

# Untangling Wicked Problems

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# Wicked Problems

- There is a need for a theory of design to describe complicated real-world problems that can guide designers towards better solutions
- Some problems are tame – the problem is well defined with a clear process for solution
  - Ex: Chess
- Horst Rittel coined the term “wicked problems” to describe “that class of problems which are ill-formulated, where the information is confusing, where there are many decision makers and clients with conflicting values, and where the ramifications in the whole system are confusing.”<sup>1</sup>

Churchman, C. W. (1967). Wicked problems. *Management Science*, 14 (4), B-141-B-142.

# Rittel's Criteria<sup>2</sup>

1. There is no single definitive description of a wicked problem.
2. Wicked problems have no clear end ("stopping rule") to indicate when the problem has been solved.
3. Solutions are not right or wrong, but instead are good or bad.
4. There is no "immediate or ultimate" test that can be applied to a solution to a wicked problem.
5. Solutions to wicked problems have irreversible consequences so solving a wicked problem is a "one shot operation."

Rittel, H. W. J. & Webber, M. M. (1973) Dilemmas in a general theory of planning. *Policy Sciences*, 4, 155-169

# Rittel's Criteria<sup>2</sup> (cont.)

6. It is not possible to exhaustively list all potential solutions to a wicked problem.
7. Every wicked problem is "essentially unique."
8. Every wicked problem is actually a symptom of a larger wicked problem.
9. There are many explanations for the cause of a wicked problem and the one chosen then determines how the problem can be resolved.
10. The planner "has no right to be wrong."

Rittel, H. W. J. & Webber, M. M. (1973) Dilemmas in a general theory of planning. *Policy Sciences*, 4, 155-169

# Widely Accepted Concept

- Hilary Clinton and Barack Obama described Syria as a “wicked problem” in their joint 60 minutes interview
- 121,000 Google hits (5,660 in Google Scholar)
- Mentioned in recent International Conference on Software Engineering keynote in reference to Ultra Large Scale Systems.

# WP Example

- Baggage handling system at Denver International Airport
  - Multiple stakeholders
  - Unforeseen consequences
  - Ultimately, failure...

# Research Questions

1. What should the criteria be for defining wicked problems?
  - Are Rittel's criteria sufficient?
2. How should these criteria be applied when determining wickedness?
  - Must they all apply? Can there be degrees of wickedness?
3. How does the wicked problem theory serve design?
  - Most discussions just point out problems – how does it help designers?

# Evaluating the Rationale for WPs

- Need for clarification
- Two-step approach to clarification:
  - Common arguments for multiple properties
  - Property-by-property analysis of WPs.



# The Need for Clarification

- **Clear meaning of the properties?**
  - Not always
- **Sound arguments?**
  - Not always
- **Missing important implications?**
  - Often
  - Rittel is interested in diagnosing wickedness
  - Additional explanations are needed to show how this enables designers to create better designed artifacts

# Common arguments

- **Common approach: Epistemological skepticism**
- **Completeness claims cannot be justified**
  - All consequences?
  - All solutions?
  - All causes?
- **Open-ended causal networks in the real world create difficulties**
  - Chains of causes of problems
  - Chains of goals for problems
  - Chains of consequences of solution ideas
  - Chains form open-ended causal networks
- **Multiple stakeholders in WPs create problems**
  - Preclude objective decisions

# Rittel's Portrayals of Design

- **Rittel's two articles on wicked problems**
- **In Dilemmas article: reduce poverty**
  - Backward chaining to find potential causes of the problem
  - Each potential cause dictates a solution
- **In Systems Analysis article: introduce new product**
  - There is no cause of this type of problem
  - Forward chaining to find effects of solution ideas
- **No portrayal of normal professional design**
  - Without this, his arguments are not persuasive.

# Normal Professional Design

- **Design professions are domain-oriented – solution domain**
- **Design professionals “pre-judge” the solution domains of the WPs they tackle**
- **Most aspects of their WPs do not have causes**
  - Problem as-a-whole has no cause & most of its parts have no cause
  - Method: Forward chaining to find effects/consequences of solution ideas
- **Some aspects – mostly negative things – do have causes**
  - Aspects with causes
    - Societal ills/goals – example: global warming/green building
    - Negative side-effects – example: pedestrian zone requires peripheral parking that angers neighbors
    - Implementation difficulties – problems in making the DIA baggage handling reliable
  - Methods:
    - Backward chaining from these aspects to domain causes
    - Forward chaining from domain solutions to negation of aspects
    - Complex combinations of forward and backward chaining.

# Property 1: There is no definitive formulation of a wicked problem

- **Definitive = formulation contains all info needed for understanding and solving the WP**
- **Refutation of Waterfall approach:**
  - first formulate then solve
- **Rittel's arguments:**
  - Systems Analysis article: WP: implement a newly designed product into product line
    - New solution ideas generate new info needs
    - Have to know all possible solutions in advance: IMPOSSIBLE!
    - Forward chaining
  - Dilemmas article: WP: reduce poverty
    - Every possible cause of a WP implies a solution idea
    - Have to know all possible causes in advance: IMPOSSIBLE!
    - Backward chaining.

# Critique of Property 1

- **Meaning of property:**
  - Unclear whether you can never have a definitive formulation, even at end of project
  - Later properties (2, 3, 4 & 6) show that you cannot
- **Soundness of arguments:**
  - Rittel does not say why you cannot generate all causes/possible solutions to a WP until Property 6
  - Does not cover normal professional design
- **Unstated taming principle:**
  - The designer never has the resources to collect all the info needed.

# Property 2: Wicked problems have no stopping rule

- **Nothing in the logic of the problems tells you when to stop working**
- **Rittel's arguments:**
  - There are no firm criteria for problem understanding
  - Causal chains are endless
    - causes, solutions, goals, consequences
  - So designer can always try to do better
- **Taming principle:**
  - You stop when you run out of resources (time, money, manpower, etc.).

# Critique of Property 2

- Meaning of property:
  - Clear
- Soundness of argument:
  - Good
  - Real designers say, “Design projects are abandoned, not completed.”



# Property 3: Solutions to WPs are not true/false but good/bad

- **Meaning:**
  - They involve value judgments, not factual judgments
- **Rittel's arguments:**
  - Usually there are multiple stakeholders
  - They are typically have different opinions
  - They are equally entitled to judge solutions
  - They express their opinions of solutions as good/bad.

# Critique of Property 3

- **Meaning of property:**
  - Clear
- **Soundness of argument:**
  - Good, but there is a missing piece:
  - Missing part of argument:
    - If multiple people with different opinions are entitled to judge a solution, then how to value (weight) their judgments is a political question that requires a value judgment.
    - That is why the judgment of a solution must be a value judgment.
- **Crucial unstated implications:**
  - There are no objective procedures for making value judgments.
  - Science requires objective procedures
  - So there is no scientific decision making with multiple stakeholders.
  - Design is not a science.

# Property 4: There is no immediate or ultimate test of a WP solution

- **Meaning:**
  - There is no definitive test.
  - There are no objective criteria for testing.
- **Rittel's argument:**
  - There are unbounded chains of consequences
  - Future consequences can outweigh earlier consequences
  - Cannot test a solution idea without knowing all consequences.

# Critique of Property 4

- **Meaning of property:**
  - Clear
- **Soundness of argument:**
  - Counter-argument:
    - The further into the future the consequences are, the less reliable our understanding is about these consequences. At some point it becomes too dangerous to base our decisions on such unreliable information.
- **Suggested taming principles:**
  - Whether we consider more consequences is determined by how best to invest our limited resources (time, money, manpower, etc.)
  - To design, we must test solution ideas without considering all the consequences
  - Designers are justified in ignoring far-future consequences that they are uncertain of

# Property 5: Solving a WP is a one-shot operation: no trial-and-error

- **Meaning:**
  - There can be no trial-and-error in the real world
- **Rittel's argument:**
  - Solutions to WPs have irreversible consequences.  
So trial-and-error cannot be justified in a project.  
It is unethical.

# Critique of Property 5

- **Meaning of property:**
  - Clear
- **Soundness of argument:**
  - Good.
- **Suggested complementary principle:**
  - In another sense, *trial-and-error may be unavoidable*, because predicting all consequences of solutions is not possible. Once a project is completed, we begin to discover the unforeseen consequences. This may require redesign to deal with these consequences. In this sense, *solving a WP is unlikely to be a one-shot operation*. There is no guarantee that trial-and-error can be avoided.
  - We call coping with feedback from implementation and use *situated reasoning*. This extends Schön's ideas beyond reflection-in-action.

# Property 6: It is not possible to list all potential solutions to a WP

- **Rittel's argument:**
  - There are no criteria for proving that all solutions have been identified
- **Soundness of argument:**
  - Sound

# Property 7: Every wicked problem is essentially unique

- **Meaning:**
  - There can exist unique aspects of a WP that are more important than similarities with other WPs
- **Rittel's argument:**
  - Unique factors always exist in a new project. They might not be important, but there is no way to know this at the beginning of a project.



# Critique of Property 7

- **Meaning of property:**
  - Clear
- **Soundness of argument:**
  - Rittel gives almost no argument.
  - Suggested missing argument: uniqueness of the physical and social context of each WP means that it is likely to differ from others in many ways due to the influence of the context. The inevitable importance of the social and physical factors suggests that some of the unique factors may be of great importance for the design.
- **Suggested complementary principle:**
  - Essential uniqueness does not imply that we should ignore the lessons learned from previous projects. In the sense that to the extent that designers are skilled, it is because of what they have learned before beginning to solve the current WP. This includes what they are learned from formal education and previous experience of themselves and others. To deny this is to deny the reality of expertise in design.

# Property 8: Every WP can be seen as a symptom of another WP

- **Meaning:**
  - Every WP is caused by another WP and can therefore be considered a symptom of that other WP.
- **Rittel's argument:**
  - Any WP can be considered as being caused by another, more fundamental WP. Solving the more fundamental problem will solve the one it causes.

# Critique of Property 8

- **Meaning of property:**
  - Clear
- **Soundness of argument:**
  - Not sound as stated.
  - The WP presented in the Systems Analysis article, i.e. the problem of implementing a new product, is not caused by another WP. It is caused by the decision to implement a new product. There may be good reasons for wanting to implement a new product, but these are not causes. They are intended, *desirable effects* of implementing a new product.
  - Most WPs solved by professional designers are not caused by other WPs.
  - Property 8 needs to be restated as follows: *Any WP that is caused by second WP can be consider a symptom of that second WP.*
  - *Most (all?) WPs with causes are negative problems, not positive problems.*

# Property 9: There are many explanations for the cause of a WP. The one chosen determines how the WP is solved.

- **Rittel's argument:**
  - He gives an example of alternative potential causes of a societal problem, and then shows how the elimination of each cause dictates the direction of the solution
- **Critique of soundness of argument:**
  - Sound as long as it does not assume that all WPs have causes. For WPs that do not have causes, the solution is determined by instrumental reasoning with causal chains to meet the stated requirements of the problem. For design professionals these causal chains connect features of artifact in their given design domain to the requirements.
  - If the problem is a difficulty that arises in solving a WP that has no cause, that difficulty is a WP that can be seen as the symptom of another WP.
  - Fails to mention impact of multiple stakeholders

# Property 10: The designer has no “right to be wrong”

- **Meaning:**
  - Karl Popper maintained that scientists have the “right to be wrong,” because it is important that they generate bold hypotheses. Rittel argues that designers, by contrast, are responsible for the consequences of their design decisions.
- **Rittel’s argument:**
  - Popper’s arguments do not apply to design. The decisions of designers are intended to affect people. They may help or harm people. Designers are therefore held accountable legally and morally for their decisions.

# Critique of Property 10

- **Meaning of property:**
  - Clear
- **Soundness of argument:**
  - Designers are in fact held accountable for what they do.
  - Partial counterargument: Given the inevitability of unforeseen consequences, society should recognize that designers cannot be held accountable for what they cannot possibly foresee. Design of necessity involves the risk of unforeseen consequences, but not designing carries its own risks to society.
- **Suggested complementary principles:**
  - Designers should have the right to design, which includes the right to produce unforeseeable consequences.
  - Designers should accept the need to redesign to deal with unforeseen consequences. In other words, designer should recognize the need for situated reasoning in dealing with WPs.

# Our contributions

- **Repaired some meanings and arguments**
- **Rewrote Property 8:**
  - Not all WPs have causes.
- **Showed how wicked problems include “normal professional design”.**

# Necessary Clarifications/ Qualifications for WPs

- Multi-stakeholder design cannot be a science—settling controversy requires value judgments
- Designers should evaluate the reliability of information when assessing potential consequences and not be paralyzed by the unknown
- Backward chaining in professional design is based on causes being within the professionals' solution domain
- Essential uniqueness does not imply that we should ignore the lessons learned.



# Necessary Clarifications/ Qualifications for WPs

- Trial-and-error may be unavoidable because of unforeseen consequences
- Designers should have the right to design, which includes the right to produce unforeseeable consequences
- Design is unlikely to be a one-shot operation. Instead, it is likely to be an iterative process – a sequence of projects – based on situated reasoning. In such cases, knowledge of the rationale for prior iterations is crucial.

# Applying the Criteria

- Important to correctly separate the wicked from the “wicked-hard”
  - Unfamiliar, complex, difficult – not sufficient for wickedness
- Many good methods exist for solving tame problems that might be ignored if a problem is incorrectly classified as wicked!

# Alternative Definitions

Rittel	Conklin	Kreuter	Camillus
No definitive description	x	x	
No stopping rule	x	x	
No right/wrong solutions	x	x	
No "immediate and ultimate" test			x
"One shot operation"	x		x
No exhaustive list of solutions	x		
Essential Uniqueness	x	x	
Symptoms of larger problems			
Many explanations		x	x
No right to be wrong			

Conklin, J. (2005). *Dialogue Mapping: Building shared understanding of wicked problems*. New York: John Wiley and Sons  
 Kreuter MW, De Rosa C, Howze EH, Baldwin GT. Understanding wicked problems: a key to advancing environmental health promotion. *Health Educ Behav.* 2004 Aug;31(4):441-54  
 Camillus, John C. "Strategy as a Wicked Problem." *Harvardness Review*, May 2008, 99–106.

# Are all criteria needed?

- Most commonly mentioned – “essential uniqueness”
  - Certainly necessary – sufficient?
- Some claim all design is wicked
  - Unlikely
- Some claim ill-defined = wicked
  - All wicked problems are ill-defined but is the reverse true? Lack of a testable solution is only one of Rittel’s criteria
- Does Rittel claim that all criteria are needed?
  - Not explicitly, although some criteria are listed as essential (essential uniqueness and each wicked problem being a symptom of another wicked problem).

# Is the DIA Baggage Handler Wicked?

1. No definitive description – maybe. If the problem is rephrased as the real problem of decreasing turn-around time then yes.
2. No stopping rule – yes. Too complex to model.
3. Good/bad, not right/wrong – yes. Many tradeoffs.

## DIA, cont.

4. No immediate and ultimate – no immediate – it did take them 10 years to eventually scrap the system!
5. Irreversible consequences – yes, each day the airport was delayed cost all businesses involved
6. Impossible to list all solutions – yes, too many interacting parts.

# DIA, cont.

7. Essentially unique – yes, similar systems existed but they did not have the same design constraints
8. Symptom of a larger problem – yes -> turn-around time - > airport expense/airline profit..
9. Many explanations of the cause – yes, baggage handling was just one possible cause of delay
10. “No right to be wrong” – yes, many lawsuits between the players, irreversible consequences on some businesses.

# How WP theory serves design

- Most discussions just point out difficulties, but how does it help designers?
- Serve design = improve design artifacts
- Rittel's Original WP:
  - Better artifacts come from looking at more opinions, causes, solution ideas, consequences
  - Better design comes from an argumentative approach to one-shot projects.
  - Capture and use rationale for one-shot project
  - Creative strategies
    - Backward chaining in causes of problems
    - Forward chaining in goal hierarchy



# Wicked Problems 2.0

- The crucial difficulty: unforeseen and unforeseeable consequences
- Need for positive principles on how the WP theory is helpful (not just how it describes issues)
- Need for stronger emphasis on multi-stakeholder involvement
- Emphasize the impact of domain constraints on the problem and solution space
- New (or extended) creative strategies for addressing Wicked Problems.

# Positive Principles

- Acknowledge the value of *learning from the past* and *supporting redesign* to deal with unforeseen (& unforeseeable) consequences.
- Plan to utilize a *sequence of design/redesign projects for each WP*
  - Can't foresee the unforeseeable!
- Provide support for *problem-specific version histories of design.*

# Stakeholder Involvement

- Conflicting goals of multiple stakeholders are a key source of wickedness
- Rittel mentions this indirectly, but does not emphasize it as strongly as he could in his WP papers
- Choose design methods that involve stakeholders early and often.

# Acknowledging and Incorporating Domain Constraints

- Capture and use rationale for problem-specific sequences of projects
- Capture and use domain-oriented rationale for design professions
- *Essential* to learn from the past, not use “one-shot” or “essential uniqueness” as an excuse to re-invent the wheel and not document the process and decisions.

# Creative Strategies

- From Rittel:
  - Backward chaining in causes of problems
  - Forward chaining in goal hierarchy
- Extended:
  - Feedback from discussion
  - Feedback from modeling: reflection-in-action
  - Feedback from implementation and use : situated argumentation
  - Plan for re-design and iteration
  - Testing and simulation to minimize damage from failed solution attempts.

# Summary and Conclusions

- Wicked problems are a compelling theory but require clarification on several points
- Misinterpretations cause trouble:
  - Belief that learning from the past is without value
  - Belief that solution iteration is impossible
- No evidence that all criteria need to hold before a problem can benefit from being approached as a WP (although all should be examined)
- Domain constraints impact WP problem and solution space
- Principles and strategies *do* exist to assist with managing wicked problems and that will result in *better designs*.