Mapping: Building Shared Understanding of Wicked Problems* (Chichester, UK: Wiley, 2006), chapter 1.

42 Kelly Levin et al., "Overcoming the Tragedy of Super Wicked Problems: Constraining Our Future Selves to Ameliorate Global Climate Change," *Policy Sciences* 45, no. 2 (2012): 123–52, https://doi.org/10.1007/s11077-012-9151-0.

43 Rittel and Webber, "Dilemmas," 160.

44 Rittel, "On the Planning Crisis," 392–93.

45 Alford and Head, "Wicked and Less Wicked Problems"; Burge and McCall, "Diagnosing Wicked Problems"; Sabrina Kirschke et al., "Clusters of Water Governance Problems and Their Effects on Policy Delivery," *Policy and Society* 38, no. 2 (2019): 255–77, https://doi.org/10.1080/14494035.2019.1586081; Peters, "What Is so Wicked about Wicked Problems," 390; B. Guy Peters and Matthew Tarpey, "Are Wicked Problems Really so Wicked? Perceptions of Policy Problems," *Policy and Society* 38, no. 2 (2019): 218–36, https://doi.org/10.1080/14494035.2019.1626595.

46 Chan, "Ethics of Wicked Problems," 38; Pieter E. Vermaas and Udo Pesch, "Revisiting Rittel and Webber's Dilemmas: Designerly Thinking against the Background of New Societal Distrust," *She Ji: The Journal of Design, Economics, and Innovation* 6, no. 4 (2020): 537, https://doi.org/10.1016/j.sheji.2020.11.001.

47 Rittel and Webber, "Dilemmas," 156. Churchman's summary of the 1967 seminar suggests similarly that

unsolvable, he replied, "Oh, we can solve 'wicked problems'… I solve many every day!"[68] It is not that wicked problems cannot be solved, but that they cannot be solved by the logic inherent in the problem.[69] There are many possible answers but no decisive way to select between them. Responses to wicked problems are thus contestable and, unlike tame problems, are not solely matters of expertise but also judgment and political relationships.[70]

If the distinction between wicked and tame differentiates types (rather than degrees) of difficulty, what distinguishes these types? For Rittel and Webber, wicked and tame correspond to distinctly different problem domains. They assert that wickedness is an inherent property of social problems,[71] resulting from the contestations of goals, preferences, and criteria among all those affected and involved.[72] Rittel and Webber associate tame problems with scientific and technical contexts, as well as with rule-governed games such as chess. They argue that "the classical paradigm of science and engineering—the paradigm that has underlain modern professionalism—is not applicable to the problems of open societal systems."[73]

Rittel and Webber's distinction reflects and responds to concerns of its time, which was a period when the shortcomings of basing design on idealized forms of scientific rationality were becoming apparent. That there are limits to using scientific reasoning in social contexts remains relevant, and the characteristics of wicked problems continue to be asserted as a way to articulate this. However, in the manner that they differentiate the wicked from the tame, Rittel and Webber imply an unconvincing dichotomy between scientific and technical contexts on the one hand and society and design on the other: "The kinds of problems that planners deal with—societal problems—are inherently different from the problems that scientists and perhaps some classes of engineers deal with."[74]

While the contexts of science and society have important differences, the binary character of Rittel and Webber's distinction is misleading. Science and its applications are entangled with bodies, politics, spaces, social and ecological relations, and issues of justice. Ecological systems and at least some physical and technological ones manifest the sort of complexities Rittel and Webber associate with social contexts. Scientific practices are themselves social.[75] They include at least some activities that are wicked[76] and that involve design activity.[77] At least some problems in social contexts may be encountered as tame. Tame procedural problems within science or rule-governed games[78] all occur within social contexts.

If the distinction between wicked and tame is not as simple as equating wickedness with social contexts and tameness with scientific and technical contexts, then what is the extent of the applicability of the wicked problem characteristics? Is it that wicked problems must be recognized and differentiated from tame problems on a case-by-case basis? Are some problems tame in their parts but wicked in terms of how these parts go together?[79] Do what seem to be tame problems hide wickedness within? Consider how the NASA space program is tame from the perspective of systems analysis and engineering, while focusing on some of its specific challenges forefronts the roles of chance, error, accident, and tragedy in reformulating problems within what from the outside seems like a well-structured engineering

"membership in the class of non-wicked problems is restricted to the arena of play: nursery school, academia and the like." Churchman, "Wicked Problems," B141.

48 Lönngren and van Poeck, "Wicked Problems," 482, 486–87, 490–92; Turnbull and Hoppe, "Problematizing 'Wickedness,'" 316, 324–25.

49 Rittel and Webber, "Dilemmas," 160.

50 McCall and Burge, "Untangling Wicked Problems," 200–201.

51 Rittel, "On the Planning Crisis," 390.

52 Rittel and Webber, "Dilemmas," 160.

53 Ken Friedman has suggested the example of choosing a restaurant for a meal, where participants have different preferences and do not wish to change them, as an everyday formulation of a wicked problem. Terry Cutler and Mark Burry, *Designing Solutions to Wicked Problems: A Manifesto for Transdisciplinary Research and Design* (RMIT University, 2010), Report, 119, available at https://apo.org.au/sites/default/files/resource-files/2010-10/apo-nid26688.pdf.

54 Opening remarks at a guest seminar by Webber at the University of Reading. Quoted in Michael Batty, "Great Planning Disasters," in *The Planning Imagination: Peter Hall and the Study of Urban and Regional Planning*, ed. Mark Tewdwr-Jones, Nicholas A. Phelps, and Robert Freestone (London: Routledge, 2014), 30.

55 Rittel, "On the Planning Crisis," 391, 393; Rittel and Webber, "Dilemmas," 162.

56 Turbull and Hoppe frame Rittel and Webber's 1973 article as part of wider debates about the type of systems analysis promoted by the RAND corporation. Turnbull and Hoppe, "Problematizing 'Wickedness,'" 319–20.

57 Rittel and Webber, "Dilemmas," 161.

58 Ibid., 165.

59 Ibid., 166.

60 Ibid., 164.

61 Ibid., 163.

62 Ibid., 166.

63 Ibid., 164.

64 Ibid., 162–63.

65 Ibid., 163.

66 Ibid., 165.

67 Rittel, "Some Principles," 19.

68 Quoted in Skaburskis, "Origin of 'Wicked Problems,'" 277.

69 Skaburskis, "Origin of 'Wicked Problems,'" 277.

70 Rittel and Webber, "Dilemmas," 160; c.f. Rittel, "On the Planning Crisis," 394–96.

71 Rittel and Webber, "Dilemmas," 160–61.

72 Rittel and Webber, "Dilemmas," 167–68, see also: Ken Friedman, "Three Thousand Years of Designing Business

and Organizations," in *Designing Business and Management*, ed. Sabine Junginger and Jurgen Faust (London: Bloomsbury, 2016), 71–75, https://doi.org/10.5040/9781474243551.ch-005.

73 Rittel and Webber, "Dilemmas," 160.

74 Ibid.

75 Turnbull and Hoppe, "Problematizing 'Wickedness,'" 318.

76 Robert Farrell and Cliff Hooker, "Design, Science and Wicked Problems," *Design Studies* 34, no. 6 (2013): 681–705, https://doi.org/10.1016/j.destud.2013.05.001.

77 Ranulph Glanville, "Researching Design and Designing Research," *Design Issues* 15, no. 2 (1999): 80–91, https://doi.org/10.2307/1511844; Ben Sweeting and Sally Sutherland, "Design's Secret Partner in Research: Cybernetic Practices for Design Research Pedagogy," *Systems Research and Behavioral Science* 40, no. 5 (2023): 765–71, https://doi.org/10.1002/sres.2974.

78 Richard Coyne, "Wicked Problems Revisited," *Design Studies* 26, no. 1 (2005): 8, https://doi.org/10.1016/j.destud.2004.06.005.

79 C.f. Simon, "Structure of Ill Structured Problems," 190.

–

80 Thomas Fischer, "Narratives of Exploration: From 'Failure Is not an Option' to 'Try Again. Fail Again. Fail Better,'" *Kybernetes* 49, no. 8 (2020): 2091–2108, https://doi.org/10.1108/K-07-2019-0502.

81 Coyne, "Wicked Problems Revisited," 8.

82 Ison et al., "Institutionalising Social Learning," 109, 114–15.

83 See, for instance, Richard Buchanan's argument that wickedness follows from the indeterminate disciplinary character of design. Richard Buchanan, "Wicked Problems in Design Thinking," *Design Issues* 8, no. 2 (1992): 16, https://doi.org/10.2307/1511637.

84 Rittel and Webber, "Dilemmas," 160.

85 Rittel, "Some Principles," 20.

86 C.f. Simon, "Structure of Ill Structured Problems," 187.

87 An example of how a problem can exist over multiple levels. "There is nothing like a natural level of a wicked problem." Rittel and Webber, "Dilemmas," 165.

88 Rittel and Webber, "Dilemmas," 161; Churchman, "Wicked Problems."

89 Chantal Spencer, "Rethinking Participatory Design Research Methodologies," *Proceedings of Relating Systems Thinking and Design* RSD11 (2022): article no. 158, p. 3, https://rsdsymposium.org/rethinking-participatory-design-research-methodologies.

90 Rittel, "Some Principles," 21.

project.[80] Could it be that all problems are wicked? If so, is tameness the result of simplifications in the way problems are framed? When would such simplifications be appropriate? Even rule-governed games rest on the social relationships, conventions, and contexts in which they are recognized and maintained as games.[81] Do wicked and tame even describe aspects of problems, or is it better to regard them instead as framing choices over how a problem is recognized and engaged?[82] Or is it that wickedness and design coincide?[83] Is planning "inherently wicked,"[84] not because of the complexity that designers attempt to address, but because of the character and structure of design activity itself?

To say that wickedness is characteristic of design does not mean that every task done by professional designers is wicked. Designers are not always designing in Rittel's sense of devising plans. Rittel notes how design activity is interspersed within periods of routine (that is, tame) procedure.[85] However, even to say that non-routine design problems are characteristically wicked underplays the extent to which the work of professional designers is often guided by (and reinforcing of) convention, regulation, precedent, tradition, and claims to unilateral expertise. While design activity is closely associated with generating new possibilities, it does not always achieve this in practice. The design of a house could be addressed through designing or by repeating the outcomes of previous design processes.[86] There is not always time, resources, or desire to treat design problems as unique. Some of the ways that designers create newness can even reinforce the status quo.[87] Consider, for instance, how design innovation in one context maintains economic patterns and privileges in others.

Treating wicked problems as if they are tame is ethically undesirable.[88] Perhaps, then, it is best to approach every problem as if it is wicked. For instance, recognizing the political and ethical aspects of (the design of) science and technology is ever more important. However, treating all problems as wicked has costs. It risks diverting attention away from the most pressing matters, and it may introduce unnecessary complications and requirements. For instance, as responses to wicked problems are closely associated with participative approaches, over-extending the category of wicked problems could lead to the unnecessary expansion of "the labour of participation."[89] When is framing something (either implicitly or explicitly) as a tame problem reductive, and when is it a helpful simplification? What should such decisions be based on?

## Designing as Generating and Reducing Variety

One way to help clarify the distinction between wicked and tame problems is to situate it within Rittel's understanding of designing and planning. After all, it is within Rittel's own conception of designing and planning processes that the distinction between wicked and tame problems was originally drawn. Like much of the discourse on design methods of the period, Rittel's account of design is an abstract explanation from the outside and, as such, it misses much of the actual practice of design activity itself.[90] While the abstraction in Rittel's account of design is limiting for many purposes, it can be helpful

in the already abstract task of clarifying the distinction between wicked and tame problems.

In this and the following section, I draw primarily on Rittel's article on the design of design education,[91] published in the *Journal of Architectural Education* in 1971,[92] as well as the published text for the seminars on design that Rittel gave at UC Berkeley in 1964.[93] The 1971 article is of particular interest. While it does not use the terminology of wicked and tame, it introduces early formulations of the wicked problem characteristics in relation to design processes. It does so without asserting a binary distinction between wicked and tame problem domains.

Rittel's account of design processes draws on ideas from cybernetics, especially Ashby's concept of variety. Cybernetics is concerned with the forms and structures of feedback processes in ways that are applicable across multiple contexts and embodiments.[94] As such, it is helpful in challenging Rittel and Webber's conception of the difference between wicked and tame problems as corresponding to a distinction between the social and scientific.

Ashby defines variety as a measure of the number of distinguishable elements in a set of possibilities,[95] using it to describe regulatory feedback processes. Ashby is explicit that variety is "not an intrinsic property of the set"[96] but depends on how it is observed. Different observers will experience different varieties,[97] which is particularly relevant in understanding the conflicting situations associated with wicked problems.

Rittel conceives designing as a process that alternates between the "generation of variety" and the "reduction of variety."[98] Generating variety refers to creating sets of possible courses of action: "the search for a set of relevant possibilities which might solve the problem at hand."[99] Reducing variety refers to making selections amongst these, evaluating and filtering which possibilities to take further:[100] "the alternatives are evaluated for their feasibility and desirability, and a decision is made in favor of the most desirable, feasible alternative, which is incorporated into the plan until another or the same difficulty arises, which gives rise to another cycle."[101] Note that the concept of variety can be applied to multiple aspects of design beyond the specific way Rittel uses it. For instance, as well as the variety of the set of different possible courses of action (Rittel's usage), each member of that set (each possible course of action) can be understood and differentiated in terms of the variety that it would display in the situation if selected and enacted.

Rittel drew on Ashby's understanding of cybernetic regulation processes to develop this description of design as generating and reducing variety.[102] Regulation in the cybernetic sense is the maintenance of some condition within desired limits in a changing environment. For example, when steering a ship, fluctuations in the direction and strength of the tide or wind are responded to by adjustments in steering that maintain and change the direction in which the ship is heading. For Ashby, "cybernetics envisages a set of possibilities much wider than the actual, and then asks why the particular case should conform to its usual particular restriction."[103] Ashby uses the term constraint to describe a set that displays a

91 Rittel, "Some Principles."
92 The article originates as a paper for a conference at the School of Architecture, Washington University, St. Louis, which Rith and Dubberly date to 1966. Chanpory Rith and Hugh Dubberly, "Horst W. J. Rittel's Writings on Design: Select Annotations," *Design Issues* 23, no. 1 (2007): 76, https://www.jstor.org/stable/25224091.
93 Protzen and Harris, *Universe of Design*, chapters 1.3–1.12.
94 W. Ross Ashby, *An Introduction to Cybernetics* (London: Chapman & Hall, 1956), 2.
95 Ibid., 121–25.
96 Ibid., 125.
97 W. Ross Ashby, "Requisite Variety and Its Implications for the Control of Complex Systems," *Cybernetica* 1, no. 2 (1958): section: Variety, reprinted in: George J. Klir, ed., *Facets of Systems Science: IFSR International Series on Systems Science and Engineering*, vol. 7 (Boston, MA: Springer, 1991), 405–17, https://doi.org/10.1007/978-1-4899-0718-9_28.
98 Protzen and Harris, *Universe of Design*, 107.
99 Rittel, "Some Principles," 20.
100 This combination of generating and reducing variety anticipates later descriptions of design processes in terms of the cybernetic structure of conversation, for example, Dubberly and Pangaro, "Cybernetics and Design"; Ranulph Glanville, "Try Again. Fail Again. Fail Better: The Cybernetics in Design and the Design in Cybernetics," *Kybernetes* 36, no. 9/10 (2007): 1173–1206, https://doi.org/10.1108/03684920710827238; Claudia Westermann, "The Art of Conversation: Design Cybernetics and Its Ethics," *Kybernetes* 49, no. 8 (2020): 2171–83, https://doi.org/10.1108/K-03-2019-0186.
101 Rittel, "Some Principles," 20.
102 Protzen and Harris, *Universe of Design*, 91.
103 Ashby, *Introduction to Cybernetics*, 3.

variety that is less than the greatest possible variety it could display.[104] Steering the ship constrains the direction in which the ship is headed, which is a selection among the many possible directions in which it could be steered or move if it is adrift. What Rittel articulates as the reduction of variety[105] or constraint[106] within design processes is the selection of courses of action among all possibilities.

Ashby uses the concept of variety to build a measure of the effectiveness of regulation. The variety of outcomes displayed follows from the relation between the variety of environmental disturbances and the variety of the possible responses that can be made to these disturbances. In the absence of responses that work for all or multiple disturbances, Ashby shows that to constrain the variety of outcomes further, it is necessary to increase the variety of the responses so that, at minimum, the variety of responses matches the variety of the disturbances—the "law of requisite variety."[107] Ashby gives an example of a fencer facing an opponent.[108] To be able to parry every move of the opponent (to constrain the outcome variety to this desirable state, regardless of the opponent's actions), the fencer must have enough variety of responses to meet the variety of challenges that the opponent presents.

Rittel adapts Ashby's scheme to the context of design. Ashby refers to the variety of a pair of sets that interact to form the variety of a third set. Together, these three sets are (1) the set of disturbances presented to a system by its environment, (2) the set of responses through which these disturbances are regulated, and (3) the set of outcomes that follow from the interaction between the disturbances and responses. In Rittel's account, there are three sets of variables:[109] performance variables, design variables, and context variables.[110] Reading Rittel in terms of Ashby, variety applies to each of these three variables. Rittel's context variables and design variables replace Ashby's disturbance and response.[111] The design variables are the possibilities that the designer has at least some control over. The context variables are "those factors affecting the object to be designed but not controlled by the designer."[112] Performance variables express the desired characteristics of what is being designed, such as the specifications given in a design brief or criteria for evaluation. In the 1971 paper, Rittel's use of performance aligns with the set of outcomes: the performance is a function of the interaction of design variables and context variables. However, the results of judgments about performance rely not only on the combination of design and context, but also on the evaluation processes and criteria that are employed. Rittel acknowledges the difficulties in evaluating overall performance where there are plural criteria, and frames this as a separate aspect of the design process.[113] In the context of wicked problems, it is, I suggest, helpful to understand evaluation criteria and processes as an additional set of variables with its own variety, alongside the varieties of design variables and context variables. The performance of an outcome relies not just on design and context but also on the variety of ways in which it is (and is not) evaluated.[114]

Rittel uses the notion of constraint in a similar way to Ashby when it comes to reducing variety.[115] Constraints are employed to exclude those

104 Ibid., 127.
105 Protzen and Harris, *Universe of Design*, 107; Rittel, "On the Planning Crisis," 395.
106 Protzen and Harris, *Universe of Design*, 114; Rittel, "Some Principles," 22; Rittel, "On the Planning Crisis," 393–94.
107 Ashby, *Introduction to Cybernetics*, chapter 11; Ashby, "Requisite Variety."
108 Ashby, "Requisite Variety," section: Examples in Biology.
109 Here I follow the 1971 article. For an earlier version of Rittel's three variable scheme, see Protzen and Harris, *Universe of Design*, 114.
110 Rittel, "Some Principles," 20.
111 Rittel is not explicit in the 1971 article about how the variables relate to Ashby's scheme. However, Protzen and Harris suggest this connection. Protzen and Harris, *Universe of Design*, 118.
112 Rittel, "Some Principles," 20.
113 Rittel, "Some Principles," 21–22. See also the contrast that Rittel draws with the biological examples given by Ashby. Protzen and Harris, *Universe of Design*, 97–98.
114 Cf. "Our point, rather, is that diverse values are held by different groups of individuals—that what satisfies one may be abhorrent to another, that what comprises problem-solution for one is problem-generation for another. Under such circumstances, and in the absence of an overriding social theory or an overriding social ethic, there is no gainsaying which group is right and which should have its ends served." Rittel and Webber, "Dilemmas," 169.
115 Protzen and Harris, *Universe of Design*, 114; Rittel, "Some Principles," 22.

116 Rittel, "Some Principles," 22.
117 Protzen and Harris, *Universe of Design*, 114.
118 Rittel, "Some Principles," 23.
119 Ibid., 19.
120 Ibid.
121 Rittel and Webber, "Dilemmas," 166.
122 Rittel, "Some Principles," 19, c.f. Rittel and Webber, "Dilemmas," 163.
123 Rittel, "Some Principles," 19.
124 Rittel and Webber, "Dilemmas," 163.
125 Rittel, "Some Principles," 23.
126 Rittel and Webber, "Dilemmas," 164.

possibilities that are not viable, meaningful, or desirable. It is best, I suggest, to understand constraint in terms of the possible combinations of variables. In designing a building, foundations (design variables) that would not be stable (performance variables) under the required loading and the ground conditions of the site (context variables) need to be constrained, that is, removed from consideration. However, what is excluded is not the structural design itself, but the specific relationship between this design, the required performance, and the context. The same foundations (design variables) may be stable (performance variables) under different loads or on sites with different ground conditions (context variables). Adding, removing, or changing evaluation criteria (e.g., cost, embodied carbon, buildability) leads to changes in judgments about performance, and, thus, changes in constraints.

Rittel argues that many constraints that seem as if they are given and unchangeable do not necessarily have to be accepted:

> "Whether something is under a constraint or not depends largely on the decision maker. The building code can be accepted as given and thus becomes a source of constraints, or one can decide to do something against some of its paragraphs. In this case 'changing the building code' has become a part of the design project."[116]

If no possibilities meet all constraints for some problem, then reconsidering the constraints can be a way "to open up a field of possible solutions,"[117] reframing the problem. If there are many possibilities within the constraints, then a further selection (constraint) must be made. Rittel notes the difficulties of definitively judging between solutions when many are possible and suggests selecting using criteria such as being "good enough."[118]

## From Wicked Problems to Wicked Possibilities

In the 1971 article, Rittel lists several wicked problem properties as "characteristics of design" that follow from conceiving design as "thinking before acting."[119] The designer "tries to behave responsibly … and not capriciously" and "worries about the potential effects" of proposed actions[120] (i.e., there is no right to be wrong).[121] "Design projects tend to be one-shot operations,"[122] and "how good a plan was will be found out later, during a future of indefinite length, reaching as far as causal chains can be and are constructed"[123] (i.e., there is no immediate and no ultimate test).[124] Rittel's understanding of design problems as involving a "unique and specific constellation of values"[125] (i.e., essentially unique)[126] is mentioned separately in the article but is closely related to this group.

These four characteristics (numbers 4, 5, 7, and 10 from the 1973 list) relate to the difference between design problems and those routine difficulties where design is not required (although it may still be desirable). Because these characteristics describe challenges that mean design is needed, it is not surprising that the limitations that follow from them accompany design activity. It is when designing is needed that these limitations on design arise. There is no need to create a new plan and try to predict its

outcomes in advance if a suitable plan already exists, such as where a problem situation is sufficiently similar to another that has been addressed. If the way a problem is solved will have no significant consequences one way or another, there is no need for design — one could act spontaneously or intuitively. If it is possible for attempts to be made, improved on, and unmade without causing unintended consequences, then there is no need to divide planning from action.

In cybernetic terms, the differences between problems that require design and those that do not can be understood through the variety of the situation in which the problem is recognized. A plan becomes necessary if differences between the variety displayed by the problem situation and possible precedents make the precedents inapplicable, if the variety of what is possible in the situation has the potential to be undesirable, or if changes in the variety of the situation could have unpredictable consequences for the future variety of this and other situations. These wicked problem characteristics are not properties of problems per se (recognized discrepancies between what is and what ought to be) or of the situations in which problems arise, but of relations among possibilities in how these situations are perceived and responded to in the making of plans.

What Rittel and Webber call tame problems include routine difficulties where design is not required, but also those design problems that are so tightly constrained that they have one clear solution — where there is only one possibility generated that is within the constraints; where there are many possibilities, and there is one that is preferrable to all others; or where there are many possibilities, and all create equivalent outcomes (such as a fencer having multiple ways to parry the same move). In these cases, the problem is experienced as tame because of how it has been formulated.[127] A chess problem for achieving checkmate in a set number of moves has (or does not have) a definitive solution because the problem framing invokes established conventions of the rules of chess and the information required to solve the problem (such as the positions of the pieces and whose move it is next). A scientific procedure follows a methodological process established by convention as required in that discipline.[128] The "strong autocratic decision structure"[129] of the military and space programs establishes a highly constrained context for everyone involved. A design brief that fully specifies the features of what is to be designed is the result of a design process that has already happened. In describing operations research, Rittel and Webber note that its methods are employed "only *after* the most important decisions have already been made."[130]

It might seem that those problems with only one solution are definitively solved, and those where no possibilities meet the constraints are definitively unsolvable. However, the status of these conclusions depends on whether it is possible to change constraints or to generate further variety. If it is possible to keep generating variety in design variables, new and better possibilities could become available. If the problem can be reformulated or if evaluation criteria can be changed, performance and context variables can be constrained in different ways. With less restrictive constraints, it can be easier to generate variety, leading to broader and more diverse possibilities from

127 C.f. discussions of undecidable and decidable decisions in second-order cybernetics. Foerster asserts that it is "only those questions that are in principle undecidable, *we* can decide…because the decidable questions are already decided by the choice of the framework in which they are asked, and by the choice of the rules used to connect what we label 'the question' with what we take for an 'answer'." Heinz von Foerster, *Understanding Understanding: Essays on Cybernetics and Cognition* (New York: Springer-Verlag, 2003), 293, see also: Glanville, "(Cybernetic) Musing"; Ben Sweeting, "Undeciding the Decidable," *Proceedings of the International Society for the Systems Sciences* 65, no. 1 (2022): 1–15, https://journals.isss.org/index.php/jisss/article/view/3888.

128 C.f. Heinz von Foerster, *The Beginning of Heaven and Earth Has No Name: Seven Days with Second-Order Cybernetics*, ed. Albert Müller and Karl H. Müller, trans. Elinor Rooks and Michael Kasenbacher (New York: Fordham University Press, 2014), 5.

129 Rittel, "On the Planning Crisis," 391.

130 Rittel and Webber, "Dilemmas," 162.

which to select. Where there is no clear ranking between multiple possibilities that meet the constraints (under-constraint), selecting between different possibilities is a matter of judgment. Depending on the circumstances, under-constraint could be welcomed as providing possibilities for conversation and choice[131] or worried about as a lack of precision. In a situation with few constraints, the variety of possibilities that could be explored may be overwhelming. For this reason, designers may assert additional constraints as well as making changes to existing ones. Whether and how to add, remove, or change constraints is another matter of judgment. Judgment is therefore involved in two interrelated senses—between under-constrained possibilities and regarding the constraints themselves. It is a matter of judgment (regarding constraints) whether and in what ways judgment (between under-constrained possibilities) is required. In a sense wickedness and tameness follow from judgments about how problems are framed. However, the relationship between wickedness and framing is not simply a matter of alternative framing choices. How design is approached, including how framing choices are made, is part of the broader dynamics of the situations in which designers try to enact change. Framing a problem as wicked or tame (either explicitly or implicitly) may be a cause of conflict within the situation.

In tightly constrained situations there are limits on the amount of variety that can be generated: "Chess has a finite set of rules, accounting for all situations that can occur. In mathematics, the tool chest of operations is also explicit; so, too, although less rigorously, in chemistry."[132] However, even in these cases, constraints can be challenged if the context is disputed. The rules of a game are contingent on the decision to play the game, and to abide by a particular version of the rules. Disciplinary norms apply within the contexts in which that discipline is invoked and shared. Those routine difficulties where design is not required can be thought about similarly. Just because design is unnecessary does not mean that it is undesirable. Reframing a routine problem as if it is unique could help create something distinctively different from the norm. Continuing with routine actions can reinforce the status of the contexts and assumptions under which they are accepted as routine. As Rittel notes: "every accepted constraint is an indicator of resignation: the decision maker has given in."[133] Challenging and redesigning routine practices can prompt changes in the contexts of these practices. In this sense, Ashby's description of cybernetics as envisaging a "set of possibilities much wider than the actual" may be interpreted in critical as well as explanatory terms—asking of tame problems and routine difficulties "why the particular case should conform to its usual particular restriction"[134] and whether, perhaps, it should not.

The remaining six wicked problem characteristics (numbers 1, 2, 3, 6, 8, and 9 from the 1973 list) appear in two places in the 1971 article. Rittel introduces several in arguing that "design problems are ill-behaved."[135] Design problems are not well-defined as "every formulation of the problem is already made in view of some particular solution principle"[136] (i.e., "no definitive formulation"[137]). It is not possible to "anticipate all conceivable

131 See, for example, the work of Thomas Fischer and Larry Richards, who have proposed orienting design around constraints rather than seeking specific goals. Fischer and Richards, "From Goal-Oriented to Constraint-Oriented Design"; Laurence D. Richards, "Cybernetics and Society Redux: The Necessity of Design," in *Design Cybernetics: Navigating the New*, ed. Thomas Fischer and Christiane M. Herr (Cham: Springer International Publishing, 2019), 263–80, https://doi.org/10.1007/978-3-030-18557-2_15.
132 Rittel and Webber, "Dilemmas," 164.
133 Rittel, "Some Principles," 22.
134 Ashby, *Introduction to Cybernetics*, 3.
135 Rittel, "Some Principles," 19.
136 Ibid.
137 Rittel and Webber, "Dilemmas," 161.

design possibilities before design starts"[138] (i.e., "wicked problems do not have an enumerable … set of potential solutions"[139]). There is "no criterion which would determine whether a solution is correct or false" and "no rule which would tell the designer when to stop."[140] The remaining two wicked problem characteristics appear among a number of other "recurring difficulties in design,"[141] and are similarly concerned with problem formulation. "Every discrepancy [problem] can be considered a symptom of a higher order discrepancy," and there are "many ways of explaining one and the same discrepancy."[142]

What Rittel describes as the ill-behaved character of design is the tendency for problems to become reformulated as they are worked on. This reformulation frustrates attempts to work on them linearly, with distinct analysis and synthesis phases.[143] Instead, Rittel characterizes design as a process where "better formulations of the problem are being developed simultaneously with a clearer and clearer image of the solution"[144] by cycling between the generation and reduction of variety. This process of reformulation has the potential to lead to further reformulation. Meeting the requirements of constraints requires generating variety. In generating variety, there is the potential to generate changes in requirements or desires: "new aspects become relevant and new kinds of information will lead to different questions about what is the case in the particular situation and about what is desired or acceptable."[145] New requirements may require more variety generation, leading in turn to further requirements in a back-and-forth cycle. As Rittel emphasizes, this continual reformulation presents significant obstacles to addressing problems. However, it is through the same processes of reformulation (generating variety and making changes to constraints) that design works through this challenge. These wicked problem characteristics, similarly to the first grouping, are not properties of problems (discrepancies between what is and what ought to be) but part of the conversational and sometimes playful[146] processes of designing. The tendency of design activity to reformulate problems is both a challenge that designers attempt to overcome and their method of overcoming this and other challenges.

The reformulation of problems through design is not confined to designers' processes. It can also extend into the contexts of these processes, reformulating the substance of perceived problems and how they are understood. Designing creates and changes relationships in multiple ways, most explicitly through various forms of participation but, more generally, in how designers' activity is embedded in the contexts in which they and others design and act. Consider a task such as the re-organization of a university. As per Rittel and Webber's discussion,[147] enacting any plan is a one-shot operation, leaving traces that cannot be undone. However, it is not just the enaction of the plan that leaves such traces. Even if no plan is carried out, researching, consulting on, and formulating proposals can lead to significant changes in how the university is organized, such as the formulation of new concerns, insights, alliances, and disputes. Understanding wickedness in terms of the relations in which designers are embedded means even the processes of designing are potentially one-shot

138 Rittel, "Some Principles," 19.
139 Rittel and Webber, "Dilemmas," 164.
140 Rittel, "Some Principles," 19, c.f. Rittel and Webber, "Dilemmas," 162.
141 Rittel, "Some Principles," 21.
142 Ibid.; Rittel and Webber, "Dilemmas," 165–66.
143 Rittel, "Some Principles," 19.
144 Ibid., 20.
145 Rittel, "Some Principles," 19.
146 Perera, "Wicked Problems, Wicked Humor"; Perera, "Wicked Problems, Wicked Play."
147 Rittel and Webber, "Dilemmas," 163.

operations, having consequences in and of themselves.[148] Who and what is included and excluded in designing, and how, may have significant consequences beyond the enacting of any plan produced. In the same way that reformulating problems presents opportunities as well as limitations, this wickedness is not necessarily problematic. Design processes may themselves be designed to reverberate through a context in ways that enact change and create new possibilities.

When wickedness is understood in terms of the relationships between design processes and the contexts in which they are embedded, the notion that designing is not limited to professional designers takes on an expanded significance. Rittel's sense of designing as the creation of plans for action is a "ubiquitous human activity."[149] Many people may be simultaneously attempting to create plans for a situation according to different values and agendas. Rittel and Webber were writing in response to such a context — the contestations and conflicts of the 1960s and 1970s. The variety generated and constrained by multiple parallel attempts to create change can have broader consequences, forming parts of what others perceive as problems and possibilities. The variables of design, context, and performance have different varieties for different people, depending on how they are positioned in the situation.[150] Evaluation criteria and processes can be defined in multiple ways. It is in this sense that wicked problems do not have "true-or-false" solutions.[151] It is not that resolutions to wicked problems are arbitrary. Recalling Ashby, variety is "not an intrinsic property of the set"[152] but is dependent on how it is observed and, so, on how different people are situated. Different varieties are experienced in parallel. These different varieties result in different constraints being desirable: "that what satisfies one may be abhorrent to another, that what comprises problem-solution for one is problem-generation for another."[153] What matters to someone in a context depends on their relationships and purposes in that context. Moreover, how different people are situated leads to asymmetries and inequities in the resources, networks, and opportunities that are needed to design and enact change. A situation may be wicked or tame for different people depending on how they are situated and the variety they experience.

The interrelationships among all involved contribute to multiple feedback loops through which problems become reformulated, leading to new possibilities and discrepancies, changing constraints and variables, and generating variety. Multiple designers (in the broadest senses of design) responding to each other could lead to a proliferating variety of differences in constraints and problem formulations, as each designer generates variety in response to the variety generated by others. When would such a process converge? When would it diverge? And when would convergence or divergence be desirable? Some situations are more sensitive to these dynamics than others. In cybernetic terms, this sensitivity relates to the variety of the situation — the number of different people involved, the variety each perceives depending on how they are situated, and the variety amongst different desires and constraints. While the social situations Rittel and Webber focus on are the most obvious examples, ecological and

148 See Rittel's discussion of trying to trace the consequences of tracing the consequences of actions. Rittel, "On the Planning Crisis," 391–92.
149 Rittel, "Some Principles," 19.
150 "But normally, different people assess the same object from different standpoints". Rittel, "Some Principles," 21.
151 Rittel and Webber, "Dilemmas," 162.
152 Ashby, *Introduction to Cybernetics*, 125.
153 Rittel and Webber, "Dilemmas," 169.

154 Churchman, "Wicked Problems," B141.
155 Rittel and Webber, "Dilemmas," 160.

some technological contexts may also be sensitive to reformulation through changes in the interactions of variety resulting from designing. When the reformulation of variety through design is minor, slow, predictable, or moderate in its consequences, it is possible for designers to catch up — to generate and constrain variety more quickly than the substance of the problem becomes reformulated through their doing so. Those problem-solving situations regarded as tame are typically like this. Attempts to solve a chess puzzle do not change the rules of chess. Each attempt can, therefore, be built on by the next. When the reformulation of variety through design is substantial, fast, unpredictable, and consequential, designers may fall further and further behind, as their attempts to plan lead to changes within the contexts for which they are planning. These dynamics may be experienced differently by different people, depending on how they are situated. Things may be proceeding according to plan from one perspective while spiraling out of control from another. This dynamic is a way to make sense of some of the most intractable challenges, where attempts to address one aspect create unpredictable consequences elsewhere — those crises where, as Churchman put it, "proposed 'solutions' often turn out to be worse than the symptoms."[154]

## Conclusion

Building on Rittel's references to the cybernetic concepts of variety and constraint, I have highlighted aspects of design processes where the different types of difficulty presented by wicked and tame problems become evident. These have included the difference between routine difficulties and those where design is required; the different ways in which design problems are constrained; differences between the challenge of meeting constraints compared to making judgments about how to employ and change constraints; the feedback relations between the generation of variety in design and the reformulation of problems; and the potential for interaction between design processes and the contexts in which these processes are embedded. Rittel and Webber's 1973 article describes the characteristics of wicked problems as "properties of social systems."[155] Many subsequent invocations of the distinction between wicked and tame have interpreted it in this way, as describing properties of problems or the situations in which problems arise. While remaining rooted in Rittel's understanding of design processes, the interpretation of the distinction between wickedness and tameness I have developed here differs from Rittel and Webber's characterization. Understanding wickedness in terms of variety and constraint means that it is not problems that are wicked or tame. Instead, wickedness and tameness are dynamics of possibilities in how multiple aspects of problems are perceived and responded to across the relationships in which designing, in its broadest senses, is embedded. Assertions that design disciplines are well suited to addressing wicked problems or that all or most design problems are wicked tell of only part of the tangled relationship between design and wickedness. It is when designing is needed that design is subject to the limitations described by the wicked problem characteristics. The tendency for design

problems to become reformulated as they are worked on is both a challenge that designers attempt to overcome and their way of overcoming this and other challenges. The wicked problem characteristics describe both possibilities and challenges in how variety is generated and constrained, how constraints are employed and changed, and how the actions of designers in all senses contribute to reformulating the contexts in which they work.

## Declaration of Interest

There are no conflicts of interest involved in this article.

## Acknowledgments

This article is developed from a presentation at the "50 Years Wicked" symposium, June 8–9, 2023, hosted at the School of Design at the Southern University of Science and Technology in Shenzhen, China. Thank you to Thomas Fischer and Christiane M. Herr for the opportunity to participate in this event, and to everyone who contributed. The ideas presented in this article have been greatly influenced by conversations with Sally Sutherland and Dulmini Perera. The phrase "wicked possibilities" was created by Sutherland for the title of a symposium hosted by the Radical Methodologies Research Group at the University of Brighton on July 15, 2020. This event was generously supported by the university's Connected Futures initiative and the School of Architecture and Design. In addition, I am very grateful to the following for their insights, comments, and support: Tom Ainsworth, Tilo Amhoff, Joanna Boehnert, Pille Bunnell, Karen Cham, Queenie Clarke, Ken Friedman, Jon Goodbun, Marie Davidová, Dana Hamdan, Jin Ma, Shobhana Nagraj, Paul Pangaro, Simon Sadler, Tanya Southcott, Mathilda Tham, and Andre Viljoen.

## References

Ackoff, Russell L. "The Future of Operational Research Is Past." *The Journal of the Operational Research Society* 30, no. 2 (1979): 93–104. https://doi.org/10.2307/3009290.

Alford, John, and Brian W. Head. "Wicked and Less Wicked Problems: A Typology and a Contingency Framework." *Policy and Society* 36, no. 3 (2017): 397–413. https://doi.org/10.1080/14494035.2017.1361634.

Allen, Peter. "The End of Modernism?: People's Park, Urban Renewal, and Community Design." *Journal of the Society of Architectural Historians* 70, no. 3 (2011): 354–74. https://doi.org/10.1525/jsah.2011.70.3.354.

Ashby, W. Ross. *An Introduction to Cybernetics*. London: Chapman & Hall, 1956.

Ashby, W. Ross. "Requisite Variety and Its Implications for the Control of Complex Systems." *Cybernetica* 1, no. 2 (1958).

Batty, Michael. "Great Planning Disasters." In *The Planning Imagination: Peter Hall and the Study of Urban and Regional Planning*, edited by Mark Tewdwr-Jones, Nicholas A. Phelps, and Robert Freestone, 28–39. London: Routledge, 2014.

Buchanan, Richard. "Wicked Problems in Design Thinking." *Design Issues* 8, no. 2 (1992): 5–21. https://doi.org/10.2307/1511637.

Burge, Janet E., and Raymond McCall. "Diagnosing Wicked Problems." In *Design Computing and Cognition '14*, edited by John S. Gero and Sean Hanna, 313–26. Cham: Springer, 2015. https://doi.org/10.1007/978-3-319-14956-1_18.

Chan, Jeffrey Kok Hui, and Wei-Ning Xiang. "Fifty Years after the Wicked-Problems Conception: Its Practical and Theoretical Impacts on Planning and Design." *Socio-Ecological Practice Research* 4, no. 1 (2022): 1–6. https://doi.org/10.1007/s42532-022-00106-w.

Chan, Jeffrey K. H. "The Ethics of Wicked Problems: An Exegesis." *Socio-Ecological Practice Research* 5, no. 1 (2023): 35–47. https://doi.org/10.1007/s42532-022-00137-3.

Churchman, C. West. "Guest Editorial: Wicked Problems." *Management Science* 14, no. 4 (1967): B141–42. http://www.jstor.org/stable/2628678.

Churchman, C. West, Jean-Pierre Protzen, and Melvin M. Webber. "In Memoriam: Horst W. J. Rittel." *Design Issues* 23, no. 1 (2007): 89–91. http://www.jstor.org/stable/25224093.

Conklin, Jeffrey. *Dialogue Mapping: Building Shared Understanding of Wicked Problems*. Chichester, UK: Wiley, 2006.

Coyne, Richard. "Wicked Problems Revisited." *Design Studies* 26, no. 1 (2005): 5–17. https://doi.org/10.1016/j.destud.2004.06.005.

Crowley, Kate, and Brian W. Head. "The Enduring Challenge of 'Wicked Problems': Revisiting Rittel and Webber." *Policy Sciences* 50, no. 4 (2017): 539–47. https://doi.org/10.1007/s11077-017-9302-4.

Cutler, Terry, and Mark Burry. *Designing Solutions to Wicked Problems: A Manifesto for Transdisciplinary Research and Design*. RMIT University, 2010. Available at https://apo.org.au/sites/default/files/resource-files/2010-10/apo-nid26688.pdf.

Dubberly, Hugh, and Paul Pangaro. "Cybernetics and Design: Conversations for Action." In *Design Cybernetics: Navigating the New*, edited by Thomas Fischer and Christiane M. Herr, 85–99. Cham: Springer, 2019. https://doi.org/10.1007/978-3-030-18557-2_4.

Farrell, Robert, and Cliff Hooker. "Design, Science and Wicked Problems." *Design Studies* 34, no. 6 (2013): 681–705. https://doi.org/10.1016/j.destud.2013.05.001.

Fischer, Thomas, and Laurence D. Richards. "From Goal-Oriented to Constraint-Oriented Design: The Cybernetic Intersection of Design Theory and Systems Theory." *Leonardo Journal* 50, no. 1 (2017): 36–41. https://doi.org/10.1162/LEON_a_00862.

Fischer, Thomas, and Christiane M. Herr, eds. *Design Cybernetics: Navigating the New.* Cham: Springer, 2019. https://doi.org/10.1007/978-3-030-18557-2.

Fischer, Thomas. "Narratives of Exploration: From 'Failure Is not an Option' to 'Try Again. Fail Again. Fail Better.'" *Kybernetes* 49, no. 8 (2020): 2091–2108. https://doi.org/10.1108/K-07-2019-0502.

Von Foerster, Heinz, ed. *Cybernetics of Cybernetics: The Control of Control and the Communication of Communication*. Urbana, Illinois: University of Illinois, 1974. Available at https://digital.library.illinois.edu/items/2504bc20-2c83-0136-4d81-0050569601ca-5.

Von Foerster, Heinz. "Cybernetics of Cybernetics." In *Communication and Control in Society*, edited by Klaus Krippendorff, 5–8. New York: Gordon and Breach, 1979.

Von Foerster, Heinz. *Understanding Understanding: Essays on Cybernetics and Cognition*. New York: Springer-Verlag, 2003.

Von Foerster, Heinz. *The Beginning of Heaven and Earth Has No Name: Seven Days with Second-Order Cybernetics*. Edited by Albert Müller and Karl H. Müller. Translated by Elinor Rooks and Michael Kasenbacher. New York: Fordham University Press, 2014.

Friedman, Ken. "Three Thousand Years of Designing Business and Organizations." In *Designing Business and Management*, edited by Sabine Junginger and Jurgen Faust, 67–80. London: Bloomsbury, 2016. https://doi.org/10.5040/9781474243551.ch-005.

Glanville, Ranulph. "Researching Design and Designing Research." *Design Issues* 15, no. 2 (1999): 80–91. https://doi.org/10.2307/1511844.

Glanville, Ranulph. "Try Again. Fail Again. Fail Better: The Cybernetics in Design and the Design in Cybernetics." *Kybernetes* 36, no. 9/10 (2007): 1173–1206. https://doi.org/10.1108/03684920710827238.

Glanville, Ranulph. "A (Cybernetic) Musing: Wicked Problems." *Cybernetics and Human Knowing* 19, no. 1-2 (2011): 165–75. Available at https://ranulphglanville.org.za/wp-content/uploads/2021/05/Wicked-Problems-final.pdf.

Irwin, Terry. "Wicked Problems and the Relationship Triad." In *Grow Small, Think Beautiful: Ideas for a Sustainable World from Schumacher College*, edited by Stephan Harding, chapter 18. Edinburgh: Floris Books, 2011.

Irwin, Terry. "The Emerging Transition Design Approach." In *Design as a Catalyst for Change—DRS International Conference 2018*, edited by C. Storni, K. Leahy, M. McMahon, P. Lloyd and E. Bohemia, 968–89. Limerick, Ireland: DRS, 2018. https://doi.org/10.21606/drs.2018.210.

Ison, Raymond L., Kevin B. Collins, and Philip J. Wallis. "Institutionalising Social Learning: Towards Systemic and Adaptive Governance." *Environmental Science & Policy* 53 (November 2015): 105–117. https://doi.org/10.1016/j.envsci.2014.11.002.

Kirschke, Sabrina, Christian Franke, Jens Newig, and Dietrich Borchardt. "Clusters of Water Governance Problems and Their Effects on Policy Delivery." *Policy and Society* 38, no. 2 (2019): 255–77. https://doi.org/10.1080/14494035.2019.1586081.

Klir, George J., ed. *Facets of Systems Science: IFSR International Series on Systems Science and Engineering*, vol. 7. Boston, MA: Springer, 1991. https://doi.org/10.1007/978-1-4899-0718-9.

Lake, Danielle. "Jane Addams and Wicked Problems: Putting the Pragmatic Method to Use." *The Pluralist* 9, no. 3 (2014): 77–94. https://doi.org/10.5406/pluralist.9.3.0077.

Levin, Kelly, Benjamin Cashore, Steven Bernstein, and Graeme Auld. "Overcoming the Tragedy of Super Wicked Problems: Constraining Our Future Selves to Ameliorate Global Climate Change." *Policy Sciences* 45, no. 2 (2012): 123–52. https://doi.org/10.1007/s11077-012-9151-0.

Lönngren, Johanna, and Katrien van Poeck. "Wicked Problems: A Mapping Review of the Literature." *International Journal of Sustainable Development & World Ecology* 28, no. 6 (2021): 481–502. https://doi.org/10.1080/13504509.2020.1859415.

McCall, Raymond, and Janet Burge. "Untangling Wicked Problems." *Artificial Intelligence for Engineering Design, Analysis and Manufacturing* 30, no. 2 (2016): 200–210. https://doi.org/10.1017/S089006041600007X.

Murphy, Ryan J. A., and Peter Jones. "Towards Systemic Theories of Change: High-Leverage Strategies for Managing Wicked Problems." *Design Management Journal* 16, no. 1 (2021): 49–65. https://doi.org/10.1111/dmj.12068.

Özbekhan, Hasan. *The Predicament of Mankind: A Quest for Structured Responses to Growing World-Wide Complexities and Uncertainties*. Proposal, Club of Rome, 1970. Available at https://s3.amazonaws.com/arena-attachments/644235/cda871b-45cee6722e3b08ab1070adda4.pdf.

Perera, Dulmini. "Wicked Problems, Wicked Humor: Fun Machines as a Method to Frame Wicked Problems in Architecture." *Proceedings of Relating Systems Thinking and Design* RSD7 (2018): 505–15. https://rsdsymposium.org/wicked-problems-wicked-humor-fun-machines-as-a-method-to-frame-wicked-problems-in-architecture/.

Perera, Dulmini. "Wicked Problems, Wicked Play: Fun Machines as Strategy." *FormAkademisk* 13, no. 2 (2020): 1–19. https://doi.org/10.7577/formakademisk.3378.

Peters, B. Guy. "What Is so Wicked about Wicked Problems? A Conceptual Analysis and a Research Program." *Policy and Society* 36, no. 3 (2017): 385–96. https://doi.org/10.1080/14494035.2017.1361633.

Peters, B. Guy, and Matthew Tarpey. "Are Wicked Problems Really so Wicked? Perceptions of Policy Problems." *Policy and Society* 38, no. 2 (2019): 218–36. https://doi.org/10.1080/14494035.2019.1626595.

Pickering, Andrew. "Wicked Problems and the Cybernetic Method." Paper presented at the *Epistemic Commitments of Complexity Theories*, ENS Lyon, January 11, 2021. Available at https://www.ixxi.fr/lyonpickeringcomplexitypolitics.pdf?lang=en.

Protzen, Jean-Pierre, and David J. Harris, eds. *The Universe of Design: Horst Rittel's Theories of Design and Planning*. London: Routledge, 2010.

Ramage, Magnus, and Karen Shipp. *Systems Thinkers*. London: Springer, 2009.

Richards, Laurence D. "Cybernetics and Society Redux: The Necessity of Design." In *Design Cybernetics: Navigating the New*, edited by Thomas Fischer and Christiane M. Herr, 263–80. Cham: Springer International Publishing, 2019. https://doi.org/10.1007/978-3-030-18557-2_15.

Rith, Chanpory, and Hugh Dubberly. "Horst W. J. Rittel's Writings on Design: Select Annotations," *Design Issues* 23, no. 1 (2007): 75–77. https://www.jstor.org/stable/25224091.

Rith, Chanpory, and Hugh Dubberly. "Why Horst W. J. Rittel Matters." *Design Issues* 23, no. 1 (2007): 72–91. https://doi.org/10.1162/desi.2007.23.1.72.

Rittel, Horst. "Some Principles for the Design of an Educational System for Design." *Journal of Architectural Education* 25, no. 1/2 (1971): 16–27. http://www.jstor.org/stable/1423929.

Rittel, Horst. "On the Planning Crisis: Systems Analysis of the 'First and Second Generations.'" *Bedriftskonomen* 8 (1972): 392.

Rittel, Horst W. J., and Melvin M. Webber. "Dilemmas in a General Theory of Planning." *Policy Sciences* 4, no. 2 (1973): 155–69. https://www.jstor.org/stable/4531523.

Simon, Herbert A. "The Structure of Ill Structured Problems." *Artificial Intelligence* 4, no. 3-4 (1973): 181–201. https://doi.org/10.1016/0004-3702(73)90011-8.

Skaburskis, Andrejs. "The Origin of 'Wicked Problems.'" *Planning Theory & Practice* 9, no. 2 (2008): 277–80. https://doi.org/10.1080/14649350802041654.

Spencer, Chantal. "Rethinking Participatory Design Research Methodologies." *Proceedings of Relating Systems Thinking and Design* RSD11 (2022): article no. 158. https://rsdsymposium.org/rethinking-participatory-design-research-methodologies.

Sweeting, Ben, Sally Sutherland, and Tom Ainsworth. "Wicked Possibilities: Alternatives to Taming." *Proceedings of Relating Systems Thinking and Design* RSD10 (2021): online. https://rsdsymposium.org/wicked-possibilities-alternatives-to-taming/.

Sweeting, Ben. "Undeciding the Decidable." *Proceedings of the International Society for the Systems Sciences* 65, no. 1 (2022): 1–15. https://journals.isss.org/index.php/jisss/article/view/3888.

Sweeting, Ben, and Sally Sutherland. "Design's Secret Partner in Research: Cybernetic Practices for Design Research Pedagogy." *Systems Research and Behavioral Science* 40, no. 5 (2023): 765–71. https://doi.org/10.1002/sres.2974.

Termeer, Catrien J. A. M., Art Dewulf, and Robbert Biesbroek. "A Critical Assessment of the Wicked Problem Concept: Relevance and Usefulness for Policy Science and Practice." *Policy and Society* 38, no. 2 (2019): 167–79. https://doi.org/10.1080/14494035.2019.1617971.

Turnbull, Nick, and Robert Hoppe. "Problematizing 'Wickedness': A Critique of the Wicked Problems Concept, from Philosophy to Practice." *Policy and Society* 38, no. 2 (2018): 315–37. https://doi.org/10.1080/14494035.2018.1488796.

Ulrich, Werner. "In Memory of C. West Churchman (1913–2004): Reminiscences, Retrospectives, and Reflections." *Journal of Organisational Transformation & Social Change* 1, no. 2 (2004): 199–219. https://doi.org/10.1386/jots.1.2.199/0.

Verma, Niraj. "The Disarming Simplicity of Wicked Problems: The Biography of an Idea." *Socio-Ecological Practice Research* 5, no. 2 (2023): 151–57. https://doi.org/10.1007/s42532-023-00143-z.

Vermaas, Pieter E., and Udo Pesch. "Revisiting Rittel and Webber's Dilemmas: Designerly Thinking against the Background of New Societal Distrust." *She Ji: The*

*Journal of Design, Economics, and Innovation* 6, no. 4 (2020): 530–45. https://doi.org/10.1016/j.sheji.2020.11.001.

Westermann, Claudia. "The Art of Conversation: Design Cybernetics and Its Ethics." *Kybernetes* 49, no. 8 (2020): 2171–83. https://doi.org/10.1108/K-03-2019-0186.

Zivkovic, Sharon. "Systemic Innovation Labs: A Lab for Wicked Problems." *Social Enterprise Journal* 14, no. 3 (2018): 348–66. https://doi.org/10.1108/SEJ-04-2018-0036.