# WICKED PROBLEMS AND THE CYBERNETIC METHOD

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**ABSTRACT**
The world is full of wicked problems, problems that resist a priori scientific solutions. So how can we address them, engage with them and even solve them? The answer must entail a sort of practical experimentation extended over time—*acting* on the system in question, seeing what it does, adapting to that, and so on, in a process I call a *dance of agency*. I show how this has worked out in attempts to manage ecological degradation on the Colorado River below the Glen Canyon Dam. I then note that although it is straightforward this process can be hard to grasp, and even to see, for several reasons, all of which put it beyond the pale of modernity. (1) It is not conceptual, it does not centre on knowledge or science. It is about agency and performance, of humans and nonhumans, topics that we do not usually talk about. (2) It is not dualist. It does not impose a human blueprint on the nonhuman world. It entails instead the attunement of human practices to the emergent properties of, in this case, nature. (3) Again in this instance, it does not issue in one-off solutions (in the sense that, say, building a dam is a classic one-off engineering solution to the problem of containing water). Instead, the solution to the wicked problem of the Colorado has been the establishment of a continuing *choreography of agency* in which the actions of dam operators are now locked into the behaviour of other rivers which feed into the Colorado below the Glen Canyon Dam.

The history of thinking about wicked systems has been entwined with cybernetics—the science of 'exceedingly complex systems' as Stafford Beer called them—and I situate my example in the history of cybernetics, including Gordon Pask's distinction of scientific and cybernetic method in terms of a linguistic metaphor of conversation. I argue that my account of engaging with wicked systems brings out the performative skeleton of cybernetic approaches which is easily lost in existing discussions—including, obviously, Pask's linguistic analysis. Second-order cyberneticians emphasise the conversational aspects of defining wicked problems, so I close by noting that in my example, and many others, the social is engaged with and depends on performative experimentation, not a separate topic.

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> The difficulties attached to rationality are tenacious, and we have so far been unable to get untangled from their web.
> Horst Rittel and Melvin Webber, 'Dilemmas in a General Theory of Planning' (1973, 160).

The natural and social worlds are full of complex systems, and I'm interested in the question of how we approach them, engage with them, deal with them, if at all. One stock answer, of course, is 'science.' Science will help us know the world and thus guide our interactions with it. But I'm interested here especially in what the cybernetician Stafford Beer in 1959 called 'exceedingly complex systems,' which he understood as systems refractory to science, either because of their sheer complexity or because they are liable to change, rendering existing knowledge obsolete—his examples were the brain, the firm and the economy. We could think of such systems as 'unknowable' (Pickering 2004) or, to make contact with a better known body of thought deriving from Horst Rittel and Melvin Webber's work on planning, 'wicked'

(Rittel and Webber 1973).[1] How to get along with wicked systems is an interesting question theoretically, but also practically—as Hugh Dubberly and Paul Pangaro (2019, 67) have pointed out, the great challenges and threats to the world today are wicked ones.

Beer's argument was that cybernetics is the science of wicked systems, so it perhaps follows that cybernetics as a field must offer pointers to engaging with wickedness. I think this is right and I will come back to it below, but I want first to outline my own perspective. I want to examine a successful solution to a real-world wicked problem in order to argue that *performative experimentation*—and *not* science and knowledge—must be the key to engaging with wicked systems. That is the central contention of this essay: I want to get clear on a different way of approaching the world from modern science, a different paradigm of action, one could say.[2] I then situate my analysis in the history of cybernetics, and I conclude with a discussion of the social dimension of the process at issue.

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My example concerns the Colorado River, which flows through the Grand Canyon in the west of the United States (Asplen 2008, Rice 2013, Pickering 2019). I'll tell a short story about the management of the Colorado and then comment on it. In 1963 a giant dam, the Glen Canyon Dam, was completed on the Colorado upstream of the Grand Canyon. The dam was intended to generate electricity, but it also set in motion many unexpected downstream transformations. Sandbanks eroded; native species of plants and fish became endangered; alien species started to move in. The problem of what to do about these transformations and how to reverse them is my paradigmatic wicked problem here—wicked in the sense that no-one knew how to address it a priori, and also in the sense that any attempt to address it was liable to change the problem itself in modifying the river.

The sequence of events that interests me—the solution of the problem—began with a chance event. In 1983, 20 years after its completion, Lake Powell, upstream of the dam, was in danger of overflowing, and as an emergency measure vast quantities of water were released through the dam. And it was noticed that this artificial flooding of the river had beneficial

[1] Rittel and Webber specify that their discussion pertains to the social sciences and not to natural science or engineering, but this exclusion depends on a false contrast which assumes that all natural scientific and engineering problems are 'tame'—specifiable and understandable in advance (eg p. 160). This is evidently not the case in general or in the example we will be discussing.
[2] I contrast the two paradigms as 'enframing' vs 'poiesis' in Pickering (2019, in prep).

downstream effects: 'Depleted beaches were replenished, exotic vegetation was killed along the riverbanks, and previously degraded animal habitats were re-created' (Asplen 2008, 172).

Much encouraged by this, the dam operators embarked on what was known as the Glen Canyon Dam Adaptive Management Program, or AMP for short. This centred on a sequence of High Flow Experiments (HFEs), deliberate artificial floods released from the dam, modelled on the first and each aiming to learn from the upshot of the others in terms of operating conditions and downstream modifications.[3] To date (December 2020), eight HFEs have been conducted on the Colorado—in 1996, 2004, 2008, 2012, 2013, 2014, 2016 and 2018.[4] Early experiments looked promising. The first HFE, in 1996, initially appeared to be a success and 'increasing sedimentation was readily apparent. . . What we found was really quite extraordinary. The success of the event exceeds . . . even our most optimistic hopes of our staff of scientists' (Rice 2013, 418-19). But the optimism soon evaporated. Sandbanks that had been built up during floods were quickly eroded again; invasive species turned out to be hiding in the mud and soon reappeared; the population of humpback chub, and endangered species, continued to decline. 'After two HFEs [1996 and 2004] and nearly 10 years of adaptive management, the ecological conditions below the Glen Canyon Dam exhibited little sustained improvement . . . Long-term increase in sedimentation had not been achieved, the presence of humpback chub continued to decline even as nonnative trout were thriving, and nonnative vegetation, particularly tamarisk, remained entrenched along the Colorado River corridor' (Rice, 420).

Nevertheless, 'a great deal of insight into the interplay of controlled flooding and ecological response was gleaned after two HFE's.' The basic understanding of what was going on had to do with the sediment carried along by the river. The Glen Canyon Dam slowed the Colorado down, leading it to deposit most of its sediment above the dam, and the conviction arose that it was a lack of sediment that was at the heart of the problems below the dam—the river was washing away sandbars and beaches without supplying enough sediment to replenish them. And the idea that came to the fore after the second HFE was that perhaps the sediment carried by two other rivers that joined the Colorado below the dam, the Paria and the Little Colorado, could be exploited. In particular the idea was to wait until one or the other of these rivers was

[3] The AMP also included modifications to ramping rates for electricity production but I omit those details here.

[4] 'There will be no fall High-Flow Experiment at Glen Canyon Dam in 2020. The best available data and modeling indicated that sediment triggering conditions necessary to conduct a 2020 fall HFE at Glen Canyon Dam were not met [see below]. . . No HFEs were conducted in calendar year 2019 or calendar year 2020.' www.usbr.gov/uc/rm/gcdHFE/index.html. 2020 was intended as the third year in a row for a 'bug flow,' modulating water flows to 'improve egg-laying conditions for aquatic insects' (USBR 2020).

in flood and thus carrying much more sediment than usual, and then to stage an HFE on the Colorado to carry this added sediment downstream, possibly recreating the sandbars and rejuvenating the ecosystem. The spring 2008 HFE was therefore ‘precipitated by flooding on the Paria River and an estimated sediment inflow to the Colorado 3 times greater than observed before the 2004 HFE . . . There was evidence of redeposition of sediment [but] six months later, however, a majority of new sedimentation was lost to erosion, and [again] nonnative . . . vegetation was temporarily buried rather than scoured from the Grand Canyon. . . Researchers now [2013] suspect that too much time had passed between sediment inflow and the 2008 HFE such that a substantial proportion was lost under normal operating conditions,' and later HFEs were accordingly planned to be 'triggered' by large sediment inflows (Rice 2013, 420, 422).[5]

This synchronised flooding of the Colorado and, especially the Paria became the pattern for subsequent HFEs and proved, in fact, effective. ‘The evidence from [HFEs up to 2014] indicated that releases timed to follow sand inputs . . . are, in fact, an effective sandbar-building strategy. . . Resource managers . . . consider the 2012-2014 results encouraging' (Grams et al 2015, 2, 5). The sandbars continue to fade away between HFEs, and the current wisdom is that there need to be relatively frequent artificial floods timed to coincide with major sediment inputs from the Paria and Little Colorado. HFEs are now, in fact, routinely seen as helping to ‘rebuild beaches, sandbars and other environmental resources’ (USBR 2018, 2, USBR 2019, 2).

In this sense, then, the initial wicked problem—how to reverse ecological degradation on the Colorado—has been solved! and that is what I want to reflect on now. What can we say about the general features of the trajectory that led to the solution? I need to emphasise three simple but fundamental points. First, it was *performative*. By this I mean that performance—action in the world, doing things—was at the heart of engaging with this wicked problem. The dam operators did things, releasing large quantities of water through the Glen Canyon Dam, and the downstream ecosystem also performed and did things: sandbars increased in size, the balance of species changed. There is then, second, a *symmetry* of the human and the nonhuman here: both the human dam operators and the nonhuman river were genuine agents in this process (where ‘agency’ has to be understood precisely in the sense of performance and not in the more traditional sense of will and intention). And, third, beyond this symmetry,

[5] ‘Interior announced in 2012 . . . the adoption of a flexible protocol through 2020 wherein each HFE is “triggered” by significant inflow of sediment to the Colorado by majot tributaries below the dam. . . A flexible protocol timed to the observance of sediment inflow will probably lead to annual or even semiannual HFEs punctuated by 1 or more years where no controlled flooding occurs due to drought conditions’ (Rice 2013, 422).

human and nonhuman performances were bound up together in a back and forth process that I call a *dance of agency* (Pickering 1995): the river's actions were evoked by the human actions, human actions responded to the prior responses of the river, and so on.

This is my basic observation, which I think is general: addressing and perhaps solving wicked problems entails *staging* this sort of performative dance of agency with the wicked system in question. There is no other way. And fourth, I want to note that this processs is genunely *experimental*. The dam operators had always to *find out* how the river would react to flows of this specific magnitude in these specific circumstances, and to tune their practices to whatever emerged. *Performative experimentation*, then, on this account, is the key to addressing wicked problems.

Perhaps this answer is obvious, but i want to note two features that might be difficult to get to grips with. First, as indicated at the start, this way of engaging with wicked systems and wicked problems is *not conceptual*, it is not about words, ideas, bold conjectures, calculations, science—as I said, it is centred on actions.[6] And this, in a way, puts it beyond the pale of modernity, in which science is more and more regarded as the key to action in the world. Performative experimentation, we could say, is in a different space from science, part of a different and heretical paradigm.

Second, it is worth thinking about the form of the solution to this wicked problem. Reading contemporary accounts of the progression of the AMP a tone of regret becomes obvious. Improvements have been made, but only temporarily; between HFEs, the river regresses towards its prior state; and this is not what we want. And the counterpart to this regret is the dream of a final solution, a one-off operation that will restore the Colorado ecosystem once and for all—just as building a dam is a one-off solution to the problem of containing water and generating electricity. This sort of dream is, again, a key feature of modernity, the telos of modern engineering: geo-engineering as the antidote to global warming, to pick a big example.

To put this point more positively, the achievement of the AMP was not a one-off solution but a *choreography of agency*, tuning the human agency of the dam operators into that of the Colorado, Little Colorado and Paria Rivers and of the downstream ecosystem in a continuing process such that the state of the ecosystem varied around a more or less desirable balance

[6] For a more nuanced account of the place of knowledge in examples like this, see Pickering (2019, in prep.). The overall conclusion remains, that addressing wicked systems requires an approach centred on performance.

point. It is not clear to me that modern engineering or modern commonsense has any image, even a word, for such a dynamic balance—hence the persistence of regret around the AMP. This, then, is another sense in which an experimental and performative approach to wicked problems might be hard to get to grips with.[7]

Of course, the notion of dynamic balance is easily imagined in cybernetics—think of servomechanisms, obviously—but cybernetics is itself part of a different paradigm from modern science and engineering (Pickering 2013). We can think more about cybernetics in the next section.

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Since I have borrowed their notion of a wicked system, we should start with Rittel and Webber (1973). Two points are clear. First, Rittel's connection to cybernetics is well established in the work of Chanpory Rith and Hugh Dubberly (2006), and the ontology underlying Rittel and Webber's paper is clearly cybernetic: their vision of a wicked system is one of causes and effects ramifying endlessly through networks with no definitive end—precisely an exceedingly complex system on Beer's definition.[8] Beyond that, however, their object is negative: to bring home how difficult and even impossible, it is to solve wicked problems.[9] It seems to me that Rittel and Webber and their followers are wrong about this impossibility.

More constructively, a notion of performative experimentation in pursuit of balance, as discussed here, figures centrally in the history of cybernetics. At the origins of cybernetics, Ross Ashby's homeostat, first constructed in 1948, was an 'ultrastable' machine that did

[7] I should be clear that an experimental approach to the world does not necessarliy lead to this sort of choreography. Any genuine research must be experimental in this sense and research can certainly sometimes lead to fixed accomplishments and one-off solutions. See, for example, my discussion of Donald Glaser's route to the invention of the bubble chamber (Pickering 1995, ch 2). See also my analysis of 'islands of stability' (Pickering 2017).

[8] For example, 'With wicked problems . . . any solution . . . will generate waves of consequences over an extended—virtually unbounded—period of time. Moreover, the next day's consequences . . . may yield utterly undesirable repercussions which outweigh the intended advantages or the advantages accomplished hitherto' (Rittel and Webber, 163, see also 156, 159, 161, 165). I am struck by the isomorphism of this picture and Masanobu Fukuoka's discussion of pests in farming (see Pickering 2019), and Gregory Bateson's (1959, 268) cybernetic analogy between controlling a complex system and trying to reverse a truck with two trailers.

[9] 'There are no "solutions"' (Rittel and Webber, 155). They also explicitly deny the possibility of an experimental approach: 'Every solution to a wicked problem is a "one-shot" operation . . . because there is no opportunity to learn by trial-and-error' (163). This is just a mistake. The recent history of social planning and policy in Britain, for example, is one of endless experimentation on a limited basis, with the expectation that successful variants will be 'rolled out' more widely. Obviously experimentation was entirely possible in our example here.

nothing but experiment performatively on its environment, randomly reconfiguring its inner workings until equilibrium was found (Pickering 2010, ch 4). We could see the dam operators in the AMP as homeostats experimenting on their riverine and ecological environments (though I have never seen the AMP analysed in such terms).

AMP was short for 'Adaptive Management Program,' and adaptive management as a general approach to management—slogan, 'learning to manage and managing to learn'—again thematises a performative experimental approach, and the cybernetic origins of adaptive management seem clear enough. Holling (1973) develops an analysis of ecological 'resilience' in terms of phase-space diagrams, basins of attractions and tipping points that are recognisably cybernetic (Ashby 1952) and, according to Asplen, the adaptive management approach to ecosystems was first suggested in Holling (1978). Holling and Meffe (1996) extend that picture to criticise 'command and control' in favour of adaptive environmental management as exemplified here. What my analysis adds is thus to pick out the *performative skeleton* of adaptive management from the details of specific projects,

In the second generation of cybernetics, Stafford Beer and Gordon Pask were the virtuosos of adaptation. Beer was the founder of management cybernetics, and his trademark Viable System Model can be understood as a blueprint for organisational structures and information flows that can address and cope homeostatically with wicked problems. Once more, my analysis helps to pick out and generalise the performative skeleton from the elaborate specficity of Beer's organisational vision (Pickering 2010, ch 6). We could also put this the other way around: the richness of Beer's organisational cybernetics makes it hard to see the wood for the trees when it comes to addressing non-organisational wicked systems.

At a higher level of generality, in 1958 Pask sought to distinguish between what he called the scientific and the cybernetic method. His argument was that the cybernetician aims to 'maximise' interaction with an assemblage, while the scientist aims to 'minimise' it (1958,171-73).[10] As far as science is concerned, he clearly had a hypothesis-testing image in mind. The scientist holds all variables except one fixed (minimising interaction) and varies the other to explore its effect on the system in question. But what could 'maximising' interaction mean? Pask saw this as entailing what he called 'conversation' with a system which would develop a 'language' appropriate to managing it, in the course of which a 'concept' would emerge. Can we relate all this to our example? It seems to me that Pask's version of cybernetic method has much in common with the performative approach to wicked problems described here. But

[10] I thank Marcus Carney for providing me with a copy of ths paper, and Paul Pangaro for putting us in touch.

there are also important divergences which illuminate ways in which Paskian 'conversation theory' (and second-order cybernetics) depart from the materialist approach to wicked problems I have been outlining, and it might be valuable to discuss this briefly.

Speaking loosely, the resonances between the two approaches are clear. Releasing megatons of water into a river, in contrast to making a measurement, corresponds to Pask's idea of 'maximal' interaction.[11] And Pask's thoughts on conversation certainly evoke the back-and-forth of what I have called the dance of agency between the dam operators and the river. At the same time, though, I have stressed the non-conceptual skeleton of an experimental approach to wicked problems, while Pask's references to conversation, which loomed ever larger in his cybernetics, turning eventually into Conversation Theory, points us strongly in a linguistic and conceptual direction. And even if we treat the reference to conversation as metaphorical, still the metaphor very quickly becomes strained. It is interesting, for example, to ask about what 'language' the human and nonhuman participants of the AMP could be said to speak. In everyday conversations it is important that the participants speak in the same shared language—English, say—but that condition does not hold for the AMP. In the AMP, the dam operators only 'spoke' a single word—'flood'—over and over again, while the river's 'replies' were different in kind and much more varied, consisting of all sorts of downstream physical and biological changes. Or, to be more accurate, it is as if the dam operators whistled a single note—corresponding to 'flood'—repeatedly but varying in volume and timing. Either way, this disparity between the two parties seems to me to undermine Pask's linguistic metaphors—even a pidgin depends on a common vocabulary.[12]

Beyond that, I analysed the solution to the problem of the degradation of the Colorado ecosystem as the achievement of a choreography of agency in which human and nonhuman performances have become artfully threaded together—and I can think of no linguistic metaphor for this choregraphy. It is more akin to the combined performance of a choir or a symphony orchestra (or a football team . . .) than the verbal interactions that are Pask's models.[13] Pask writes as if *the point* of conversation (in his sense) is to build up a shared concept, but I have emphasised that the AMP centred on performance, not concepts, and Pask thus offers us no language to think about actions combining together.[14] Like Beer's

[11] In Pask (1958) 'maximal' refers to sending currents through all possible sets of electrodes in developing an 'organic controller.'
[12] The cybernetician 'builds up . . . a common language in terms of which he and the system may interact and form a macrosystem' (Pask 1958, 171).
[13] The symphony orchestra is Fleck's metaphor (1979) for the team performance of the Wassermann reaction.
[14] 'Conversation is "concept sharing"' (Pask 1980, 999). ''Conversation, the act of concept sharing' (1980, 1003). I may as well say I am puzzled by Pask's emphasis on conversarion, language and

cybernetics, then, Pask's language-centred language takes us away from the performative approach to wicked problems exemplified by the AMP. I am a vast admirer of the work of both men, but I think there is an argument here for retracing our steps in the history of cybernetics and moving forward in a new direction, one focussed on performance and experimentation.

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An aspect of Rittel and Webber's sense of wickedness that I have not so far discussed is the idea that problems can be wicked in the sense of lacking agreed definition. Dubberly and Pangaro (2019) emphasise that this brings in conversation (Pask, again), now between interested parties, to delineate just what problems are, and that this sort of conversation is the topic of so-called second-order cybernetics, which emphasises the ethics of taking responsibility for one's position. Sometimes second-order cyberneticians foreground conversation alone.[15] But to conclude, I want just to note that all of the examples that come to my mind actually involve this sort of social negotiation *constitutively entwined with* the performative experimentation we have been discussing. Here is a brief list.

1) The Glen Canyon Dam Adaptive Management Project was subject to periodic evaluations by a wide variety of groups interested in the Colorado and its ecosystem, including the dam operators, scientists, users of waterflows and electricity, state governments and Native American tribes. These groups have repeatedly convened to reflect on the outcomes of

concept-sharing (and 'analogy'). In his 1958 essay on 'cybernetic method' I find it hard to see how these terms attach to his discussion of 'organic control,' which points, rather, to a concern with performance and 'patterns of behaviour' (169, 173). My remarks above on the problems of the linguistic metaphor apply equally to Pask's famous Musicolour machine, his prototypical cybernetic device, though in his robot-artwork, the *Colloquy of Mobiles*, the robots do communicate with one another in a single language of lights and sounds. My guess would be that the emphasis on language grew out of Pask's work on teaching machines, and that Conversation Theory is best seen not as a general theory of cybernetics but as a theory of such very specific machines. Pask (1970, 25) contrasts 'taciturn' and 'language oriented' systems, differentiated by their accessibility to language. In my example, all of the nonhuman participants are taciturn on this definition, and probably the dam operators are too. The discussion in Pask (1970) focusses instead on language-oriented systems, especially humans and teaching machines. We could also think here about the 'linguistic turn' in 20th-century Anglo-American philosophy and its emphasis on epistemology to the exclusion of ontology. Paul Pangaro has reminded me of the more performative aspects of Pask's work (such as the reference to 'patterns of behaviour' mentioned above) and I have no wish to deny these. From this angle my argument has to be that, again, my analysis serves to foreground the performative skeleton that is overshadowed by Pask's linguistic/conversational concepts. To say this another way, when I began this essay my intention was to show how Pask's concepts illuminated the AMP, but I gave up—in the end it seemed to me that Pask's concepts got in the way.

[15] As one example, see the video and very extensive discussion: Lissack (2020). Lissack was the President of the American Society for Cybernetics, 2014-2020.

previous HFEs and projections for the future, and to decide collectively on the parameters of future HFEs.[16]

2) I mentioned Beer's Viable System Model earlier. The most famous implementation of it was Project Cybersyn, aimed at organising the Chilean economy in the early 1970s (Medina 2014, Pickeriing 2010, ch 6), and a major element of Cybersyn was its control room, a high-tech information environment where all of the key decision-makers, including the President, could gather to survey the state of the system, emerging problems, computer projections of the future and so on, in making and remaking policy.[17]

3) Management of the biggest river in the US, the Mississippi, has long been organised around a series of physical and computer models, which have served as the basis for conceptualising possible outcomes of engineering interventions (such as building dikes and control structures) (Pickering in prep). The Mississippi remains a wicked problem, in the sense that no model can exhaustively represent the river, and surprises always remain.[18] Nevertheless, Cheramie (2011, 11) emphasises that the largest physical model of the river 'was envisioned not only as a highly efficient, technologically advanced machine, but also as a platform for communication. . . For decades the model was the site of major conversations about American-built and natural environments. Governors, mayors, tourists and engineers gathered to see the river in motion, to discuss possible solutions, likely ramifications and the division of responsibility.'

4) We can distinguish between two extreme approaches to software design. In a top-down approach, the overall aim of a software system is specified and broken down into subtasks which are reassembled when complete. So-called Agile programming, in contrast, proceeds in a bottom-up fashion as if software engineering were itself a wicked problem, writing and testing short passages of code in a repeating process. And the important aspect of Agile programming in the present context is that passages of code are regularly presented to future users for evaluation, so that the overall specification of the system, rather than being given in

[16] A federal advisory committee, the Adaptive Management Work Group, has met twice a year (or more) since 1997. Its membership comprises 25 institutional entities, including five Native American tribes and nations and seven states: www.usbr.gov/uc/progact/amp/amwg.html
[17] Fifty years later, the Prime Minister's chief adviser, Dominic Cummings (2019) argued for just such a space for British policy-making.
[18] Noting the different vertical and horizontal scales of the model, the quotation below continues: 'How many policy decisions were shaped by politicians who misunderstod the lessons of the basin model because of the height of its hills and cliffs?'

advance, can evolve in the process of construction—including the development of features not recognised in advance (Marick 2008).[19]

Where does this get us? The conclusion is that the social dimensions of wicked problems should not be treated as independent of their practical ones. At minimum, we need to recognise that the substance of wicked problems can itself change in time, as did the Colorado in response to artificial floods, so that decision-makers *need* to periodically reconvene to re-assess developments. In this sense, performative experimental engagements with wicked problems necessarily and literally constitute the dynamic site and substance for social engagements.

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[19] The Agile Software Alliance actually presents a Gordon Pask Award: https://agilecoach.typepad.com/agile-coaching/2010/08/the-gordon-pask-award.html. We could see Agile programming as an example of participatory design more generally.

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