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THEMATIC ESSAY

Science, Uncertainty, and Society: Getting Beyond the Argument Culture to Shared Visions

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Abstract: Practical problem-solving in complex societies requires the integration of three elements: (1) active and ongoing envisioning of both how the world works and how we would like the world to be, (2) systematic analysis appropriate to and consistent with the vision and (3) implementation appropriate to the vision. Scientists generally focus on the second step, but integrating all three is essential for both good science and effective, democratic decision-making. Subjective values enter the vision of broad social goals and the pre-analytic vision that necessarily precedes any form of scientific analysis. Because of this need for vision, completely objective scientific analysis is impossible. To better support democratic decision-making, scholars of all varieties need to acknowledge the need to engage more directly in all three elements of the process while sharing their knowledge of how the world works and bringing their understanding of uncertainty more effectively to the table. This more integrated role of the scholars can help overcome the currently widespread denial of critical knowledge about how the world works, especially about climate, wellbeing, and evolution, and support better, more democratic decision-making about how we would like the world to be and how to get there.

1. WHAT IS SCIENCE?

The public and policy-makers often confuse science with "objective" analysis. Because of the need for a vision, completely objective scientific analysis is impossible. Joseph Schumpeter put it this way:

> In practice we all start our own research from the work of our predecessors, that is, we hardly ever start from scratch. But suppose we did start from scratch, what are the steps we should have to take? Obviously, in order to be able to posit to

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> ourselves any problems at all, we should first have to visualize a distinct set of coherent phenomena as a worthwhile object of our analytic effort. In other words, analytic effort is of necessity is preceded by a preanalytic cognitive act that supplies the raw material for the analytic effort. In this book, this preanalytic cognitive act will be called Vision. It is interesting to note that vision of this kind not only must precede historically the emergence of analytic effort in any field, but also may reenter the history of every established science each time somebody teaches us to *see* things in a light of which the source is not to be found in the facts, methods, and results of the preexisting state of the science. (Schumpeter 1954, 41)

Nevertheless, it is possible to separate the process into a more subjective, or normative, envisioning component and a more systematic, less subjective analysis component (which is based on the vision). "Good" science is that which makes clear its underlying preanalytic vision, and whose analysis is consistent with that vision.

2. A CHANGING VISION OF SCIENCE

The task would be simpler if the vision of science were static and unchanging. But as the quote from Schumpeter makes clear, this vision is itself evolving as we learn more. This does not invalidate science, as some deconstructionists would have it. Quite the contrary, by being explicit about their underlying preanalytic visions, scientists can enhance their honesty and thereby their credibility. Scientific credibility proceeds from an honest discussion of this underlying vision and its inherently subjective elements, as well as from constant, pragmatic testing of conclusions against real-world problems, rather than by appealing to non-existent objectivity. The preanalytic vision of science is changing from the "logical positivist" view, which holds that science can discover ultimate truth by falsification of hypotheses, to the more pragmatic view that we do not have access to any ultimate, universal truths, but only to useful, abstract representations (models) of parts of the world. Science, in both the logical positivist and this "pragmatic modelling" vision, works by building models and testing them. But the new vision recognizes that the tests are rarely, if ever, conclusive (especially in the life sciences and the social sciences); the models can only apply to a limited part of the real world; and the ultimate goal is therefore not the truth, but quality and utility. In the words of William Deming, "All models are wrong, but some models are useful" (McCoy 1994).

The primary goal of science, then, is the creation of models whose utility and quality can be tested against real world applications (Costanza 2001). The criteria by which one judges the utility and quality of models are themselves social constructs that evolve over time. There is, however, a fairly broad and consistent consensus in the scientific community about what these criteria are. They include (1) testability, (2) repeatability, (3) predictability, and (4) elegance (i.e., Occam's razor: The model should be as simple as possible, but no simpler!). But because of the nature of real-world problems, there are many applications for which some of these criteria are difficult or impossible to apply. These applications may nevertheless still be judged as "good" science. For example, some purely theoretical models are not directly testable, but they may provide fertile ground for thought and debate and lead to more explicit models that are testable. Likewise, field studies of watersheds are not repeatable, strictly speaking, because no two watersheds are identical. But there is much we can learn from field studies that can be applied to other watersheds and tested against the other criteria of predictability and elegance. How simple a model can be depends on the nature, type and scope of the questions being asked. If we ask a more complex or more detailed question, the model will probably have to be more complex and detailed. As science progresses and the range of applications expands, the subjective criteria by which utility and quality are judged, must also adapt. This inherently subjective process goes on constantly within the scientific community.

Scientists are not the only ones building models of the world. Every human, and indeed every sentient life form, employs models. A model, in this context, is any abstract, useful, representation of reality. We navigate the world using the model of the world each of us has in our brains. Our mental models or world-views guide our every action and determine how we interpret things that happen in the world and predict what will happen next (Gentner and Stevens 2014). Traditional and religious belief systems are also models of how the world works. Like all models, they are wrong, but they may be useful guides to behaviour while helping to build social capital. The discussion about traditional/religious models versus scientific models thus needs to move beyond "truth" to the utility of the models in guiding behaviour and creating a sustainable and desirable future. From the point of view of utility, these models are not necessarily mutually exclusive (Wilson 2010). More on this further on.

One often hears these days about "cognitive bias" — the idea that we only perceive things that conform to our mental model of the way the world works (Caverni *et al.* 1990). Religious fundamentalists may reject data that does not conform to their mental model of a 6,000-year-old world. Climate-deniers will not accept data of human-caused climate change if it does not conform to their mental model.

Science, as an enterprise, explicitly attempts to overcome confirmation bias by testing hypothesis against the real world and not existing mental models. For example, mental models based on the hypothesis of the inherent superiority of one subset of humans over others can be shown to be inconsistent with reality. But racist or misogynist mental models are difficult to change, in part because of confirmation bias. Science itself is not immune to confirmation bias, and there are many historical cases of theories that have ultimately been proven false hanging on in spite of overwhelming evidence to the contrary. But an important part of the issue is that, as argued above, there is often no definitive answer to complex problems. The best we can do is to develop useful models that acknowledge the uncertainty. How we deal with uncertainty is a key issue in the world of "fake news" and "alternative facts."

3. DEALING WITH UNCERTAINTY

One of the main issues with scientific uncertainty is not just its existence, but the radically different expectations and modes of operation that scientists, the public and policymakers have developed to deal with it. To solve this, these differences need to be understood and better methods designed to incorporate uncertainty into democratic decision making.

To understand the scope of the problem, it is necessary to differentiate between risk and true uncertainty. Risk is an event with a known probability (sometimes referred to as statistical uncertainty). True uncertainty is an event with an unknown probability (sometimes referred to as indeterminacy) (Tversky and Fox 1995). For instance, every time you drive your car, you run the risk of having an accident because the probability of car accidents is well known. The risk involved in driving is well known because there have been many car accidents with which to calculate their historical frequency, which is taken as an estimate of the probability of having a car accident in the future. These probabilities are known with enough precision to be used by insurance companies, for instance, to set rates that will assure those companies of a certain profit. There is little uncertainty about the possibility of car accidents. If you live near the disposal site of some newly synthesized toxic chemical, however, your health may be in jeopardy, but no one knows to what extent. Because no one knows the probability of your getting cancer, for instance, or some other disease from this exposure. This is true uncertainty. Most important policy issues suffer from true uncertainty, not mere risk.

Uncertainty may be thought of as a continuum ranging from zero for certain information to intermediate levels for information with statistical uncertainty and known probabilities (risk) to high levels for information with true uncertainty or indeterminacy. Risk assessment has become a central guiding principle in many government management agencies but true uncertainty is yet to be adequately incorporated.

Scientists treat uncertainty as a given, a characteristic of all information that must be honestly acknowledged and communicated. Over the years, scientists have developed increasingly sophisticated methods to measure and communicate uncertainty arising from various causes. Scientists have often uncovered more uncertainty rather than the absolute precision that the lay public often mistakenly associates with scientific results. Scientific inquiry can only set boundaries on the limits of knowledge. It can define the edges of the envelope of known possibilities, but often the envelope is very large, and the probabilities of what's inside can be a complete mystery. For instance, scientists can describe the range of uncertainty about global warming and toxic chemicals and maybe say something about the relative probabilities of different outcomes, but, in most important cases, they cannot say which of the possible outcomes will occur with any degree of accuracy. Current approaches to management and policymaking, however, avoid uncertainty and gravitate to the edges of the scientific envelope. The reasons for this bias are clear. Policymakers want to make unambiguous, defensible decisions, which are often codified into laws and regulations. Although legislative language is often open to interpretation, regulations are much easier to write and enforce if they are stated in absolutely certain terms. For most of criminal law, the system works reasonably well. Either Cain killed his brother, or he did not; the only question is whether there is enough evidence to demonstrate guilt beyond a reasonable doubt (with essentially zero uncertainty). Because the burden of proof is on the prosecution, it does little good to conclude that there was an 80-percent chance that Cain killed his brother. But many scientific studies come to just these kinds of conclusions. Science defines the envelope while the policy process gravitates to an edge—usually the edge that best advances the policymaker's mental model and political agenda. But to use science rationally, democratic policy decisions must consider the whole envelope and all its contents.

4. WHO BEARS THE BURDEN OF PROOF?

A key question in dealing with uncertainty is: who bears the burden of proof? In many cases, in western democracies, the burden of proof has fallen on the public. This allows uncertainty to be manipulated to benefit private interests, who cannot be held responsible for damages until it is proven that they were the cause. Given the discussion of uncertainty above, it should be clear that this is a severe burden of proof. It allows private interests to externalise the risks of their activities. This distorts market behaviour and leads to overuse and exploitation of the commons. A necessary condition for efficient markets is that all externalities be internalised. The question is how? If impacts are uncertain, how can we internalize them?

Our current approach to dealing with the risk of private interests damaging public assets is to assign liability to the private interests with the burden of proof on the public. The public must demonstrate damages after the fact, claim compensation, endure a lengthy judicial process, and finally hope to recover just reparations. In addition, the total liability is often limited. For example, in the U.S., the Oil Pollution Act of 1990 limits the liability for oil spills to USD 75 million and the Price-Anderson Act limits the liability for nuclear power plant accidents to USD 10 billion. The Exxon Valdez oil spill resulted in an estimated USD 3.4 billion in fines, compensation, and clean-up costs, and a court settlement of USD 2.5 billion in punitive damages that took decades of lawsuits after the incident and was ultimately reduced by the Supreme Court to USD 500 million in 2008 (Maag 2008).

In many other parts of society, we require private interests to buy insurance to deal with the risks they impose on the public. For example, purchasing automobile insurance is often mandatory, and assurance bonds are often required from building contractors. Requiring assurance bonds or insurance forces private interests to internalize the risk of their activities before any damages occur. It gives them strong financial incentives to reduce risk, since it is their own money that they stand to lose. The Deepwater Horizon incident, like the banking crisis, resulted from inadequate attention to the risks that the public was left to bear. Precautionary measures were known but not taken. Investments in safety devices (like the acoustic blowout preventer) were not made. Corners were cut. Short-term private profits motivated taking high risks with public assets. The fundamental problem is that while private interests are ultimately liable for damages to public assets, they are only held accountable long after the fact and only partially. This gives private interests strong incentives to take large risks with public assets—far larger than they should from society's point of view. If society does not change investment incentives, private interests will continue to devote vast sums of capital to pursue increasingly risky oil reserves (or financial products) that provide less net energy and maintain our oil addiction—an addiction which simply cannot be physically sustained. It also encourages climate inaction, since costs and liabilities can be externalized and pushed into the future.

One way to internalize these risks would be to require private interests to post an "assurance bond" large enough to cover the worst-case damages (Costanza and Perrings 1990; Costanza and Cornwell 1992). Portions of or the entire bond (plus interest) would be returned, if and when the private interests demonstrate that the suspected worst-case damages had not occurred or would be less than was originally assessed. If damages did occur, portions of the bond would be used to rehabilitate or repair the assets and to compensate injured parties. The critical feature is that the risk to the public asset is apparent to the private interests in financial terms before the fact, not as a liability that may or may not be enforced after the damage occurs. Science can contribute to this process substantially, because it is often easier to quantify the worst-case scenario than to identify where within the range of uncertainty the impact may fall.

Consider the impact of fossil fuel use on climate. Climate deniers argue that there is no impact while the scientific community presents a range of estimates that acknowledge the uncertainty, including a worst-case scenario. What if the fossil fuel producers were required to post an assurance bond to cover the potential worst-case impact of carbon emissions from fossil fuels, in addition to internalizing the social cost of carbon emissions with a carbon tax? The speed of transition to renewables that this would cause would be amazing.

5. MANIPULATING UNCERTAINTY IN THE ARGUMENT CULTURE

Uncertainty can be manipulated for political purposes. The climate "debate" is the most obvious current example. The scientific community, as summarised in the IPCC reports, clearly lays out what is known about the changing climate, its causes, and the degree of uncertainty in each element of the assessments. Climate deniers seize on the fact that there *is* uncertainty to argue that the assessments lack any credibility and cannot "prove" that humans cause climate change.

This feeds into what Deborah Tannan (1998) has called the "argument culture." In this culture, even the most complex problems are cast as polar opposites with no uncertainty. All discussions are cast as a debate between two extremes in which one side is right while the other is wrong. The media, the law, politics, and academia are all caught in the argument culture, and its influence and control over our lives is increasing. The problem is that, while there is nothing inherently wrong with debate and direct confrontation on *some* topics, it does not work for all topics. Certainly, the complex problems that are the focus of democratic decision-making require a more multifaceted, complex approach—one that encourages real dialogue and does not cast every discussion as a zero-sum, win-lose, either-or dichotomy.

As Tannen notes:

> Throughout our educational system the most pervasive inheritance is the conviction that issues have two sides, that knowledge is best gained through debate, that ideas should be presented orally to an audience that does its best to poke holes and find weaknesses, and that to get recognition, one has to 'stake out a position' in opposition to another. (Tannan 1998, 261)

The argument culture pervades our political process and makes truly democratic decision-making difficult, if not impossible. The 'winner take all', win-lose, two party system is locked in to the argument culture and cannot support informed discussion of issues that acknowledge the fundamental uncertainties involved. Democracy *should be* about building a broad consensus about shared goals and the policies to achieve them. Instead, the argument culture obscures the complexity of the world and allows disinformation and distortion to flourish.

Tannen goes on to challenge us to find ways to go beyond the argument culture: "It will take creativity to find ways to blunt the most dangerous blades of the argument culture. It's a challenge we must undertake, because our public and private lives are at stake" (1998, 290)

We need to further develop processes like deliberative democracy (Drysack 2010) that can facilitate engaged discussion among a broad range of stakeholders about complex issues, rather than confrontational debates. Scientists are a key group in these processes, especially as they bring their understanding of uncertainty into the discussions. As Buchanan (1954) put it: "The definition of democracy as 'government by discussion' implies that individual values can and do change in the process of decision-making" (Buchanan 1954, 120). To reinvent democracy, we have to reinvent discussion and move beyond the argument culture.

6. WHAT CAN WE DO?

Science is critical to the process of building a shared-vision of the world we want and implementing policies to achieve that vision. But the system today is locked-in or addicted to patterns of behaviour that prevent the needed transformation. Societies, like individuals, can get trapped in patterns of behaviour called social traps or "societal addictions" that provide short-term rewards but are detrimental and unsustainable in the long-run (Costanza 1987). Examples include our societal addiction to inequitable over-consumption fuelled by fossil energy and a "growth at all costs" economic model. We can learn from therapies that work at the individual level to help develop therapies that might work at the societal level (Costanza *et al.* 2017). In particular, Motivational Interviewing (MI) is one of the most effective therapies at the individual level. It is based on engaging addicts in a positive discussion of their goals, motives, and futures. One analogy to MI at the societal level is a modified version of scenario planning (SP) that has been extended to engage the entire community (community scenario planning, CSP) in thinking about goals and alternative futures via public opinion surveys and deliberative forums. Both MI and CSP are about exploring alternative futures in positive, non-confrontational ways and building commitment or consensus about preferred futures. Effective therapies for societal addictions may be possible, but, as we learn from MI, they will require a rebalancing of effort away from only pointing out the dire consequences of current behaviour (without denying those consequences) towards building a shared vision of a positive future, and the means to get there.

In the policy sphere, science has mainly contributed to pointing out the dire consequences of the current behaviour. But part of the reason this science is now being ignored by some is that it does not conform to their mental model of how the world works. Climate deniers are indeed in denial about the science of global climate change, in the same way that drug addicts or cigarette smokers can be in denial of the well-known harmful effects of their habit.

At the individual level, MI techniques engage with addicts in a non-judgmental way to help them develop a positive vision of a better life for themselves that is based on their deepest values. Such a vision can often motivate a substantial change. This is what a strategy of scenario planning and envisioning extended to include public opinion surveys and broad societal dialogue about what alternative futures could provide at the societal level. What is necessary to implement this strategy is to fully engage the larger society in discussing and sharing alternative futures and building consensus on preferred futures. Putting future scenarios out to the public in the form of public opinion surveys (Costanza *et al.* 2015, Chambers *et al.* 2019), dialogues, media events, films, videos, and other approaches can do this, but this is a largely unexplored area and is certainly a far cry from politics as usual. Workshops with a broad range of stakeholders from across the political spectrum have consistently shown that if the question is: "what kind of world do you want in the future?" there is much broader consensus than one would imagine based on current, polarized positions. In order to bring people together we need to first focus on developing a shared vision of the future, and this will not be as difficult as it at first appears.

There is ample room for creative design and testing of a range of societal therapies to build this shared vision and escape the argument culture. Scaling up what works at the individual level may be an important path for more effective societal therapies that will allow us to build a truly democratic, sustainable, and desirable future together.

7. SUMMARY AND CONCLUSIONS

I sum up my observations as follows:

(i) There is no such thing as scientific objectivity, because all science must be (1) based on a pre-analytic vision that is inherently subjective and (2) judged for utility and quality against criteria that are inherently subjective. We can, however, be very clear about the distinction between the vision and values component of the process and the analysis component built on that vision.

(ii) The quality of scientific work can thus be judged based on its adherence to the pre-analytic vision and its pragmatic utility in modelling the real world, as tested against the general criteria developed by the scientific community. We can judge between "good" science and "bad" science according to these subjectively determined criteria of quality, but it is not really honest or useful to use objectivity as a yardstick.

(iii) Subjective values also enter the discussion when we talk about how we would like the world to be. This aspect of future visions strongly determines which set of current policies are most appropriate, given the huge level of uncertainty about the current and future state of the world.

(iv) The major source of uncertainty about our current policies is at this level of visions and worldviews, not in the details of analysis or implementation within a particular vision.

(v) Democracy *should be* about building a shared vision of the world we want and implementing policies to achieve that vision. The Sustainable Development Goals (SDGs) are a major step in the right direction.

(vi) By developing alternative future scenarios, the critical assumptions and uncertainties underlying each vision can be more easily seen. The broader public can be engaged (via public opinion surveys, deliberative fora, and other methods) to overcome the argument culture and build a broad consensus on the future we want and how to get there.

REFERENCES

Buchanan, J.M. 1954. "Social choice, Democracy, and Free Markets." *Journal of Political Economy* 62: 114–23.

Caverni, J-P., J-M Fabre, and M. Gonzalez, eds. 1990. *Cognitive Biases*. Amsterdam: North Holland Press.

Chambers, I., R. Costanza, L. Zingus, S. Cork, M. Hernandez, A. Sofiullah, T. Z. Htwe, D. Kenny, P. Atkins, T. Kasser, I. Kubiszewski, Y. Liao, A. C. Maung, K. Yuan, D. Finnigan, and S. Harte. 2019. "A Public Opinion Survey of Four Future Scenarios for Australia in 2050." *Futures* 107: 119-132.

Costanza, R. 1987. "Social Traps and Environmental Policy." *BioScience* 37: 407-412

Costanza, R. 2001. "Visions, Values, Valuation and the Need for an Ecological Economics." *BioScience* 51: 459-468.

Costanza, R. and C. Perrings. 1990. "A Flexible Assurance Bonding System for Improved Environmental Management." *Ecological Economics* 2: 57-76.

Costanza, R. and L. Cornwell. 1992. "The 4P Approach to Dealing with Scientific Uncertainty." *Environment* 34: 12-42.

Costanza, R.., I. Kubiszewski, S. Cork, P. W. B. Atkins, A. Bean, A. Diamond, N. Grigg, E. Korb, J. Logg-Scarvell, R. Navis, and K. Patrick. 2015. "Scenarios for Australia in 2050: a Synthesis and Proposed Survey." *Journal of Future Studies* 19: 49–76.

Costanza, R., P. Atkins, M. Bolton, S.Cork, N. J. Grigg, T. Kasser, and I. Kubiszewski. 2017. "Overcoming Societal Addictions: What Can We Learn From Individual Therapies?" *Ecological Economics* 131: 543–550.

Dryzek, J.S. 2010. *Foundations and Frontiers of Deliberative Governance*. Oxford: Oxford University Press.

Gentner, D. and A. L. Stevens, eds. 1983. *Mental Models*. New York: Psychology Press.

Maag, C. 2008. "Supreme Court decision on Exxon Valdez damages a blow to Alaskans." *The New York Times* June 26. Accessed at https://www.nytimes.com/2008/06/26/world/americas/26iht-alaska.4.14027236.html on June 6, 2019.

McCoy, R. 1994. *The Best of Deming*. Knoxville: Statistical Process Control Press.

Schumpeter, J. 1954. *History of Economic Analysis*. London: Allen & Unwin.

Tannen, D. 1998. *The Argument Culture: Moving from Debateto Dialogue*. New York: Random House.

Tversky, A. and C. R. Fox. 1995. "Weighing Risk and Uncertainty." *Psychological Review* 102: 269–283.

Wilson, D. S. 2010. *Darwin's Cathedral: Evolution, Religion, and the Nature of Society*. Chicago: University of Chicago Press.