Graham, Loren R. 1981. *Between Science and Values*. New York: Columbia University Press.

A historical examination of the interaction of science and values in the twentieth century using cases from physics and biology.

Grice, Paul. 1991. *The Conception of Value*. Oxford: Clarendon Press.

A theory of value drawing on both Aristotle and Immanuel Kant.

Hansson, Sven Ove. 2001. *The Structure of Values and Norms*. Cambridge, UK: Cambridge University Press.

Presents a formal system for the representation of values and norms.

Jonas, Hans. 2000. *The Genesis of Values*, trans. Gregory Moore. Chicago: University of Chicago Press. Originally published 1997.

A historicophilosophical analysis of the work of Friedrich Nietzsche, William James, Émile Durkheim, Georg Simmel, Max Scheler, John Dewey, and Charles Taylor arguing that "values arise in experiences of self-formation and self-transcendence."

Lewis, Clarence Irving. 1946. *An Analysis of Knowledge and Valuation*. La Salle, IL: Open Court.

Argues a naturalist theory of evaluations as a form of empirical knowledge.

Maslow, Abraham H. 1971. *The Farther Reaches of Human Nature*. New York: Viking.

A humanistic psychologist's argument for a hierarchy of needs-values.

Morris, Charles. 1956. *Varieties of Human Value*. Chicago: University of Chicago Press.

An early psychometric study of different value preferences.

Pepper, Stephen C. 1958. *The Sources of Value*. Berkeley: University of California Press.

One of the most systematic and expansive pragmatic theory of values.

Perry, Ralph Barton. 1926. *General Theory of Value: Its Meaning and Basic Principles Construed in Terms of Interest*. New York: Longmans, Green. Reprint, Cambridge, MA: Harvard University Press, 1950.

Defines value as simply the object of an interest.

Perry, Ralph Barton. 1954. *Realms of Value: A Critique of Human Civilization*. Cambridge, MA: Harvard University Press.

Extends the 1926 interest theory of value into a critical assessment of interests in society, ethics, politics, law, economics, science, art, and more.

Scheler, Max. 1973. *Formalism in Ethics and Non-formal Ethics of Values: A New Attempt toward the Foundation of an Ethical Personalism*, trans. Manfred S. Frings and Roger L. Funk. Evanston, IL: Northwestern University Press. Originally published 1913–1916.

Distinguishes five basic feeling values: physical, useful, vital, mental, and religious.

von Wright, Georg Henrik. 1963. *The Varieties of Goodness*. London: Routledge and Kegan Paul.

A conceptual analysis of goodness as a type of value.

Winner, Langdon. 1986. *The Whale and the Reactor: A Search for Limits in an Age of High Technology*. Chicago: University of Chicago Press.

A collection of influential essays.

Carl Mitcham

VALUES IN SCIENCE

Values of many kinds play important roles in science. Ethical values constrain the types of experiments that scientists perform and the conditions under which they perform them. Moral and political values influence the choice of problems to address. Social values are operative in organizing social behavior in the scientific community. Values of some sort influence the methods of scientific knowledge production; the focus here is on the precise nature of the values that govern these methods.

Based on the work of Pierre Duhem (1954), Otto Neurath (1983), W. V. Quine (1951), and others, it is well established that logic and data underdetermine the choice of theories, models, and hypotheses. Hypotheses cannot be tested in isolation but rather are tested in bundles; as a result, a disconfirming experimental result does not imply that any particular hypothesis is false, but only that one among a complex of hypotheses and auxiliary assumptions is false. The upshot is that there is a logical gap between theory and observation; something additional must fill this gap, which opens the door to the operation of values in the epistemic appraisal of research. A major area of disagreement concerns which values should be allowed to enter.

Thomas S. Kuhn (1977) identifies five characteristics for evaluating theories—accuracy, consistency, scope, simplicity, and fruitfulness—and argues that they function as values rather than rules. Each of these characteristics can be interpreted differently, and they can be weighted differently with respect to one another, such that different scientists might reasonably choose different theories on the basis of the same values. Similarly, Ernan McMullin (1983) identifies six "epistemic values"—predictive accuracy, internal coherence, external consistency, unifying power, fertility, and simplicity—and argues that they play an essential role in theory choice by filling the logical gap between theory and observation. McMullin, however, goes further than Kuhn by distinguishing these epistemic values from "non-epistemic values" (such as moral and political values) on the basis of their respective relationships to truth. Epistemic values, he argues, are truth conducive, whereas non-epistemic values are not, and as a result, the latter should be excluded from the appraisal of theories.

The view that these epistemic values are sufficient to close the gap between theory and observation has been criticized on a number of grounds. Kuhn himself argues that different scientists can reasonably choose different theories on the basis of the same broad criteria, and that which criteria are adopted is influenced by factors that some consider to be non-epistemic (Kuhn 1977). This raises the question of whether one can distinguish clearly between epistemic and non-epistemic values. Helen E. Longino

VALUES IN ENGINEERING

Whereas science aims at increasing our knowledge about the world, technology and engineering aim to change the world by designing, constructing, and managing structures, products, systems, or tools suited to particular purposes. That engineers aim to change the world immediately entails not only the question of "how to" change things but also questions of "how should" we change things. One implicit and assumed value in the "how to" category is efficiency. For present purposes, however, the focus is on the "how should" category.

Most philosophers—and indeed, many engineers—have treated the issue of "how should" values in engineering as merely an ethical question. Engineers and engineering societies have since the middle of the nineteenth century developed professional codes of ethics; engineering education today almost universally includes ethics education; and engineering ethics is by far the most advanced area of the philosophy of engineering. But those involved with the ethics education of engineers have begun to realize that narrow approaches concerned chiefly with the professional conduct of engineers fail to encompass the extent of values in engineering. The question of values in engineering now includes not only narrow ethical issues, but also issues of the values inherent in design and in the relationship between science, technology, and society.

One example of this broader approach to values in engineering is what Carl Mitcham (1994) calls an engineer's "duty *plus respicere*"—the obligation to take into account more than technical considerations in the design of artifacts and tools. Corresponding to the question of "how to" design an artifact are all the technical questions involved in making the artifact; engineers following their duty *plus respicere* would also ask "how should" the artifact be designed. Where a focus merely on the technical aspects of design turns the making of an artifact into a question of thinking out (for instance, a plan to be followed), a duty *plus respicere* shifts the making of an artifact into a question of thinking through (for instance, the relation between the artifact in question and its possible effects on society).

One might object to the suggestion that engineers have a duty *plus respicere* on several grounds:

1. The responsibility of engineers is limited to technical issues (thinking out how to), so questions of the relation between technology or technological artifacts and society (thinking through technology) are beyond the scope of engineering knowledge and practice (Mitcham and Holbrook 2006).
2. Because no one can successfully predict all aspects of the future, it is illegitimate to hold engineers responsible for thinking through more than the technical aspects of design. Moreover, it is illegitimate to hold engineers responsible for the unpredictable (mis)uses of their tools. In other words, the obligation to *take more* into account asks *too much* of engineers (Mitcham and Holbrook 2006).
3. The duty *plus respicere* is too vague—*how much more* engineers should take into account is not specified.

Several responses to these objections are also possible:

1. Suggesting that the responsibility of engineers is limited to technical issues presupposes one answer to the issue raised by the duty *plus respicere*. In other words, this objection commits the logical fallacy of begging the question.
2. Appealing to the fallibility of predictions as an objection to the duty *plus respicere* commits the perfectionist fallacy—suggesting that unless one's ability to predict is perfect, one cannot expect any efforts to predict. Contemporary efforts to explore responsible research and innovation, real-time technology assessment, new and emerging science and technology (NEST) ethics, and value-sensitive design illustrate different ways of incorporating a duty *plus respicere* into engineering.
3. J. Britt Holbrook and Adam Briggle (2014) argue that vagueness can be a virtue of principles. On such a view, it would be a mistake to reduce the duty *plus respicere* to a set of permitted and prohibited behaviors or a decision procedure, which would turn the duty to *think through* technological design back into a *thinking out* of the technical details. Put differently, adding too much specificity to the duty *plus respicere* would reduce a philosophical principle to a legal notion akin to *due diligence*.

Should engineers concern themselves only with questions of how to change the world, or should they also ask whether and how we should change the world?

Ultimately, the viability of the idea that engineers have a duty *plus respicere* turns on the question of the types of values that ought to be associated with engineering knowledge and practice.

BIBLIOGRAPHY

Holbrook, J. Britt, and Adam Briggle. 2014. "Knowledge Kills Action: Why Principles Should Play a Limited Role in Policy Making." *Journal of Responsible Innovation* 1 (1). Published electronically January 28, 2014. doi:10.1080/23299460.2014.882554.

Mitcham, Carl. 1994. "Engineering Design Research and Social Responsibility." In *Ethics of Scientific Research*, edited by Kristin Shrader-Frechette, 153–168. Lanham, MD: Rowman and Littlefield.

Mitcham, Carl, and J. Britt Holbrook. 2006. "Understanding Technological Design." In *Defining Technological Literacy: Towards an Epistemological Framework*, edited by John R. Dakers, 105–120. New York: Palgrave Macmillan.

J. Britt Holbrook

(1996) goes further by proposing an alternate set of values for evaluating research—empirical adequacy, novelty, ontological heterogeneity, mutuality of interaction, applicability to human needs, and diffusion of power—and arguing that one might reasonably choose these on the basis of ethical (in particular, feminist) grounds (see also Rooney 1992). As a result of arguments such as these, many conclude that factors traditionally regarded as non-epistemic play an ineliminable role in the appraisal of research.

The argument from underdetermination, or the "gap argument," is one of the most important arguments for an essential role for values in science (Biddle 2013; Howard 2006, 2009; Longino 1990, 2002; Kourany 2003, 2010). Another is the argument from inductive risk. This argument, which was put forward by C. West Churchland (1948), Carl G. Hempel (1965), Richard Rudner (1953), and others, begins with the premise that the scientist as scientist accepts or rejects hypotheses (for a contrasting view, see Jeffrey 1956). Because no hypothesis can be verified with certainty, one must choose what counts as sufficient evidence for accepting or rejecting a hypothesis. But what counts as sufficient evidence will be "a function of the *importance* [italics in the original], in a typically ethical sense, of making a mistake in accepting or rejecting the hypothesis" (Rudner 1953, 2). Paraphrasing Rudner's classic example, one would demand a relatively high degree of confirmation before accepting the hypothesis that a sample of pharmaceuticals was not toxic, because the consequences of wrongly accepting this hypothesis would be grave by one's moral standards; in contrast, one would not demand such a high degree of confirmation before accepting the hypothesis that a sample of machine-stamped belt buckles was not defective.

Churchman, Hempel, and Rudner focused exclusively on one area within the justification process in which there is inductive risk: the decision of how much evidence is enough to accept or reject a hypothesis. More recently, scholars have extended this argument, identifying a number of areas throughout the research process in which inductive risk is present (e.g., Biddle 2007; Biddle and Winsberg 2010; Douglas 2000, 2009; Elliott 2011b; Kukla 2012; Wilholt 2009). In particular, Heather E. Douglas (2000) argues that there is inductive risk in the choice of methodology (e.g., levels of statistical significance), the characterization of evidence, and the interpretation of results. These arguments, if successful, show that values traditionally regarded as non-epistemic, including ethical and social values, play an ineliminable role throughout the epistemic evaluation of research. (For arguments against the thesis of value neutrality that do not rely on underdetermination or inductive risk, see Okruhlik 1994 and Solomon 2001.)

If one accepts that science cannot be value free—or, more specifically, free from non-epistemic values—a number of important questions remain. One of these concerns the positive role that values should play in research. Douglas (2009) argues that values cannot serve as reasons for or against a hypothesis, but that they play an indirect role in the choice of methods, the characterization of evidence, and so on. (For a critique of Douglas's argument, see Elliott 2011a.) Matthew J. Brown has criticized the view that evidence always trumps values—which he calls the "lexical priority of evidence over values"—on the grounds that (1) evidence is revisable and (2) value judgments can be adopted on the basis of reasons and can even be open to certain kinds of empirical test (Brown 2013, 829). Another important question is whether the language of *values* is the right language within which to frame this discussion (Biddle 2013); there are a number of non-epistemic factors that influence the appraisal of research, and not all of these are plausibly seen as values. These issues, and many others, are fertile topics for further investigation.

SEE ALSO *Engineering Design Ethics; Engineering Ethics: Overview; Hormesis; Transformative Research; United States National Science Foundation, Broader Impacts Merit Review Criterion.*

BIBLIOGRAPHY

Biddle, Justin. 2007. "Lessons from the Vioxx Debacle: What the Privatization of Science Can Teach Us about Social Epistemology." *Social Epistemology* 21 (1): 21–39.

Biddle, Justin. 2013. "State of the Field: Transient Underdetermination and Values in Science." *Studies in History and Philosophy of Science*, pt. A, 44 (1): 124–133.

Biddle, Justin, and Eric Winsberg. 2010. "Value Judgments and the Estimation of Uncertainty in Climate Modeling." In *New Waves in Philosophy of Science*, edited by P. D. Magnus and Jacob Busch, 172–197. Basingstoke, UK: Palgrave MacMillan.

Brown, Matthew J. 2013. "Values in Science beyond Underdetermination and Inductive Risk." *Philosophy of Science* 80 (5): 829–839.

Churchland, C. West. 1948. *Theory of Experimental Inference*. New York: Macmillan.

Douglas, Heather E. 2000. "Inductive Risk and Values in Science." *Philosophy of Science* 67 (4): 559–579.

Douglas, Heather E. 2009. *Science, Policy, and the Value-Free Ideal*. Pittsburgh: University of Pittsburgh Press.

Duhem, Pierre. 1954. *The Aim and Structure of Physical Theory*. Translated by Philip P. Wiener. Princeton, NJ: Princeton University Press. Originally published as *La théorie physique: Son objet, et sa structure* (Paris: Chevalier and Rivière, 1906).

Elliott, Kevin C. 2011a. "Direct and Indirect Roles for Values in Science." *Philosophy of Science* 78 (2): 303–324.

Elliott, Kevin C. 2011b. *Is a Little Pollution Good for You? Incorporating Societal Values in Environmental Research*. Oxford: Oxford University Press.

Hempel, Carl G. 1965. "Science and Human Values." In *Aspects of Scientific Explanation, and Other Essays in the Philosophy of Science*, 81–96. New York: Free Press.

Howard, Don. 2006. "Lost Wanderers in the Forest of Knowledge: Some Thoughts on the Discovery-Justification Distinction." In *Revisiting Discovery and Justification: Historical and Philosophical Perspectives on the Context Distinction*, edited by Jutta Schickore and Friedrich Steinle, 3–22. Dordrecht, Netherlands: Springer.

Howard, Don. 2009. "Better Red than Dead: Putting an End to the Social Irrelevance of Postwar Philosophy of Science." *Science and Education* 18 (2): 199–220.

Jeffrey, Richard C. 1956. "Valuation and Acceptance of Scientific Hypotheses." *Philosophy of Science* 22 (3): 237–246.

Kourany, Janet A. 2003. "A Philosophy of Science for the Twenty-First Century." *Philosophy of Science* 70 (1): 1–14.

Kourany, Janet A. 2010. *Philosophy of Science after Feminism*. Oxford: Oxford University Press.

Kuhn, Thomas S. 1977. "Objectivity, Value Judgment, and Theory Choice." In *The Essential Tension: Selected Studies in Scientific Tradition and Change*, 320–339. Chicago: University of Chicago Press.

Kukla, Rebecca. 2012. "'Author TBD': Radical Collaboration in Contemporary Biomedical Research." *Philosophy of Science* 79 (5): 845–858.

Longino, Helen E. 1990. *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry*. Princeton, NJ: Princeton University Press.

Longino, Helen E. 1996. "Cognitive and Non-cognitive Values in Science: Rethinking the Dichotomy." In *Feminism, Science, and the Philosophy of Science*, edited by Lynn Hankinson Nelson and Jack Nelson, 39–58. Dordrecht, Netherlands: Kluwer.

Longino, Helen E. 2002. *The Fate of Knowledge*. Princeton, NJ: Princeton University Press.

McMullin, Ernan. 1983. "Values in Science." In *PSA 1982: Proceedings of the Biennial Meeting of the Philosophy of Science Association*, Vol. 2, edited by Peter D. Asquith and Thomas Nickles, 3–28. East Lansing, MI: Philosophy of Science Association.

Neurath, Otto. 1983. "The Lost Wanderers of Descartes and the Auxiliary Motive (on the Psychology of Decision)." In *Philosophical Papers, 1913–1946*, edited and translated by Robert S. Cohen and Marie Neurath, 1–12. Dordrecht, Netherlands: Reidel.

Originally published in German in 1913.

Okruhlik, Kathleen. 1994. "Gender and the Biological Sciences." In "Biology and Society: Reflections on Methodology," supplement, *Canadian Journal of Philosophy* 24 (supp. 1): 21–42.

Quine, W. V. 1951. "Two Dogmas of Empiricism." *Philosophical Review* 60 (1): 20–43.

Rooney, Phyllis. 1992. "On Values in Science: Is the Epistemic/Non-epistemic Distinction Useful?" In *PSA 1992: Proceedings of the Biennial Meeting of the Philosophy of Science Association*, Vol. 1, edited by David Hull, Micky Forbes, and Kathleen Okruhlik, 13–22. East Lansing, MI: Philosophy of Science Association.

Rudner, Richard. 1953. "The Scientist *qua* Scientist Makes Value Judgments." *Philosophy of Science* 20 (1): 1–6.

Solomon, Miriam. 2001. *Social Empiricism*. Cambridge, MA: MIT Press.

Wilholt, Torsten. 2009. "Bias and Values in Scientific Research." *Studies in History and Philosophy of Science*, pt. A, 40 (1): 92–101.

Justin Biddle

VEBLEN, THORSTEIN

Economist, sociologist, and a founder of institutional economics, Thorstein Bunde Veblen (1857–1929) was born in Manitowoc County, Wisconsin, on July 30, 1857. He studied under the economist John Bates Clark at Carleton College in Minnesota, then at Johns Hopkins University before earning his doctorate in philosophy at Yale University in 1884. After a career of teaching at the University of Chicago, Stanford University, the University of Missouri, and the New School for Social Research, he died near Menlo Park, California, on August 3, 1929.

Veblen was an iconoclast. During the early twentieth century he was the foremost critic of the business