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A (Cybernetic) Musing: Wicked Problems

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Intentions

In this column, I explore what are known as *Wicked Problems*. I have recently come to understand that Wicked Problems can be placed in a central position that brings together a number of different ideas which are significant in second order cybernetics.

I will start by describing the context in which the Wicked Problem concept was developed. Then I move to explore connections between Wicked Problems and other cybernetic ideas, specifically undecidable questions, trivial and non-trivial machines, and the Black Box. I conclude by discussing the somewhat surprising benefits that we can gain from the concept, and position this with other second-order cybernetic concepts.

Wicked Problems: Context and Background

I expect most readers are familiar with the notion of the Wicked Problem but, for those who are not familiar, I give a brief summary taken from Wikipedia:

> "Wicked problem" is a phrase originally used in social planning to describe a problem that is difficult or impossible to solve because of incomplete, contradictory, and changing requirements that are often difficult to recognise. Moreover, because of complex interdependencies, the effort to solve one aspect of a wicked problem may reveal or create other problems.[2](http://en.wikipedia.org/wiki/Wicked_problem)

The term *Wicked Problem* comes, originally, from design, in particular from (social) planning. Since this is not a design journal, I shall take some space sketching this background. According to Wikipedia, Wicked Problems were so named by C. West Churchman in 1967, in relation to a seminar given by Horst Rittel. The terminology was developed by Rittel and Martin Webber (1973) in their paper "Dilemmas in a General Theory of Planning." Rittel and Webber's specification of a Wicked Problem consists of a daunting list of ten characteristics, respecified by Jeff Conklin (2005) in a cleaner list of six characteristics. Rittel and Webber's list can be found most conveniently in the Wikipedia article. Conklin's list is quoted in the main body of the text. At their heart is the notion of problems which cannot be solved through recourse to conventional methods of problem solving, which I stipulate as the precise,

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1. CybernEthics Research, Southsea, UK
2. Note the use of the words incomplete, contradiction and change (i.e., non-repeatable). These are words used in discussions of Kurt Gödel's seminal incompleteness theorem, which changed the course of mathematics and which are at the centre of discussions of self-reference. In effect, Wicked Problems are to be expected.

irreducible specification of requirements and the development of their logical connections, leading to a unique and perfectly working consequence (the solution) exactly satisfying the specification.

It is no surprise that the origin of the Wicked Problem is in design, or that Rittel (by training, a mathematician) was first to describe it. In the 1950s, he was involved with others such as Tomas Maldonado and Hanno Kesting, at the Hochschule für Gestaltung in Ulm, Germany, and Bruce Archer at the Royal College of Art in London, in an attempt to scientise design by defining design problems more precisely through measurement and method. He also worked with Dieter Rams, designer at the German household electronics manufacturer, Braun, where this attempt was put into commercial practice—supposedly.

I see this approach, which was enormously influential (it featured in my architectural education and took me many years to transcend), as a response to post-war science and technology optimism suggested science, uniquely, would provide all the answers, and that the power of technology was unlimited.[3]

It is relatively easy to show this position is naïve, but, nevertheless, it persists.[4]

Rittel's introduction of the Wicked Problem concept indicates one of the hard liners in the attempt to make design scientific realising the folly of that aim, allowing that design provides an alternative way of looking at the world. Furthermore, as I shall show, Wicked Problems can be given a central place in cybernetics, greatly to the benefit of cybernetics.[5]

Wicked Problems and Cybernetics

The concept of the Wicked Problem is not isolated, but I argue is part of a family, remarkable because, in principle, the family members cannot be handled by classical problem solving approaches. For some people, such phenomena are not real and, therefore, are denied. This attitude is held by many hard line scientists, and a particular variety of atheist. I consider it more sensible to talk of them existing, if they do, outside the framework of conventional science,[6] rather than denying their existence because they do not fit a theory: my position is that theory should take second place to experience.[7]

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3. This uniqueness is what Paul Feyerabend (1975) argued against in that very important but currently downplayed book *Against Method*.
4. One method utilised the intersection of sets (of functional requirements) in a Venn diagram. The unique intersection of all sets would generate the best design. I leave the reader to imagine conditions under which this approach fails!
5. It is worth noting the people at Ulm (and elsewhere) were very interested in (first-order) cybernetics and systems theory.
6. A radical constructivist interpretation denies that we can ever be sure we are dealing with the "real" world argued by such people. For a radical constructivist, the concept of possibly existing outside conventional sensing need not create a difficult.
7. Graham Barnes (2002) has shown us, in his PhD, the great danger of denying that which does not fit within our framework of reference, and of setting up tests that, in their operation, exclude certain types of evidence.

For me, this family is endlessly intriguing because its members cannot be decided; so we can worry at them for as long as we wish, keeping ourselves interested and entertained in the magical act of thinking.

Trivial and non-trivial machines

Let me start with Foerster's trivial and non-trivial machines (Foerster, 1991).[8]

A trivial machine is predictable. It has an unchanging mechanism, so there is no challenge in it: Its behaviour is trivial, without variation, in contrast to the non-trivial machine (which Foerster tells us has an internal mechanism which changes states, and hence behaviours, which cannot be predicted with certainty because of this apparently arbitrary variation). Its behaviour may change as the internal states change at any (unpredictable) time.

Figure 1: Foerster's Drawing of a Trivial Machine (Foerster, 2001)

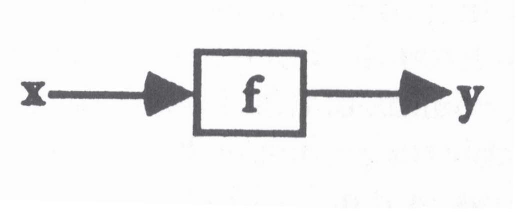
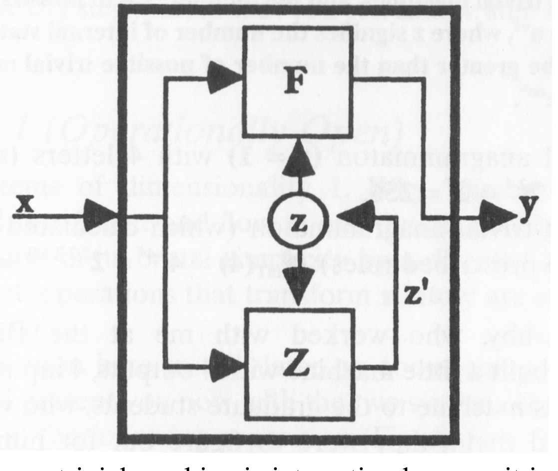


Figure 2: Foerster's Drawing of a Non-trivial Machine (Foerster, 2001)



The behaviour of a non-trivial machine is interesting because it is unpredictable. The non-trivial machine embodies Wittgenstein's critique of history, that there is no causal connection between past and future events. The non-trivial machine creates surprise.

8. The term *trivial* has caused some consternation. Alfred Inselberg (2010), a PhD student of Foerster's in the 1960s, dislikes what he sees as the silliness of the term and claims it does not provide suitable credibility and gravitas. Inselberg argues that, as a result, many do not take Foerster's idea seriously. I like the term *trivial* because, as I understand Foerster, he is, in effect, talking about variation and learning.

Surprise, when not positively valued by an observer, may be considered as error (a surprise you do not want may be thought of as an error).

Foerster (2001) gives this comparison between the trivial and non-trivial machines:

Table 1: Foerster's Comparison of the Trivial Machine to the Non-trivial Machine

Trivial Machine	Non-trivial Machine
Synthetically determined	Synthetically determined
Independent of the past	Dependent on the past
Analytically determinable	Analytically determinable
Predictable	Unpredictable

The point of the distinction between trivial and non-trivial machines is that, whereas the trivial machine is predictable (it's decided), the non-trivial is undecidable because it does not generate a repeatable pattern, and so is a source of eternal curiosity for an observer.[9]

It is thus that the non-trivial machine begins to be an example of a partner in an interaction.[10]

Undecidable Questions

This brings us to another family member, one that helps us better understand the value of trivial and non-trivial machines: the *undecidable question*. Undecidable questions are members of a broader group, *undecidable problems*. According to wikipedia

> an undecidable problem is a decision problem for which it is impossible to construct a single algorithm that always leads to a correct yes-or-no answer (http://en.wikipedia.org/wiki/Wicked_problem)

Foerster described the significance of undecidable questions thus:

> Only *those* questions that are in principle undecidable, ***we*** can decide. (http://www.cybsoc.org/heinz.htm)

I understand this evaluation, known as Foerster's metaphysics fundamental theorem, as very positive. In my interpretation, Foerster is telling us that, because these in principle undecidable questions cannot be determined by any mechanical procedure, because there is no "correct" answer to the question, we have control over which of a

9. However, the architect Stephen Gage (2006) argues for "The Wonder of Trivial Machines," showing ways of considering the trivial machine as non-trivial.
10. I do not have room herein to explain both how it is and how it is not a partner in an interaction.

number of possible answers we choose: the choice is each of ours. Importantly, responsibility for the choice is therefore also ours. Foerster gives a list of examples, which includes:

- Where does feedback go?
- How did the Universe come into being?
- Am I a part of, or apart from, the Universe?[11]

These examples of in principle undecidable questions will surely be both familiar and appealing to a readership interested in second-order cybernetics. They are undecidable because

1. The system is circular: consequently you can chose any start point, and any end point.
2. According to all "commencement" accounts, there was no sentience around to notice.
3. If I am not part of it, I cannot know it, but being part of it, I cannot know whether or not it has an independent existence.

This third explanation goes hand in hand with the statement usually attributed to Foerster but actually originated by [12] Glasersfeld (1992).[13]

> Objectivity is a subject's delusion that observing can be done without him. (http://www.cybsoc.org/heinz.htm)

Let me expand on this. Foerster (1991) rephrases his undecidable question 3 above thus:

> Is the world the primary cause? (That is, my experience is the consequence.)
>
> Or,
>
> Is my experience the primary cause? (That is, the world is the consequence.)

This is a way of stating the realist/idealist argument. Foerster talks of the possibility of choosing either of the positions, and of not needing to stick with the one you chose. According to Foerster,[14] each of us may chose to act as though we believe in a real world, or as though we do not to believe in it, but that choice is only for that moment.

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11. These examples are taken from a page in the web site of the Cybernetics Society, where many others can be found (http://www.cybsoc.org/heinz.htm, visited 1.1.2012). This site is a delight for those interested in aphorisms having collections of aphorisms and similar material collected from the work of several significant, now dead cyberneticians. Unfortunately, it has no entries from the living, reflecting one of the great problems in contemporary cybernetics.
12. These explanations are mine: for Foerster's, see his 1991 paper.
13. I owe this information to Dr. Albert Mueller, keeper of the Foerster Archive in Vienna.
14. in conversation

Generally, Foerster chose to believe in the real world for reasons, he told me, of convenience and efficiency.

I would add two more positions that are important, which Foerster overlooks. The first is that of sitting on the fence. While most may want to take one side of the fence, or the other, there is a need for those who determinedly do not take sides but remain undecided (sceptics). Following the metaphor further, there are those who build and maintain the fence for others to sit on, or to move to one or other side of (those who deal with conditions and assumptions, that which comes before that which is fundamental).

It is my contention that Wicked Problems and undecidable questions share this characteristic: neither can be decided mechanically, which is how we become free to chose whatever legitimate solution we wish. However, Wicked Problems may be more radical than undecidable questions, for, when we try to solve them, we use an approach that is very different from choosing between items on a list of possible, legitimate answers. This approach is design. I will return to this.

Undecidable questions perform like the non-trivial machine, and decidable questions (no matter how unimaginably difficult) perform like the trivial machine. If my analogy is correct, Wicked Problems are undecidable and decidable problems are thus non-wicked (tame, as Rittell and Webber called them). The undecidable and wicked may be reified in the concept of the non-trivial machine while the decidable and non-wicked (tame) are reified in the trivial machine.

The trivial machine's input behaviour gives rise to output behaviours both causally and of necessity. Foerster (1991) remarks that the complement of necessity is not chance (as Monod, 1972 tells us), but rather choice. According to the Viennese psychotherapist Viktor Frankl (2004), believing we have a choice is at the centre of humanness. He argued that prisoners in concentration camps remained alive in inconceivably awful circumstances so long as they believed they had that smallest bit of control, a choice. He claimed to see that, when someone lost the belief there was choice, he would die within 24 hours.

Thus, we see how these (different) ideas may be fitted together to create a constellation, a cluster of related ideas: and we may better understand the use of the term *trivial*.[15]

The Black Box

The concept of trivial and non-trivial machines is often conflated with the Black Box. I can see the attraction of this unification, but there are some very important differences.

The Black Box is a conceptual device, a thought experiment, due originally to James Clerk Maxwell, which has the peculiar characteristic that it is unopenable.[16]

15. This interpretation of wicked as good fits with the recent slang use of the word *wicked* to mean excellent.
16. I have explored the Black Box in these columns (Glanville, 2007, 2009a). The reader is invited to consult those papers, for clarification and further discussion.

Therefore, the observer must construct an account for his observations of various input behaviours and their corresponding output behaviours, for which he proposes some function that consistently and repeatedly connects the set of inputs to the set of outputs, suggesting the outputs are consequences.[17]

The unopenability of the Black Box is crucial, prohibiting us from arguing a particular output must result from a particular input, since we cannot examine the suggested mechanism.[18]

The account we propose explains behaviours we have observed as we interact with the Black Box—as Ashby points out (see Ashby, 1958; Glanville, 2007a). Unopenability makes certain the behaviour of a Black Box cannot be assumed to result from a constant mechanism. Hence, just because something has always happened, does not guarantee it will persist.

The Black Box seems to resemble the non-trivial machine because of this uncertainty about future behaviour (the engineer's whitened Black Box matches the trivial machine). Yet we should treat this parallel with caution, for Foerster's usage places the source of the behaviour in the machine, which is *white* (he reveals a mechanism that produces non-trivial behaviours). In contrast, what is being investigated (recursively?) in the Black Box is the relationship between the (proposed) Black Box[19] and the observer (what Ashby calls the investigator).

What we know of the Black Box's behaviour lies in our description (or collection of descriptions of what we determine are behaviours), not the thing described. It is a construction. The Black Box allows us to explore how we might understand a relationship with what we call reality, but is not based on and does not confirm an observer-independent reality. It is a deeply and radically constructivist device, so all theorising based on its use is founded in constructivism, no matter what guise it is presented under. Trivial and non-trivial machines do not morph, whereas a Black Box can appear trivial, metamorphosing into the non-trivial. The Black Box cannot be opened (whereas the trivial and non-trivial machines are open) and the Black Box's observer is involved where the trivial and non-trivial machines' are not. Finally, the Black Box is not properly predictive, while the trivial machine is. The Black Box lies in a constructivist account of the world and our relationship to it, whereas the trivial and non-trivial machines lie in a realist account.

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17. In engineering, however, this characteristic is often forgotten or ignored, leading to the assertion that the Black Box can be whitened (a technical term for opening a Black Box).
18. The Black Box argument may (and I have argued) should be used recursively (Glanville, 1982).
19. The Black Box was never "there." It is a construct of an observer, and is inserted in place in such a manner that it creates inputs and outputs. But it is and remains a thought experiment, not an actuality.

Table 2: Trivial and Non-trivial Machine, and Black Box: Similarities and Differences

Trivial Machine	Non-trivial Machine	Black Box
open	open	unopenable
observer uninvolved	observer uninvolved	observer involved
future predictable	future non-predictable	future non-predictable

There is a relationship between the Black Box and both trivial and (more strongly) non-trivial machines. But this relationship remains, in certain key respects, far from analogical.

Handling Wicked Problems

One major difference between Wicked Problems and the non-trivial machine/ undecidable question is the descriptive focus of the latter contrasted to the actional focus of the former. One expects descriptions and explanations in science, rather than actions. Where science is used for action, it is usually called technology or engineering. Science may generate its descriptions and explanations through action. However, these descriptions and explanations are not actions nor do they automatically and easily facilitate effective action: We make them to record a world as found, not to change (create) such a world.[20]

In contrast, Wicked Problems originate in and are concerned with action. They are seen as impediments because they lie outside areas of conventional problem solving. Being Wicked in principle, we cannot solve them by improving the problem statement. Yet we hope to alleviate these problems. The question is

Is there a way of solving an in principal Wicked Problem?

I answer yes: we use a familiar, ancient, tried and tested approach: design. Given that Wicked Problems were first distinguished in planning, it is no surprise that a way of handling them might also derive from planning—normally thought of as a design discipline.

Recently, I have described in this journal how I understand design, and how I see design and cybernetics as opposite sides of the same coin. They bind each other, each gaining strength from their mutualistic relationship (Glanville, 2009b).

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20. In response to the difference between describing the world as it is, and changing it, I have suggested developing 2 types of knowledge, knowledge of and knowledge for. (Glanville, 2007b) These relate to Gibbons et al.'s (1994) mode 1 and mode 2 investigations.

Design offers a way of acting on "problems" that handles the characteristics of Wicked Problems. Below, I take the six characteristics[21] Conklin (2005) developed and describe briefly how each is accommodated in designing. This will strengthen my view, that design and cybernetics are complementary.

1. The problem is not understood until after the formulation of a solution.
If you ask designers, they will agree this is so. In contrast to what we have come to think of as the natural order of things, in design the solution defines the problem. It may be possible to partially break a problem into sub-problems that are clear, but the coherent form in which they can be fitted (the solution) is created by the designer through the conversational process of designing. Sometimes, a solution completely redefines a problem.

2. Wicked problems have no stopping rule.
The criterion appropriate to design is *good enough (for now)*, an evaluation strategy that indicates and responds to the lack of a stopping rule. This criterion does not deny designs of wonderful quality. It excludes that the notion of absolute best, for the only possible yardstick would appear after the event (see above). A designer stops when patience, time and/or money runs out, when they feel what they have done is good enough (as good as can reasonably be!)—for any of a number of other reasons. Correctness is not an overriding criterion. Where to stop is arbitrary, determined by experience and other seemingly random criteria.

3. Solutions to wicked problems are not right or wrong.
This is what *good enough (for now)* means. If there are conflicting or incomplete criteria, there can be no specification for right or wrong. I interpret this as a benefit, for the lack of specification leaves room for a designer to reframe a problem, giving rise to extraordinary and imaginative solutions that could never have emerged, and so could not be considered in a world of right and wrong. It also means there is always another problem waiting to interest us.

4. Every wicked problem is essentially novel and unique.
Where there are no determining guides and aims, where each problem is impossible yet needs a solution, each attempt to reach a solution will be different from every previous one. There is no path and no obvious goal other than to act appropriately. This does not mean there are no design strategies, only no pre-determinable methods. The outcome of design actions depends on endless local conditions in constant flux. The process leads to a proposal. It is not the only possible proposal: there is an infinitude of these. It is the only one that has been produced by that designer at that time. There is no alternative to value it against.

21. See simplified list at Wikipedia. Retrieved January 1, 2012 from http://en.wikipedia.org/wiki/Wicked_problem

5. Every solution to a wicked problem is a one shot operation.
See 4. above.

6. Wicked problems have no given alternative solutions.
See 4. above.

Although I have used them in this column, I do not like to use the words *problem* and *solution* in relation to design because they carry with them the culture of problem solving, to which design is a radical alternative: radical, not only because design seems extremely different, but because it goes back to its root: I have argued, ultimately, that designing is what we do as we form concepts and compose these concepts together into our own understandings and world views (Glanville, 2011).

Benefits

I have attempted to bring together Wicked Problems, undecidable questions and trivial and non-trivial machines (and the Black Box), examining them for the commonalities that form analogies. I have done what I believe humans do in order to construct their worlds: make a pattern which allows me to treat one as if were the other, reducing variation (creating constancies in my account of my world, as I experience it). This is, I believe, the quintessential human activity:[22] we are better thought of as Man the Pattern Maker (Homo Designans) than as Man the Wise (Homo Sapiens). The occurrence of *Designans* in this Latin translation,[23] from which we have our notion of design, is one of those pieces of serendipity which reminds me I do not control the world!

Coping with Wicked Problems requires us to value certain qualities, which go with other qualities I have extracted from my understanding of second-order cybernetics: listening (Glanville, 2001); generosity, open-mindedness and respect; sharing, selflessness and trust; and a certain degree of honesty which, I have argued, are necessary for second order cybernetics to function, and which I have used as an argument in support of this way of looking at the world (Glanville, 2004). Perhaps as importantly, “solutions” to Wicked Problems always leave us with a problem to work on, because they are never definitively solved. And the criterion of *good enough* can lead to the aim of constant improvement of quality. We are thus left with wonderfully human challenges.[24]

Wicked Problems and their already established cybernetic cousins, undecidable questions, (non-) trivial machines (and the Black Box), help us make a world that is ethically better, by expecting that we demonstrate these qualities as we act. They make

22. Freedom and the Machine, Exaugural Lecture given at UCL London, 10 March 2010 (Glanville, 2010)
23. Translated by Prof Maria Wye, Head of Department of Classics, UCL, London.
24. I was first introduced to the Wicked Problem idea in the early 1980s, by Gerard de Zeeuw. It was he who brought to my attention the importance for humans of always having a problem to challenge and interest us, and of the notion of constant improvement, which Zeeuw saw as ways of dissolving the Wicked Problem and of handling the lack of stopping rule (Glanville, 2002).

better by requiring better of us. The undecidability of Wicked Problems placed at the heart of a cluster of second order cybernetic ideas offers us opportunity and benefit—and a way of seeing that reflects higher human qualities.

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