Proceedings of 2021 Winter Simulation Conference
S. Kim, B. Feng, K. Smith, S. Masoud, Z. Zheng, C. Szabo and M. Loper, eds.

A NEW ETHICAL PRINCIPLE FOR ANALYSTS WHO USE MODELS

Paul K. Davis

RAND and Pardee RAND Graduate School
1776 Main Street
Santa Monica, CA 90407-2138

ABSTRACT

This paper reviews some existing ethical principles applying to modelers and analysts. It then proposes a new principle motivated by modern advances that allow modeling and analysis to confront uncertainty—even deep uncertainty—and to do so effectively. Given these advances and the high stakes that are often involved, analysts have an obligation to convey more information than has been expected in the past—information to help decisionmakers choose strategies that will hedge as well as feasible against uncertainties. Using dilemmas familiar to analysts, including some that draw on topical events, the paper then discusses challenges involved in following the principle and suggest tactics that can help in doing so.

1 INTRODUCTION

Ethics, also called moral philosophy, is the discipline concerned with what is morally good and bad and morally right and wrong. The term is also applied to any system or theory of moral values or principles (Singer 2021).

Ethics are the science of morals, and morals are the practice of ethics (Fowler and Crystal 2010)

Why discuss ethics at a conference on modeling and simulation? The reasons vary with the type of participant.

Engineers build things that change the world. In doing so, they assume responsibilities to individual, organizational, and government clients, and to humanity in the large. Sometimes, the obligations are in conflict.

Scientists have obligations such as the search for truth and the advancing of science but also obligations to the people and animals who participate in or are subjects of research.

Analysts use modeling and simulation to aid policymakers about decisions that affect their publics and the world.

Modelers have the obligation to build their models so that analysts can use them easily to inform decision-makers wisely.

A given reader, of course, may identify with any or all of these classifications. In any case, in the remainder of this paper I address in turn (1) ethics in the modeling and analysis process, (2) why such ethics matter, (3) approaches to ethics, (4) the role of professional codes, and (5) what I see as an important new ethical principle to be included in such codes.

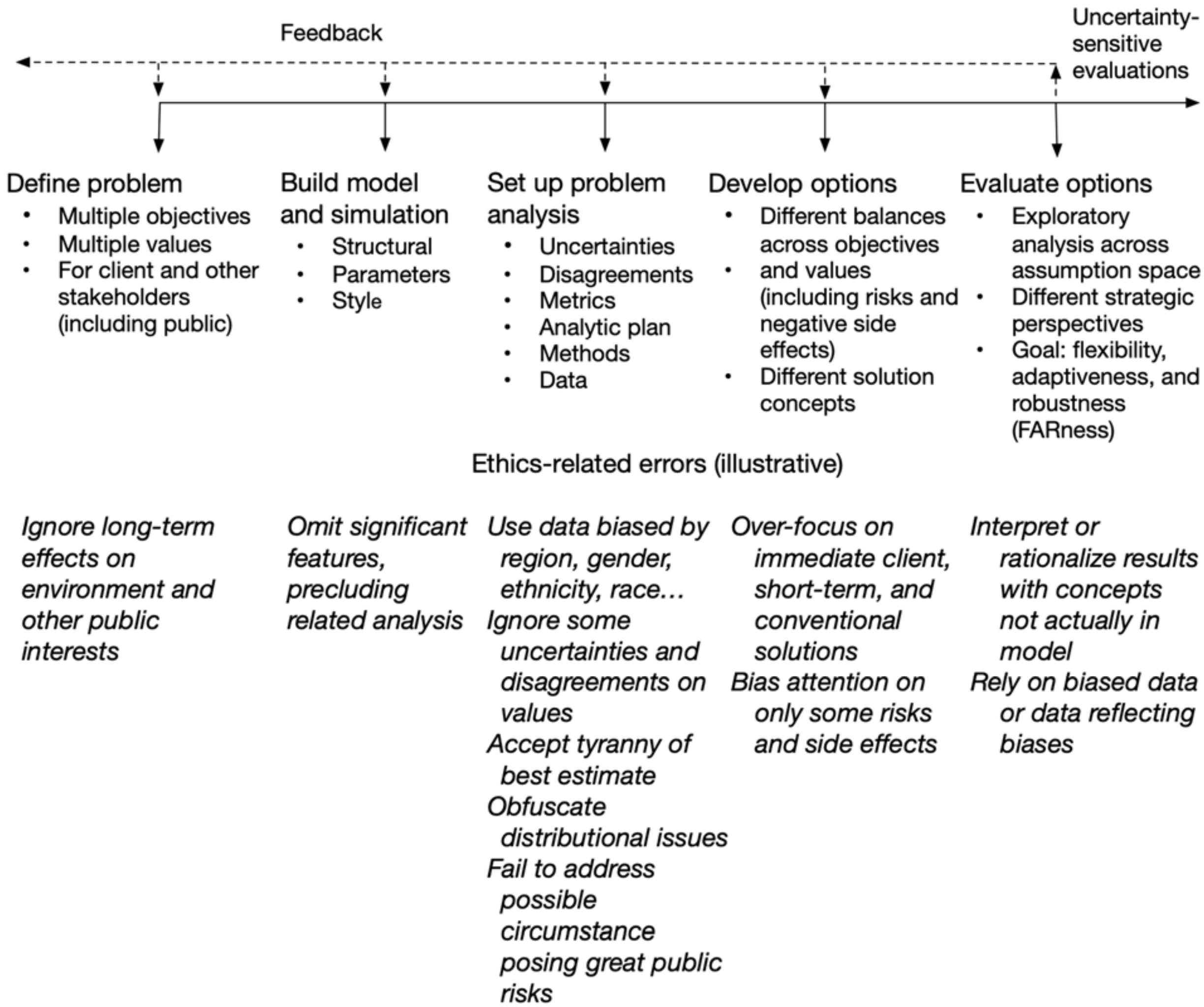
1.1 The Larger Process Generating Analysis To Aid Policymakers

An excellent book on ethics was written with engineers in mind (Van de Poel and Royakkers 2018). A key point of that book is that ethical issues arise throughout the process of defining a challenge, developing a

978-1-6654-3311-2/21/$31.00 ©2021 IEEE

solution, building a system (whether physical or in software), and later installing and applying it. I have adapted the book's process for the broader purposes of this paper as indicated in Figure 1. The process is iterative.

The top row of Figure 1 appears initially to be rather traditional, moving from problem definition to option evaluation. However, upon inspection the reader will see emphasis on analysis under uncertainty and disagreement. Even in the problem-definition step (left side), Figure 1 notes multiple objectives. These will often be in tension. Further, there may be tensions between the stated objectives of the immediate client and considerations of other stakeholders and of the public. Do the latter matter? If the modeler sees himself merely as a "hired gun," then perhaps not. But more generally, yes. And, even if the modeler is focused exclusively on serving the immediate client, that service should include protecting the client by adhering to laws and apprising the client of risks and other potentially adverse implications—to himself and to others, including the public.



Source: adapted from(Van de Poel and Royakkers 2018)

Figure 1: Ethics in the Process of Modeling and Analysis.

Continuing through Figure 1 we see concerns about balance, about avoiding harm, and of planning under uncertainty. In the lower line, we see some of the many ethics-related errors that may occur in the process. These include short-changing the long term, propagating or introducing bias, counting unduly on conventional wisdom or falling victim to the curse of the best estimate, and communicating results that are not in fact supported by the models or analysis that has been conducted.

1.2 Importance of Ethical Considerations

Most readers will find the importance of such ethical matters evident, but a few examples may be worthwhile.

Consider an urban planning exercise that focuses entirely on economic rejuvenation. The results may include destroying neighborhoods and cultural features, depriving people of their life-long homes, forcing such people to move to more hostile but affordable areas, and generating a "sterile" downtown without character. Such obliviousness to the many dimensions of the problem might be seen as incompetence, but perhaps not if the only consideration was stimulating economic growth in the downtown area.

Or consider developing a simulator for an aircraft, a simulator that is exceedingly accurate for most conditions but does not address some plausible circumstances that would be expensive to understand and represent well. Pilots training in such simulators would not be prepared if the troublesome circumstances arose. People might die. All this and more occurred in the notorious case of the Boeing 737-MAX—an embarrassment to America and engineers generally—that included corner-cutting. allowing a single point of failure, and deception. A newspaper account touched high points (Kitroeff 2019). An official release describes federal charges against Boeing (U.S. Department of Justice 2021). The aircraft's failures killed 346 people.

Many other examples could be given, such as those involving NASA’s Challenger and the Ford Pinto (Van de Poel and Royakkers 2018); the failure of simulators for the MV-22 Osprey and the Patriot anti-ballistic missile system, which shot down allied aircraft in 2003 (Tolk 2017)(Chapter 3); and the financial failures of 2008, which reflected poor financial modeling and analysis (Knowledge @ Wharton 2009). See also discussion of climate change in several chapters of an edited book (Boston et al. 2010) and an interesting recent paper that uses competing critical reviews of a proposal to address subtleties that arise in addressing social issue with simulation (Shults et al. 2018).

2 APPROACHES TO APPLYING ETHICS

It is sometimes useful to distinguish among three different approaches that scholars take in addressing ethical issues. The exact labels vary, but three approaches are (1) consequentialist (utilitarian); (2) universalist (deontological or duty-driven, as with adherence to laws, norms, or principles); and (3) virtue-seeking (seeking good character traits, such as reliability, honesty, ...). These are, roughly, associated respectively with Jerome Bentham and John Stuart Mill, Emanuel Kant, and Aristotle. They are discussed and compared, with examples, in the book mentioned earlier (Van de Poel and Royakkers 2018). Related issues are discussed by Jonathan Haidt in his attempt to explain social polarization on issues of politics and religion (Haidt 2013). Authors vary as to whether altruism should be seen as part of consequentialism, an ingredient of utilitarianism, or something else.

Many ways exist for addressing ethical considerations, but here I address only one, having professional organizations adopt codes of conduct. John McLeod, founder of the Society for Modeling and Simulation, was a pioneer on such issues (McLeod 1983), as was Tuncer Ören, who wrote an influential paper for the 2003 Winter Simulation Conference (Ören 2003).

Ethical codes can be crafted to be inspirational, advisory, or disciplinary in nature (Frankel 1989; Busert 2018). Numerous examples exist, as well as a corresponding literature. Here I merely touch upon examples.

2.1 Inspirational Code

An inspirational expression of engineering ideals is the oath taken to join the Order of the Engineer:

> *I am an Engineer, in my profession I take deep pride. To it I owe solemn obligations.*
>
> *Since the Stone Age, human progress has been spurred by the engineering genius. Engineers have made usable Nature's vast resources of material and energy for Humanity's benefit. Engineers have*

vitalized and turned to practical use the principles of science and the means of technology. Were it not for this heritage of accumulated experience, my efforts would be feeble.

As an Engineer, I pledge to practice integrity and fair dealing, tolerance and respect, and to uphold devotion to the standards and the dignity of my profession, conscious always that my skill carries with it the obligation to serve humanity by making the best use of Earth's precious wealth.

As an Engineer, I shall participate in none but honest enterprises. When needed, my skill and knowledge shall be given without reservation for the public good. In the performance of duty and in fidelity to my profession, I shall give the utmost.

(copyrighted by the Order of the Engineer, Inc.)

To be sure, not all engineers take the oath and not all that do necessarily live up to it in all respects, but the oath reflects an ideal with which many can resonate and to which many make every effort to adhere.

2.2 Advisory Codes

Advisory professional codes provide guidelines that help members to make good decisions to Codes of Best Practices. Many codes of professional conduct are advising society members how to behave professionally. The IEEE Code of Ethics (Institute of Electrical and Electronics Engineers, Inc. 2020) falls into this category.

We, the members of the IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree:

1. *to accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment;*
2. *to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;*
3. *to be honest and realistic in stating claims or estimates based on available data;*
4. *to reject bribery in all its forms;*
5. *to improve the understanding of technology; its appropriate application, and potential consequences;*
6. *to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;*
7. *to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;*
8. *to treat fairly all persons regardless of such factors as race, religion, gender, disability, age, or national origin;*
9. *to avoid injuring others, their property, reputation, or employment by false or malicious action;*
10. *to assist colleagues and co-workers in their professional development and to support them in following this code of ethics.*

2.3 Disciplinary Codes

Disciplinary codes tie violations of the code to the imposing of negative consequences, such as paying fees for not disclosing conflicts of interests, being excluded from certain types of contract competition because of past violations, or being excluded from the professional society.

Although many professional science and engineering societies have their own code of ethics, certain elements are common to most of them, such as pursuit of truth, protection of community and environment, accountability for actions, mentoring the next generation, and informing and engaging the public. Recently, diversity and integration of minorities have been recognized as valuable goals, for fairness and because they allow new perspectives and ideas suggesting better solutions for supporting society. Rigor, respect, responsibility, honesty, and integrity have been identified as core values for scientists and engineers, including simulationists.

2.4 The Odd Case of Policy Analysis

Oddly, policy analysts do not have an ethical code. Decades ago, Douglas Amy stated "Ethical inquiry is shunned because it frequently threatens the professional and political interests of both analysts and policymakers. The administrator, the legislator, the bureaucracy, and the profession of policy analysis itself all resist the potential challenges of moral evaluation" (Amy 1984). Others have long argued otherwise and have urged having a code of conduct (Wolf 1980; Ben Veniste 1983; Boston et al. 2010).

In the remainder of this paper, I discuss a topic that might be an element of such a code if one is ever developed.

3 A NEW OBLIGATION FOR THOSE WHO BUILD M&S AND USE IT FOR ANALYSTS

Codes of ethics largely deal with higher level issues such as those mentioned above. (e.g., honesty, competence, fairness). A notch below the surface, however, these and the informal codes governing analysts typically discuss the important matter of expressing assumptions clearly. This may be reflected in language referring to honesty, to the transparency of assumptions, or being forthcoming about assumptions. The ethical requirement to express assumptions clearly and honestly is something all good analysts with whom I am acquainted learned early in their careers. Further, they take this seriously and truly feel obligated to behave accordingly. The obligation applies in numerous fields, as discussed by Andrew Moravcsik (Moravcsik 2014, p.48), who describes the requirement as the “cornerstone of social science”.

Although this ethic is virtuous, I have observed over the years that viewgraphs with long lists of assumptions are not exactly welcomed by busy officials, in part because such lists are perceived more like exercises in tail-covering than decision-aiding. How useful is it, really, to have a slide listing numerous assumptions about model and parameter values, usually in fine print? It is little wonder that such slides are often deleted in reviews and their analogues in reports are relegated to appendices. We need something very different.

3.1 The Principle

The principle that I urge (Davis 2014) is that analysts should routinely discuss how results vary with major assumptions on which there is uncertainty or disagreement. This should reflect exploratory analysis in which assumptions are varied simultaneously, rather than in mere variable-at-a-time sensitivity analysis. Further, and most important, analysts should demonstrate ways in which clients can hedge against uncertainties and address major disagreements, i.e. how to identify strategies with the attributes of FARness, i.e., strategies that are relatively more Flexible (to changes of mission), Adaptive (to changes of circumstance), and Robust (to adverse shocks or to one perspective proving to be more nearly valid than another) (Davis 2014). More recently, this has been seen as part of Robust Decisionmaking (RDM) within Decisionmaking Under Deep Uncertainty (DMDU). DMDU now has international stature as a core method of analysis (Lempert et al. 2003; Marchau et al. 2019). A vibrant professional society now exists (DMDU Society).

In my view, finding and communicating feasible ways to hedge against uncertainty should become an ethical obligation for analysts and making it possible to do so should become an ethical obligation for those engaged in modeling and simulation. As Steven Popper and I have argued elsewhere, we believe that “in the future, analysis that fails to address effectively uncertainties about both models and their inputs will be regarded as fatally flawed.” (Davis and Popper 2019)

According to this principle, the analyst should indicate the circumstances (sets of assumptions) under which the consequences of the strategies being considered are relatively predictable and favorable, or are instead quite risky. Those developing M&S should seek designs that make related analysis possible.

3.2 When Things Are Easier Said Than Done: Surmounting Obstacles

The principle I suggest may seem to readers against the grain and infeasible, at least in many organizations. One reason is that, historically, decisionmakers have often associated discussion of uncertainty with paralysis. As a result, they have perhaps tolerated discussion of uncertainties but have then gone on to say "Yes, things are uncertain, but we have problems and need to take action. If we take some wrong steps, we can make corrections later, but we can't just wring our hands and do nothing."

In the past this perspective was perhaps justified because, in fact, uncertainty analysis did not assist convergence Today, however, the methods for decisionmaking under deep uncertainty are by no means paralytic; rather, they inform well-hedged *actions*. To be sure, applying the methods demands some time for pondering and analysis—in preference to making immediate decisions aided only by gut instincts—but the demands are reasonable and no more onerous than what, in many domains, is regarded as practicing *due diligence*—something seen as required for professionalism. Another positive way to express matters is that while "we cannot eliminate uncertainty, we can become expert at managing it."(Rouse et al. 2021)

I have several suggestions for analysts as they deal with policymakers on these matters.

3.2.1 Put Energy into Identifying the Crucial Assumptions

As has long been recognized, assumptions drive analysis and some of the crucial assumptions may not even be on the table for discussion. They may be recognized but considered off limits; they may not even be recognized because "everyone" accepts them or because of the tyranny of the best estimate; or they may not be recognized because they are simply not obvious, except in retrospect. In any case, it is crucial in strategic planning to lay bare the assumptions on which analysis depends. This is a core element of uncertainty sensitive planning as introduced in 1989 and summarized more recently (Davis 2014)), and of the closely related approach called assumptions based planning richly developed to book length by James Dewar (Dewar 2003).

3.2.2 Changing the Default Form of Analysis to Show Dealing with Uncertainty

Historically, the initial display shown for an analysis is often for some base-case situation or scenario. Uncertainty analysis, if presented at all, may then be a series of subsequent displays, which—at some point—may cause eyes to glaze. It would be better and more consistent with the ethical principle if the initial display comprehensibly demonstrates how the goodness of the option depends on key parameters or other uncertain assumptions. If it does, framing the issue as seeking robust strategy (a principle for *decisionmaking under deep uncertainty*), and then building in hedges to achieve robustness, will become routine and will perhaps be sought as a *matter of course* by the better policymakers.

3.2.3 Provide Alternatives and Tradeoffs

At a next level of detail, analysis should show alternative ways to hedge—in varying degrees—against the most serious uncertainties and disagreements. This will acknowledge that hedging has a cost but will be framed to encourage decisions about how much of what kind of hedging is desirable and affordable.

An analogy here might be in purchasing a home. The *default* option is to purchase insurance against fire and some other hazards. If asked for, alternatives might involve a big deductible with a reduced cost and perhaps some exclusions where insurance costs are unjustifiably high (floods and earthquakes sometimes fall in this category). The option of going without insurance, however, is not encouraged unless perhaps for those so wealthy as to self-insure comfortably.

3.2.4 Uncertainty Sensitive Default Metrics

Elaborating on a point already made, default metrics should deal with uncertainty. A standard display might show (e.g., Fig. 2) the range of circumstances in which outcomes will be good or at least tolerable for alternative strategies (Davis 2012). Even better, the display might show the “other” assumptions and allow instantaneous response to What if? questions as indicated at the top of Figure 2. This would be in the spirit of capabilities analysis as used in DoD and some other U.S. government agencies. The viewer can see how results change if these are varied—singly or in combination. This is the stuff of exploratory analysis. Using such displays encourages the real-time interaction that increases confidence and brings higher-ups into the process. Through such interactions they may “buy into” the model.

3.2.5 Appeals to Authority

Sometimes, uncertainty-sensitive analysis will not be received well by mid-level officials. If necessary, a good tactic is to point to authoritative guidance from top officials requesting attention to uncertainties.

Many government agencies and corporations have guidance requesting uncertainty analysis. The U.S. Department of Defense has emphasized such matters for years (Rumsfeld 2001; Gates 2010). What defense secretaries have gotten in response has not always met their desires, something that caused the U.S. DoD to terminate a sizable group engaged in model-based analysis. After a review that included extensive interviewing of senior officials, I concluded that the action was justified and that the very nature of supporting analysis should be transformed (Davis 2016).

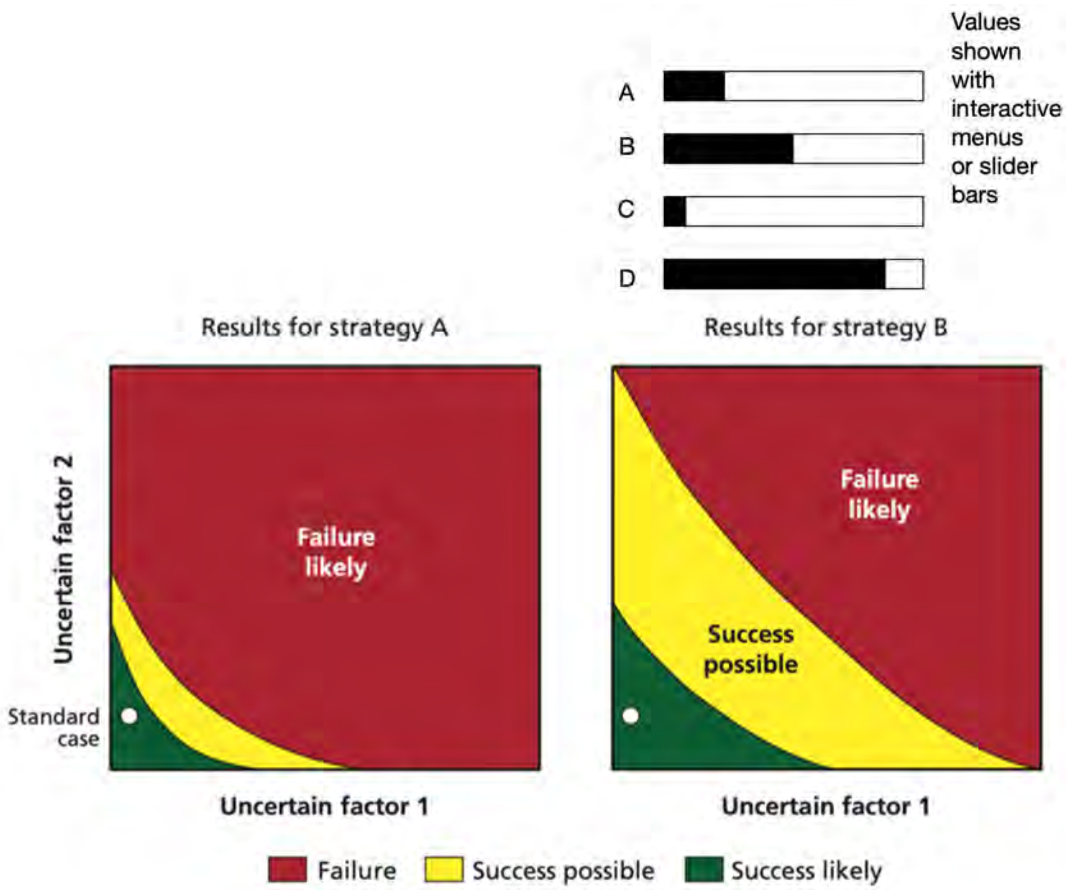


Figure 2: Comparing Options in Terms of Circumstances Covered.

4 FINAL OBSERVATIONS

Today's models are powerful computational tools that can be seen as the third pillar of science (Davis and O'Mahony 2019), along with theory and empirical data. The ethical responsibilities of modelers, simulationists, and those who use M&S are growing in parallel to these technological advances. An additional challenge for policy analysis is that foundations of the field are being rethought as the result of better appreciating the consequences of seeing policy interventions as interventions in complex adaptive systems, with all the notorious problems that suggests. A system perspective is crucial, *wicked* problems are common, unanticipated side effects are frequent, and it likely that policy adaptions will be crucial over time as the system changes, in part because the human actors in the system will change their behaviors in accordance with changing incentive structures and other system developments (Davis et al. 2021). Planning, then, must enable subsequent adaptation. That is by no means straightforward but may at some point be the basis for yet another principle of good analysis, if not of ethical analysis.

ACKNOWLEDGEMENTS

Parts of this paper draws on material prepared with Andreas Tolk for a forthcoming entry (Davis and Tolk forthcoming) in a Book of Knowledge for modeling and simulation (Ören et al. forthcoming). More generally, I thank the many colleagues at RAND and internationally with whom I have discussed the emerging field of decisionmaking under deep uncertainty (DMDU).

REFERENCES

Amy, D.J. 1984. "Why Policy Analysis and Ethics Are Incompatible". *Journal of Policy Analysis and Management* 3(4): 573-91.

Ben Veniste, G. 1983. "On a Code of Ethics for Policy Experts". *Journal of Policy Analysis and Management* 3(4): 561-72.

Boston, J., A. Bradstock, and D. Eng, Eds. 2010. *Public Policy: Why Ethics Matters*, Australian National University E Press.

Busert, P. 2018. "Examining the Professional Codes of Design Organizations," University of Limerick, accessed May 10, 2021.

Davis, P.K. 2012. "Some Lessons from RAND's Work on Planning Under Uncertainty for National Security". TR-1429-OSD

———. 2014. *Analysis to Inform Defense Planning Despite Austerity*. Santa Monica, Calif.: RAND Corporation. Accessed at https://www.rand.org/pubs/technical_reports/TR1249.html.

———. 2016. *Capabilities for Joint Analysis in the Department of Defense: Rethinking Support for Strategic Analysis*. Santa Monica, Calif.: RAND Corporation. Accessed at http://www.rand.org/pubs/research_reports/RR1469.html.

Davis, P.K. et al. 2021. "Reforming the Teaching and Conducting of Policy Studies to Deal Better with Complex Systems". *Journal on Policy and Complex Systems* Spring

Davis, P.K., and A. O'Mahony. 2019. "Improving Social-Behavioral Modeling," in P.K. Davis, A. O'Mahony, and J. Pfautz, Eds. *Social-Behavioral Modeling for Complex Systems*, Hoboken, N.J.: John Wiley & Sons, 15-48.

Davis, P.K., and S.W. Popper. 2019. "Confronting Model Uncertainty in Policy Analysis for Complex Systems: What Policymakers Should Demand". *Journal of Policy and Complex Systems* 5(2): 181-201.

Davis, P.K., and A. Tolk. forthcoming. "Ethics for Simulationists and Analysts Using Modeling and Simulation," in T.I. Ören, B.P. Ziegler, and A. Tolk, Eds. *SCS Modeling and Simulation Book of Knowledge Guide*, Springer.

Dewar, J. 2003. *Assumption Based Planning*. London: Cambridge.

Fowler, H.W., and D. Crystal. 2010. *A Dictionary of Modern English Usage: The Classic First Edition*. Oxford University Press.

Frankel, M.S. 1989. "Professional Codes: Why, How, and with what Impact?". *Journal of Business Ethics* 8(2): 109-15.

Gates, R. 2010. "Report of the Quadrennial Defense Review", Washington, D.C.: Department of Defense.

Haidt, J. 2013. *The Righteous Mind: Why Good People Are Divided By Politics and Religion*. New York: Vintage.

Institute of Electrical and Electronics Engineers, Inc. 2020. "IEEE Code of Ethics," https://www.ieee.org/about/corporate/governance/p7-8.html

Kitroeff, N. 2019. "Boeing 737 Max Simulators Are in High Demand. They Are Flawed.," *New York Times*, May 17, Accessed at https://www.nytimes.com/2019/05/17/business/boeing-737-max-simulators.html.

Knowledge @ Wharton. 2009. "Why Economists Failed to Predict the Financial Crisis," Wharton, University of Pennsylvania, https://knowledge.wharton.upenn.edu/article/why-economists-failed-to-predict-the-financial-crisis/

Lempert, R.J., S.W. Popper, and S.C. Bankes. 2003. *Shaping the Next One Hundred Years: New Methods for Quantitative Long-Term Policy Analysis*. Santa Monica, Calif.: RAND Corporation. Accessed at http://www.rand.org/pubs/monograph_reports/MR1626.html.

Marchau, V.A.W.J. et al., Eds. 2019. *Decision Making Under Deep Uncertainty: From Theory to Practice*, Cham, Switzerland: Springer.

McLeod, J. 1983. "Professional Ethics and Simulation,". In Proceedings of *15th Winter Simulation Conference*, 371-74.

Moravcsik, A. 2014. "Transparency: the Revolution in Qualitative Research". *Political Science and Politics* 47(1): 48-53.

Ören, T.I. 2003. “Rationale for a Code of Professional Ethics for Simulationists,”. In Proceedings of *2002 Summer Simulation Conference*, Waite, W.F., edited by, 428-33.

Ören, T.I., B. Zeigler, and A. Tolk, Eds. forthcoming. *SCS Modeling and Simulation Book of Knowledge*, Springer.

Rouse, W.B. et al. 2021. “Strategies for Addressing Uncertain Markets and Uncertaint Technologies”.

Rumsfeld, D. 2001. “Report of the Quadrennial Defense Review”, Washington, D.C.: Department of Defense.

Shults, F.L., W.J. Wildman, and V. Dignum 2018. “The Ethics of Computer Modeling and Simulation,”. In Proceedings of *2018 Winter Simulation Conference*, Rabe, M. et al., edited by, 4069-83.

Singer, P.W. 2021. “Ethics,” https://www.britannica.com/topic/ethics-philosophy, accessed August 2, 2021.

Tolk, A. 2017. “Code of Ethics,” in A. Tolk, and T. Ören, Eds. *The Profession of Modeling and Simulation: Discipline, Ethics, Education, Vocation, Societies, and Economics*, Hoboken, N.J.: John Wiley & Sons, Inc.

U.S. Department of Justice. 2021. “Boeing Charged with 737 Max Fraud Conspiracy and Agrees to Pay over $2.5 Billion”, Press release 21-7, Washington, D.C.: Office of Public Affairs. Accessed at https://www.justice.gov/opa/pr/boeing-charged-737-max-fraud-conspiracy-and-agrees-pay-over-25-billion.

Van de Poel, I., and L. Royakkers. 2018. *Ethics, Technology, and Engineering: An Introduction*. Chichester, West Sussex, UK: Wiley-Blackwell.

Wolf, C.W. 1980. “Ethics and Policy Analysis”, P-6463-2, Santa Monica, Calif.: RAND Corp.

AUTHOR BIOGRAPHIES

PAUL K. DAVIS is a professor of policy analysis in the Pardee RAND Graduate School in Santa Monica, California. He is also a adjunct to the RAND Corporation as a retired Senior Principal Researcher. He received his B.S. from the University of Michigan, majoring in chemistry, and his Ph.D. in theoretical Chemiclal Physics from the Massachusetts Institute of Technology. After several years in research, he joined the U.S. government bringing science and analysis to bear on defense planning and strategic arms control. He was a charter member of the Senior Executive Service in the Office of Program Analysis and Evaluation (now Cost Assessment and Program Evaluation). He then joined RAND, where his research interests have included strategic planning (especially for national security), modeling and simulation, deterrence and influence theory, theory for counterterrorism, and social-behavioral modeling for complex systems. He has taught many graduate courses, most recently modeling for policy problems involving complex systems. His email address is pdavis@rand.org. His website is https://www.rand.org/about/people/d/davis_paul.html.