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Wicked problems in a technological world

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1. Introduction: the wickedness of problems and the promises of utopias

Although the term 'wicked problems' did not emerge from the realm of technological design, but rather from the realm of policy and planning, it quickly became a popular term to indicate the nature of technological design problems (Buchanan, 1992). Through solving technological design problems, we have developed so many devices and systems that we often speak of a 'technological world' in which we live today. That term is reductionist in a way, because there is more in life than technology, but it does indicate the enormous impact technological products have on our daily life. That is why reflection on the nature of technology is so important for understanding our contemporary society and culture. That is why we have philosophy of technology as the branch of philosophy that focuses on the nature of technology and its relations to humans and society. In this article I want to reflect on the way the term 'wicked problems' and the content given to it by its original 'inventors' can help us understand the strength and limitations of technology. To most people the strength of technology is obvious: thanks to technology we live longer, healthier, wealthier, better informed and better connected to each other, although I hasten to add that these benefits of technological developments are distributed unevenly from a global perspective. The limitations of technology, however, are often left out of our expectations. In rhetoric concerning technology, utopian promises are often made (Sibley, 1973; De Vries, 2012). Particularly striking is the use of the word 'unlimited' in those promises: 'unlimited internet, data, mileage, eating, car washing, etcetera, etcetera. A world without limitations is presented as an ideal world and technology can make this world become reality. Literally 'utopia' means a 'no-place' (ou-topos in Greek), but thanks to technology we will reach this pot of gold at the rainbow's end.

If design problems are really 'wicked', they may disturb this dream. It is at least not evident that we will be able to solve them in such a way that they no longer stand in the way to our ideal world. It is remarkable that the term 'wicked' was chosen, given the moral connotation it has. Some synonyms for 'wicked' are: bad, evil, peccable, nasty, and sinful, and all of these have a morally negative meaning. But how can problems be 'wicked'? They have no intention or will. It is striking that this predicate, which is uncommon for a problem, is used almost without any comment. Humans can be wicked, not problems. Or can they? What do we mean by 'wicked problems' given the moral associations we have with the word 'wicked'? Is it, perhaps, that we experience them standing in the way of the ideal world we want to shape, that is seen as immoral, even if the problem itself can hardly be blamed for it? To investigate this, I will first discuss an article in which the concept of wicked problems is related to utopian thinking (Brown, 2015). Also I will discuss two of the rare examples of an article in which the 'moral dimension of wicked problems' is identified and explored (Wexler, 2009; Churchman, 1967). Then I will present the characteristics of wicked problems as identified by Rittel and Webber in their 'classic' article on wicked problems. Finally I will show how the work of the Dutch philosopher Herman Dooyeweerd can help to see wicked problems in a way that does justice to their nature.

2. Wicked problems and utopian thinking

In her article about wicked problems and interdisciplinarity, Brown also makes a connection with utopian thinking (Brown, 2014). The fact that in our contemporary technological challenges we are dealing with 'wicked' problems causes her to consider utopian thinking fruitful only when it is not the search for an 'impossible perfection' but when it is the 'dream' of a future that is able to deal with uncertainty, diversity, disappointment and surprise. This raises the immediate question if it makes sense to still see this type of future as a utopia, but at least it is a move away from an unrealistic trying to find the pot of gold at the end of the rainbow. Rather than using the concept of a utopia in a (post-)modernist approach of total control over reality, utopias are then used as a scenario-type of method for stimulating inspiration and creativity. The notion of wicked problems then fulfils the useful role of creating awareness of the inappropriateness of using utopias as a goal to be realised. Utopias are very popular in the rhetoric surrounding engineering nowadays. People have very high expectation of engineering being able to stretch the length of human life (even up to 'unlimited living'), of banning all diseases, of providing endless communication opportunities ('unlimited Internet/data'), to mention just some examples. One can question if the pushing away of all limitations is real progress. Whoever surrendered to the utopia of 'unlimited eating' (or 'all you can eat . . .') quickly finds out that this seeming utopia soon turns into a dystopia of terrible stomach pains. The utopia of unlimited communication and data can confuse us very much and the perspective of living hundreds of years can work paralyzing if we are not able to give rewarding content to these years. Apparently there are some hidden assumptions in much of utopian thinking (living longer is better, healthier is better, more communication is better, etcetera) that should be complemented by considerations of purpose (how can I use my long life or my health for a good case, and what is really 'good'?). In any case, utopian thinking without the company of the notion of wicked problems can lead to unrealistic and even undesirable ambitions.

3. The morality of wicked problems in technological design

In 1967, C.W. Churchman responded to Horst Rittel's recent introduction of the notion of 'wicked problems' by pointing out that there is a moral dimension to solving those problems. In his Guest Editoral, Churchman shifts the morality from the problem itself (in the term 'wicked problem') to the morality of those who try to solve it and present the outcomes of their efforts. According to Churchman, it would be immoral to suggest that the wicked problem has been solved in its entirety. There is certainly the temptation for scientists to do so. But it would be more appropriate for the scientist to claim (in Churchman's words): "I've not tamed the whole problem, just the growl; the beast is as wicked as ever". The word 'tame' was used by Rittel for indicating the effort of 'solving' the wicked problem. This term suggests a wild beast, and Churchman picks up this metaphor by referring to the threat of the problem as the growling of a wild animal. The best one can do, according to Churchman, is to reduce the direct threat caused by the problem, but in essence the problem does not really change. Churchman sees it is immoral to claim that the whole danger is averted. In his words: “Deception becomes an especially strong moral issue when one deceives people into thinking that something is safe when it is highly dangerous” (Churchman, 1967). Now there is morality in both the problem itself (it is like a wild beast that threatens people) and it the extent to which one is honest in what one has been able to do about the problem.

The morality that is identified by Churchman is easiest to understand: presenting things in a way that deceives, is morally undesirable. This can be applied to rhetoric that suggests all wicked (socio-)technological) problems will be solved in the end and a world without limitations is at hand. This is deceptive, as it is well known among engineers that there is no ideal solution to a design problem. That is why future engineers in their education learn to make sophisticated trade-offs. In an international Delphi study for basic concepts in technology/engineering, the concept of ‘trade-offs’ was one of the most often mentioned concepts by a group of around 30 experts in philosophy of technology, technology education (primary and secondary level) and engineering education (Rossouw, Hacker and De Vries, 2011). Trade-offs are an essential element in engineering design. Engineers always have to give in at certain requirements in order to address others. Dealing with conflicts within the list of requirements is one of the most important skills engineers need to master. Suggesting that engineers are capable of finding solutions without any sacrifices to any design requirement would be deceptive and therefore is to be morally rejected.

More problematic is the notion of morality as applied to the problem itself, as it is in the term ‘wicked problems’. What does the ‘wickedness’ of the problem mean? What is it guilty of? Probably the most appropriate way of finding an answer to those questions is to investigate the way the ‘wicked problem’ is identified. Here we turn to the ten characteristics of ‘wicked problems’ as listed by Rittel and Webber in their classic 1973 article in Policy Sciences. The belief in ‘makeability’ of reality, which was given a boost by the Enlightenment, has strongly increased in popularity in the 20th Century, according to Rittel and Webber. Planning problems – the type of problems from to which the term ‘wicked problems’ was originally attached by Rittel and Webber– have characteristics that make them unlikely to allow for a makeable reality. As we go along the characteristics one by one, we will not only see how they relate to the notion of wickedness, but also challenge that wickedness by showing how doing justice to that characteristic can be an antidote for the wickedness of falsely presenting wicked problems as if they can be solved fully.

4. Characteristics and wicked problems and their morality

a. No definitive problem formulation

Rittel and Webber claim that for wicked problems no problem statement can be developed that contains all the information that is needed for understanding and solving the problem. That is the case for planning problems, but also for design problems. Given the open character of design problems (in principle the set of possible solutions is infinite), it is impossible to foresee all possible constraints and requirements that determine how good a solution is. Every new possible solution can bring about new conditions that require revision of the problem statement, including the list of requirements. In terms of the dual nature of artefacts approach in the philosophy of technology (Kroes and Meijers, 2006), this issue is related to the fact that the physical nature (the solution) cannot be deduced from the functional nature (in the problem formulation). The same, by the way, holds for the opposite direction: one physical realisation can be related to a variety of functions. In other words, there is always a variety of possible solutions for one and the same problem, and therefore the list of requirements can never be taken to be complete. Is wickedness something morally problematic here? To the contrary. One could even claim that this is what makes design problems attractive for human beings: it allows them to bring in their creative capabilities. If a solution was deducible from the problem statement, a computer could solve it and for a human designer it would be boring work. The designer with the heart at the right place will appreciate this characteristic of design problems and make use of the opportunities to be creative and act like a human being rather than a computer.

b. Wicked problems have no 'stopping rules'

Here Rittel and Webber make a comparison with a chess problem. For such a problem there are clear rules that determine when someone has won the game. For design problems, as for planning problems, there is no rule that says: destination reached, problem solved. At best one can say: 'time is up', or 'money is up', or 'good enough', but these are not rules that are related to what Rittel and Webber call the 'reasons inherent in the logic of the problem'. Besides that, always the opportunity remains open to continue and improve the solution or try out new solutions. What could be an appropriate stopping rule for a design problem that does come forth from the 'logic of the problem'? The best candidate seems to be: a physical realisation has been found that meets all requirements. That would be a very good solution. But even then one could question if it is the best solution. Maybe there is a different solution that also meets all requirements, but also one that one has not thought off yet. The possibility of coming up with such an additional requirement has been stated in the previous characteristic. Here, too, one can challenge the idea that this makes a problem wicked in a moral sense. Human creative potential would be seriously blocked if a design problem would be regarded as solved because a stopping rule said so. It would probably mean that designers would see no use in picking up the problem later on, with new information available about material properties for instance, as the problem is considered to be solved already and the stopping rule would say solved', even before a new effort would have stated.

c. Solutions to wicked problems are not true-or-false, but good-or-bad

What Rittel and Webber mean with the characteristic that wicked problems are not true-or-false, but rather 'good-or-bad' is that the evaluation of their solution depends on values at least as much as it does on facts. They make a comparison with a proposed structural formula for a chemical compound, which can be evaluated as true-or-false, at least in their view. Farrell and Hooker (2013) challenged this because the outcomes of science are also more than false-or-true, but subject to other criteria such as elegant or efficient. Still, design problems probably leave more space for value-laden criteria than scientific problems, as there is already normativity in the problem itself (it is by definition a quest for 'improving' the world in some sense). Here, too, the question can be raised if this is a morally wicked property of design problems. Does it not confront designers with the reality that artefacts are inherently normative and thus prevent thinking about them as neutral entities for which the total responsibility for consequences of use is with the users only? If, in the words of Langdon Winner, it is true that artefacts 'have politics', than it is a good thing that design problems are regarded as not having true-or-false, but good-or-bad solutions.

d. There is no immediate and no ultimate test of a solution to a wicked problem

The way Rittel and Webber describe this characteristic is a bit different than the title suggests. That there is no immediate and ultimate test for solutions to wicked problems is no more than a consequence of two of the other characteristics, namely that there is no definite formulation of the problem and that there are no clear criteria for when the problem has been solved. A test requires both. But in their text, Rittel and Webber in fact point out something else, namely that any solution brings about consequences that have not been foreseen and thus raises new questions. A solution that seems good today may appear to fail tomorrow. The awareness of this characteristic has moral implications. We cannot take irresponsible risks by ignoring the possibility of harmful effects emerging from the implementation of the solution. Part of these effects cannot be predicted, but at least some can be guessed. This aspect of the design problem's 'wickedness' is morally a bless as it reminds designers of limitations in their knowledge about the future. The precaution principle is often used as an answer to this. This can paralyze the design process, and therefore some experimentation is unavoidable, as Van de Poel argued (Van de Poel, 2009). This brings us to the next characteristic.

e. There is no opportunity to learn by trial-and-error

Here Rittel and Webber refer to the fact that implementing solutions to wicked problems mostly have consequences that cannot be undone. One cannot try out a couple of options without causing irreversible effects. This characteristic is clear for planning problems, the sort of problems they discuss in their text, as implementing a new planning strategy usually is so radical that comprehensive that it cannot easily be taken back. For design problems, this may be different. It is in fact quite common to test possible solutions of products on customers in trial sessions. Customer responses can then be used to improve the design. There are, however, design problems for which this does not hold. Two examples are: architecture and structural design. One cannot try out a couple of options for a new railway station or a new bridge in a real situation. Such an implementation is what Rittel and Webber call a 'one-shot operation'. In those situations it is morally obligatory to think through the possible consequences very carefully. Here, too, the awareness of the 'wickedness' of such design problems is a blessing rather than a curse.

f. Wicked problems do not have an enumerable set of potential solutions

In design methodology this is often indicated as the infiniteness of the design solution space (i.e., the collection of all possible solutions). Depending on the creative capabilities of the designers, it is always possible to come up with new possible solutions. Every solution that has already been found inspires further exploration and expansion of the solution space. Is this characteristic morally undesirable or ‘wicked’? Is it not one of the most positive aspects of design problems? The unlimited number of possible solutions is a wealth that should be exploited rather than a threat that should be ‘tamed’. At the same time, designers will be cautious not to ‘drown’ in this sea of possibilities. In the process of solving the design problem, the solution space needs to be limited (Dorst and Cross, 2001).

g. Every wicked problem is essentially unique

This characteristic is related to the fact that design problems and solutions are entities, not laws. Dutch philosopher Egbert Schuurman identified the Modernist ideal of applying the universality focus of science to technology resulting in uniform designs (Schuurman, 2010). He never related this to the issue of ‘wicked’ problems, but there is connection in that uniformity in designs is likely to originate from a denial of the uniqueness of design problems as related to different needs of different individuals. Individuality is ignored in order to ‘tame’ the wicked design problem. But one could argue that the ‘tamed’ problem is more ‘wicked’ than the ‘wicked problem’, as it does not do justice to the individuality of people and this can be seen as morally problematic. The uniformity of designs brought along feelings of alienation. Living in the huge uniform living blocks in the former Eastern European countries is an example of a uniform design that brings about such feelings. The uniqueness of the problem that is included in the idea of ‘wicked’ problems, and with it the possibility that its solution is also unique, is therefore a blessing rather than a curse.

h. Every wicked problem can be seen as a symptom of another problem

Rittel and Webber here mention the example of solving street crime. Solving this problem will lead to the insight that this problem is not a stand-alone problem, but a symptom of a larger problem, namely a decay in social morality. That again can be seen as a symptom of a wider problem by investigating its cause. This characteristic is related to the idea that one can never say that a wicked problem is fully solved. It is always possible to go back a step in looking for deeper causes of the problem. That is why the question as to whether there is ‘wickedness’ in this characteristic has already been discussed earlier. The fact that new issues arise when a problem is being solved is also positive in the sense that it keeps designers alert to keep innovating. Taking into account the newly arisen issues can lead to newer and better solutions.

i. The existence of the discrepancy between the existing and the desired situation (the design problem) can be explained in numerous ways

Here, too, Rittel and Webber seen to repeat themselves. They again use the example of solving the problem of street crime, and now point out that there are different angles of view in perceiving the problem. In a non-reductionist view on reality, each of these angles of view has its own characteristics so that one cannot be reduced to another. This calls for a multi- or interdisciplinary approach. Several authors (Schmidt, 2008); Brown, 2014) pointed out the necessity to treat wicked problems in an multi- or interdisciplinary approach. In particular characteristic i (multiple explanations for the gap between desired and actual situation) calls for a consideration of different aspects of reality. The study of different aspects has resulted in different disciplines (for instance, the study of the physical aspect led to physics and the study of the economic aspect led to economy). Multidisciplinary means that relatively independent disciplines, each focused on a particular aspect of reality, are used in combination to solve a problem. Interdisciplinarity goes beyond that because the disciplinary contributions have merged into a new (inter-)discipline. Although richer in scope than a monodisciplinary approach, multi- or interdisciplinary approaches are still of an abstract nature and therefore reduce reality to certain aspects. Design problems aim at interventions in reality and for this to be successful reality has to be taken into account in its full integral complexity, and not as a sum of aspects, not even when the range of aspects that is considered widens thanks to a multi- or interdisciplinary approach. Schmidt writes about an object-oriented interdisciplinarity. He used the term 'interdisciplinary objects' for that way of looking at objects in reality. Yet the term, if taken literally, is a pleonasm. What would be a 'non-interdisciplinary object'? Is not it the case that all objects can always be observed by studying all aspects of reality? Any object is a spatial and a physical and an economic and a (etcetera) object. The multi-aspectuality is given with the object a part of reality. The term thus is not very helpful.

j. The planner has no right to be wrong

In the context of this article, we have to read 'designer' instead of 'planner'. Again this characteristic seems to be equivalent to one of the others. We saw before that there is no 'free' opportunity to try out, as implementation of a wicked problem often has irreversible effects. Therefore I refer to the discussion of that characteristic for an evaluation of its morality.

5. The value of Dooyeweerd's philosophy for reflecting on the nature of wicked problems

I will now discuss the work of the Dutch philosopher Herman Dooyeweerd and show that his perspective of reality provides a useful approach to wicked problems (even though he himself never referred to this issue).

Dooyeweerd made a distinction between two ways of studying reality: from the object-side and from the law-side. The object side focuses on the individuality of entities in reality. Particularly his notion of the different functions of an object is relevant for designers. Subject functions are those in which an artefact serves as a subject, in which it acts itself. Object functions are those in which the artefact serves as an object, in which someone or something else acts on it. A designer has to think about both types of functions. A bridge has a subject function in that it exerts forces on the foundation and it has an object function in that cars that pass it exert forces on it. Also the notion of the qualifying function is a useful one for designers. The qualifying function is what the artefact is ultimately for. A pacemaker produces an electric pulse but that is not its final purpose. It has been designed to enhance the wellbeing of cardiac patients. The pulse production can be called the technical or operational function, a notion that Dooyeweerd does not yet have but was added later by Verkerk et al. (2016). Note that the qualifying function can be both a subject and an object function (a car is there to move itself, but a painting in there to be admired, not to admire itself). Reflecting on the object-side of reality will help the designer recognise the design needs that stem from the artefact as it functions in reality. It is crucial that a proper qualifying function is identified and also that the designer realises which aspects that function refers to. The qualifying function of a painting is related to the aesthetic aspect of reality (things in reality can be ascribed an aesthetic value). The qualifying function of a bridge is usually in the social aspect (it enables communities of people to see each other). But in the case of the three small bridges near Schiphol airport, designed by the famous architect Santiago Calatrava, the qualifying function seems to be aesthetic rather than social (their role in traffic is marginal but they look beautiful; therefore one can see that they are bridges according to their technical/operational function in that they connect two shores, but they are sculptures in that they are primarily there to be admired).

The law-side takes as different stance. It deals with the generic laws or regularities in reality. These laws are of different kinds, depending on which aspect of reality one studies. Dooyeweerd identified fifteen aspects in reality. Most of his followers have realised that this is not an absolute number but useful as it shows the variety of aspects but still can be reasonably overseen. Some of the aspects Dooyeweerd identified are the numerical aspects (reality lends itself to counting things, like the number of parts in an artefact), the spatial one (artefacts take space), the economic aspect (artefacts can be ascribed an economic value) and the belief or trust aspect (artefacts can be regarded to be trustworthy, or not). Each aspect can be studied separately, which leads to different disciplines each producing its own body of knowledge (arithmetic studies the numeric aspect, geometry studies the spatial aspect, economy studies the economic aspect, etcetera; theology can be seen as a discipline that studies why and how humans put their trust in God). A multidisciplinary approach means that the outcomes of studies of different aspects of reality are combined. Interdisciplinarity brings this to a different level in which the contributions of the different disciplines merge into new insights that transcend insights about the individual aspects.

Although richer in scope than a monodisciplinary approach, multi- or interdisciplinary approaches are still of an abstract nature and therefore reduce reality to certain aspects. An important notion Dooyeweerd brought forward is the irreducibility of the aspects: the aspects cannot be reduced to one another and thus each of them needs individual attention. This is important for designers, as there is always a danger of reductionism, for instance when the whole design problem is reduced to an economic one (as long as the artefact is not too expensive, it will be a success on the market) or a physical one (as long as the design does not violate the laws of physics, it will work properly and be a success).

Schmidt (2008) writes about an ‘object-oriented interdisciplinarity’. He used the term ‘interdisciplinary objects’ for that way of looking at objects in reality. Yet the term, if taken literally, is a pleonasm. What would be a ‘non-interdisciplinary object’? Is it not the case that all objects can always be observed by studying all aspects of reality? Any object is a spatial and a physical and an economic and a (etcetera) object. The multi-aspectuality is given with the object a part of reality. The term thus is not very helpful. It confuses what Dooyeweerd nicely distinguished, namely the object-ad the law-side of reality.

Now let us see how this philosophy provides us an approach that helps us get a better understanding of the wickedness of design problems. I have to be brief here and merely hint at the Dooyeweerdian notions that can be used to understand the various characteristics. For characteristic a I have already referred to the dual nature of technical artefact approach as a useful way of analysing that. Dooyeweerd's aspect are in fact a further elaboration of that. His first five aspects (up to the biotic aspect) are in fact non-intentional and belong to the physical nature, whereas the remaining aspects all involve intentionality and therefore belong to the functional nature ('function' taken widely). So here Dooyeweerd's contribution is not unique, but gives more profile to the dual nature approach. Another way of understanding this characteristic from a Dooyeweerdian perspective is that problem formulation is an abstraction and takes the problem to the law-side of reality in which the variety of aspects and the many laws that can be identified in each aspect prevent a definite problem statement. Characteristic b (the absence of stopping rules) can be explained from the complexity that comes with the variety of aspects that need to be taken into account. According to characteristic c design solutions are not true or false, but good or bad. Dooyeweerd's distinction between the object and the law-side of reality provides an understanding into this by pointing out the difference between 'true' and 'false' in the theories that emerge from studying the law-side of realty and the normative that is inherent in the concept of 'functions' (they do not describe what the artefact does, but what it ought to do). Characteristic d is a direct consequence of aspects a and b, as I argued, and so what has been remarked about Dooyeweerd's contribution also applies to this characteristics. The irreversible effects of implementing design solutions (characteristic e) is related to Dooyeweerd's notion of the uniqueness of objects. Even if the object is removed, the situation will not become as before as circumstances have changed. This is all part of the nature of the object-side of reality. Characteristic f (the endless number of possible solutions) is explained by the same Dooyeweerdian notions related to characteristic a. Characteristic g is a consequence of the uniqueness of the objects (as design problem solutions) in Dooyeweerd's philosophy. All solutions are unique because all design problems are unique. Characteristic h (each wicked problem being a symptom of another problem) is again a consequence of the abstractness of the problem formulation as conceptualised on the law-side of reality. As several authors have noted (Schmidt, 2008); Brown, 2014), wicked problems require a multi- or interdisciplinary approach. In particular characteristic i (multiple explanations for the gap between desired and actual situation) calls for a consideration of different aspects of reality. Design problems aim at interventions in reality and for this to be successful reality has to be taken into account in its full integral complexity, and not as a sum of aspects, not even when the range of aspects that is considered widens thanks to a multi- or interdisciplinary approach. Finally, characteristic j is directly related to characteristic c, as I argued before, and I refer to what has been remarked to Dooyeweerd's contribution to understanding that characteristic earlier.

I realise that this is a very incomplete account but it does at least provide suggestions as to how a Dooyeweerdian approach offers a good framework for understanding the nature of wicked problems.

6. Conclusion and final considerations

An awareness of the wickedness of design problems is a blessing when it helps us to do justice to the complexity of design challenges and help us move away from an inappropriate and according to

Churchman even unethical use of the notion of utopias. A Dooyeweerdian approach to reflecting on reality comprises notions that are useful for designers when solving wicked problems because it does justice to the complexity of reality and at the same time it helps to structure the study of this complexity. Dooyeweerd's philosophy is based on a Christian worldview in which both the richness and complexity and the structuredness and orderliness of reality are seen as tokens of God's almightiness and trustworthiness. The Christian notions of sin and evil give rise to concern about utopian ambitions in design and technology. Although other worldviews may also provide useful contributions to the understanding of the nature of design problems as wicked problems, a Christian worldview probably provides a fairly unique combination of different elements all of which contribute to a coherent framework for understanding this nature.

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