sification in astronomy. There is much to take from Dick's work, both from the elaborate scientific and historical details of the case studies and from the rich analyses of them from a synergetic science studies perspective.

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Daniel Steel, ***Philosophy and the Precautionary Principle: Science, Evidence, and Environmental Policy***. Cambridge: Cambridge University Press (2014), 266 pp., $95.00.

We have recently witnessed a surge of interest in socially engaged philosophy of science, as evidenced by the publication of journal issues on this topic (C. Fehr and K. Plaisance, "Socially Relevant Philosophy of Science: An Introduction," *Synthese* 177 [2010]: 301–16; Francis Cartieri and Angela Potochnik, "Toward Philosophy of Science's Social Engagement," *Erkenntnis* 79 [2014]: 901–16) and the formation of new societies (e.g., the Joint Caucus for Socially Engaged Philosophy and History of Science and the Consortium for Socially Relevant Philosophy of/in Science and Engineering). Daniel Steel's new book provides an excellent illustration of the potential for philosophers of science to help address important contemporary social issues. Indeed, Steel mentions in his preface that he began to pursue this project as a result of conversations with a colleague from Michigan State University's Department of Animal Science about the best ways of assessing social risks from new nanotechnologies.

As the title suggests, Steel's central project is to analyze the precautionary principle (PP), which is a heavily debated concept in environmental policy and law. Roughly, it refers to the notion that precautionary actions should be taken to prevent serious threats to human health or the environment, even when those threats have not yet been well characterized scientifically. Given that the principle is notoriously vague and ill defined, it is a prime subject for philosophical analysis. Steel's main goal is to develop a unifying characterization of the PP that can make sense of the wide variety of ideas that have been associated with it. In the process of doing so, he addresses an impressive array of related issues from decision theory, economics, ethics, and the philosophy of science.

The first four chapters of the book focus on traditional issues related to the PP. In chapter 1, Steel develops his own three-part account of the principle. Chapter 2 shows how his account evades the classic objection that the PP ends up being either trivial or irrational, depending on whether it is inter-

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preted in a weak or a strong fashion. Chapter 3 clarifies how his account relates to the variety of other concepts that have been associated with the principle, and chapter 4 explores how the history of poor responses to environmental problems can be used to support the PP.

Chapters 5–9 explore a variety of issues that go beyond most discussions of the PP. Chapter 5 develops an argument that scientific uncertainty should be defined in terms of the absence of empirically well-confirmed predictive models rather than in the typical decision-theoretic fashion, which focuses on whether or not probabilistic information about outcomes is available. Chapter 6 examines the economic issue of whether future costs and benefits should be discounted relative to current ones, and Steel develops a pragmatic argument that to do so hampers the implementation of long-term environmental plans. Chapters 7 and 8 challenge the value-free ideal for scientific reasoning and offer an alternative ideal that allows the non-epistemic values embedded in the PP to influence scientific methodology. Finally, chapter 9 illustrates how the PP applies to three case studies: mitigating climate change, regulating recombinant bovine growth hormone, and regulating industrial chemicals under the US Toxic Substances Control Act (TSCA) and the EU Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) legislation.

Steel's characterization of the PP in the first four chapters is carefully reasoned, and it is helpful that he shows how the principle can serve in three different capacities: as a procedural requirement for how decisions should be made, as a decision rule for making policy choices, and as an epistemic rule that guides scientific inferences. Nevertheless, the book's most interesting contributions—especially for philosophers of science—may fall in the broader discussions that occur in chapters 5–9. For example, his effort to develop a different definition of scientific uncertainty from the one commonly used in decision theory is intriguing. It provides a welcome alternative to the questionable decision-theoretic distinction between decisions under risk (where probabilistic information about outcomes is available) and decisions under uncertainty (where probabilistic information is not available; Kevin Elliott and Michael Dickson, "Distinguishing Risk and Uncertainty in Risk Assessments of Emerging Technologies," in *Quantum Engagements: Social Reflections of Nanoscience and Emerging Technologies*, ed. Torben Zülsdorf, Christopher Coenen, Arianna Ferrari, Ulrich Fiedeler, Colin Milburn, and Matthias Wienroth [Heidelberg: AKA, 2011], 165–76). Steel's definition also has the welcome consequence of clarifying how the PP can be applicable even in cases where some probabilistic information is available about the potential outcomes of a decision.

At various points in the book, Steel makes clever use of pragmatic arguments in an effort to avoid appealing to controversial ethical principles. In chapter 4, he argues that instead of defending the PP by appealing to ethical

principles about the importance of threats to human health or the environment, one can defend it as a needed corrective to systematic mistakes that we tend to make in responding to environmental problems. In chapter 6, he develops a pragmatic argument in favor of intergenerational impartiality—namely, the principle that current generations should not discount future costs and benefits simply because they are in the future. He argues that current generations cannot expect future generations to assist in implementing long-term sequential plans if current generations discriminate against them by giving a pure time preference to the interests of the present. Nevertheless, this argument deserves further scrutiny. For example, one wonders whether the current generation could initiate sequential plans that incorporate a pure time preference but that crystallize particular policy trajectories that would make it unappealing for future generations to deviate significantly from the plans.

Steel's integration of the PP with the recent literature on values in science in chapters 7 and 8 will be particularly engaging for philosophers of science. Chapter 7 provides an excellent primer on the inductive-risk argument against the value-free ideal for scientific reasoning (see Heather Douglas, *Science, Policy, and the Value-Free Ideal* [Pittsburgh: University of Pittsburgh Press, 2009]). In contrast to many opponents of the value-free ideal, he defends a distinction between epistemic and non-epistemic values, but he proceeds to argue in chapter 8 that non-epistemic values can appropriately influence scientific reasoning as long as they do not conflict with epistemic values (178). He contends that this position, which he calls the "values-in-science standard," is preferable to Heather Douglas's preferred approach of distinguishing appropriate from inappropriate influences of values based on whether they play indirect or direct roles (Douglas, *Science, Policy, and the Value-Free Ideal*).

Steel makes a wide variety of arguments in these chapters that are worthy of further reflection. For example, while his critique of Douglas's appeal to direct and indirect roles may have merit, one wonders whether non-epistemic values should indeed never be allowed to override epistemic ones. Perhaps non-epistemic values could justifiably play a more significant role as long as scientists were adequately transparent about the influences of values and they adopted appropriate cognitive attitudes toward their conclusions (Kevin Elliott and Daniel McKaughan, "Non-epistemic Values and the Multiple Goals of Science," *Philosophy of Science* 81 [2014]: 1–21).

Whatever one concludes about the details of Steel's arguments about values in science, his efforts to unearth some of the potential implications of the PP for scientific methodology are most welcome. He focuses especially in chapter 8 on the notion that the PP justifies the use of uncertainty factors as a way of protecting human health when performing risk assessments. But he also makes the important point that the PP can actually determine which hazards are taken to be quantifiable and which are not, insofar as it can in-

fluence "which methods of quantification are taken to be scientifically legitimate" (194). This is a valuable point of contact between the literature on the PP and recent discussions among philosophers about values in science, because proponents of the PP have been arguing that their values can appropriately influence the questions that scientists ask, the methodologies that they employ, and the standards of evidence that they demand (Kevin Elliott, "Ethical and Societal Values in Nanotoxicology," in *In Pursuit of Nanoethics: Transantlantic Reflections on Nanotechnology*, ed. B. Gordijn and A. M. Cutter [Dordrecht: Springer, 2014], 147–66). Steel has made a valuable contribution by bringing these bodies of literature together in such a thoughtful manner, and his book provides a model for philosophers who aim to help address contemporary social issues.

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