Science, Values, and Power

Toward a Christian-Critical Perspective on Responsible Science

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This essay critically examines a questionable presupposition of contemporary science—that science is an instrumental means to human ends and as such is a value-neutral project. According to this presupposition, the responsibility for the ethical evaluation of science concerns only the uses to which science is put by society and thus does not belong properly to the scientific profession. This view, which C. P. Snow called "the myth of ethical neutrality," is critiqued along ethical, philosophical, and theological axes of analysis. Once we recognize that science is essentially a form of power, it becomes clear that science is morally ambiguous because the power over nature that science enables contains the potential for domination over humanity. From the Christian perspective, which holds that all worldly power is "fallen," it is evident that science also is in need of being "ransomed" from evil uses and reoriented toward the priorities of God's Kingdom. Accordingly, to be responsible science must be accountable to transcendent values and must be in dialogue with other disciplines, including ethics, philosophy, and theology.

Claritas: Journal of Dialogue and Culture, Vol. 4, No. 1 (March 2015)
75–103 © 2015

Science and Values

To expose and examine the contemporary presupposition of the value-neutrality of science and its implications, I draw from several statements on the relationship between science and values as expressed by prominent scientists in the second half of the twentieth century whose scientific works have significantly impacted society.[1]

The Division of Labor

To gain leverage on this question of how contemporary science views the relationship between science and values, I take as a pivot point the view of Albert Einstein on the relationship between science and religion. Einstein saw an intimate motivational connection between religion (as he understood it) and scientific research. He maintained, "The cosmic religious feeling is the strongest and noblest motive for scientific research."[2] He went so far as to say, "In this materialistic age of ours the serious scientific workers are the only profoundly religious people."[3]

Beyond such esoteric remarks, Einstein saw potential for a fruitful reciprocal relationship between science and religion that could overcome a past of mutual suspicion and conflict. The goal of science, in his view, is to establish an objective, systematic knowledge

1. Heather Douglas, *Science, Policy, and the Value-Free Ideal* (Pittsburgh: University of Pittsburgh Press, 2009), 44–65, shows that the contemporary ideal of the value-neutrality of science is largely a product of the post–World War II era.
2. Albert Einstein, *Ideas and Opinions* (New York: Wings Books, 1954), 39.
3. Ibid., 40.

of what *is*, namely, the facts about the observable world; this scientific knowledge then "provides us with powerful instruments for the achievement of certain ends." The limit of science appears as soon as we introduce the question of value, namely, which *ends* ought we pursue with science-enabled means? In his view, "the ultimate goal itself and the longing to reach it must come from another source," for "knowledge of what *is* does not open the door directly to what *should be*." What is that other source? Einstein concludes, "To make clear these fundamental ends and valuations . . . seems to me precisely the most important function which religion has to perform in the social life of man."[4] In a nutshell, Einstein holds that science makes possible the means to do what we so choose but is incapable of telling us what we should choose to do; for that, we need religion-inspired values. Einstein sums it up in a pithy statement: "Science without religion is lame, religion without science is blind."[5] In Einstein's view, the goal of cooperation between scientific means and religious ends is the "free and responsible development of the individual, so that he may place his powers freely and gladly in the service of all mankind."[6]

Einstein achieved the peaceful coexistence and reciprocal cooperation between science and religion via a division of moral labor premised upon a demarcation between disciplinary domains that categorically dissects fact from value.

> Science is the century-old endeavor to bring together by means of systematic thought the perceptible phenomena of this world into as thorough-going an association as possible. . . . Religion is the age-old endeavor of mankind to become clearly and completely conscious of [superpersonal] values and goals and constantly to strengthen and extend their effect. If one conceives of religion and science according to these definitions then a conflict between them appears impossible. For science can only ascertain what *is*, but not what *should be*, and outside of its domain value judgments of all kinds remain necessary. Religion, on the other hand, deals only with evaluations of human thought and action: it cannot justifiably speak of facts and relationships between facts. . . . The realms of religion and science in themselves are clearly marked off from each other.[7]

In short, science tells us the facts, religion inspires our values, and each is mutually exclusive of the other.[8] This fact/value dichotomy correlates directly with a means/ends division: Science-discovered facts provide a value-neutral means to achieve science-independent ends inspired by religious values.[9] It is assumed here that one can independently evaluate means and ends and that the standards of critique that apply to one (scientific methods) are disjointed from those applying to the other (human goals). Hence, moral modes of evaluation germane to religion are irrelevant to (indeed, inappropriate for) judging science as science; likewise, epistemological modes of evaluation germane to science are irrelevant to (indeed, inappropriate for) judging religion as religion. The two meet only

4. Ibid., 42.
5. Ibid., 46.
6. Ibid., 43.
7. Ibid., 44–45.
8. See also Einstein, "Religion and Science: Irreconcilable?" in *Ideas and Opinions*.
9. On the connection between the fact/value dichotomy and the means/ends division, see Hilary Putnam, *The Collapse of the Fact/Value Dichotomy and Other Essays* (Cambridge, Mass.: Harvard University Press, 2002).

in the practical endeavor, where the sole judgment to be made is whether the scientific instruments are efficient and effective means for the chosen ends.

Physicist Richard Feynman likewise performed a dissection of the scientific and the ethical along a parallel fact/value line. Feynman claimed that "science and moral questions are independent" on the grounds that "it is impossible to decide moral questions ['Should I do this?'] by the scientific technique," which can answer only questions of the form, "If I do this what will happen?"[10] It is true that empirical science itself cannot decide our moral values ("ultimately we have to decide," as Feynman puts it). From the claim that questions of values cannot be decided by scientific method, however, it does not follow logically that science and values are necessarily independent. For, as will be argued below, it may well be that science has *already* decided (implicitly) in favor of certain values as the very essence of its practice.

Einstein's view of the mutual independence of science and religion, and thus of the value-neutrality of science, is not simply an historical artifact. Indeed, the late Stephen Jay Gould articulated this view more recently under the acronym NOMA: Science and religion constitute "non-overlapping magisteria."[11] Gould defines this notion as follows: "Each domain of inquiry frames its own rules and admissible questions and sets its own criteria for judgment and resolution. These accepted standards, and the procedures developed for debating and resolving legitimate issues, define the magisterium—or teaching authority—of any given realm."[12] Applying this definition to science and religion, Gould demarcates science as the domain of inquiry whose aim is the description and explanation of "the factual construction of nature" and whose criterion of judgment is successful experience (i.e., if the experiment works, if the theory explains, then the science is good).[13] Religion and ethics constitute a separate domain of inquiry whose aim is the value and meaning of life.[14] While Gould maintains that the domains of science and religion "hold equal worth and necessary status for any complete human life," nonetheless these respective domains are logically independent and methodologically distinct.[15]

Now, recognizing that Einstein was pantheistic (à la Spinoza) and Gould was agnostic, one might think that such a view of science and religion is peculiar to nontheists. Not so. Jean Pond, a biologist and a Christian, has taken up Gould's NOMA view and endorsed it from a Christian perspective. She writes, echoing Gould:

> Science and theology are different ways of acquiring different kinds of truths about the world. Science and theology differ in their areas of inquiry and in the methods they use. . . . Science seeks an understanding of the physical or natural world, whereas theology seeks the fullest possible knowledge of God's actions in human history and God's purpose for our own lives.[16]

10. Richard P. Feynman, *The Meaning of It All: Thoughts of a Citizen-Scientist* (Reading, Mass.: Perseus Books, 1998), 44, 46.
11. Stephen Jay Gould, *Rocks of Ages: Science and Religion in the Fullness of Life* (New York: Ballantine, 1999).
12. Gould, *Rocks of Ages*, 52–53.
13. Ibid., 54.
14. Gould, like Einstein, bases separation of science and religion on a fact/value (or "is-ought") dichotomy. For his part, Gould acknowledges that this dichotomy is philosophically dubious but proceeds to utilize it anyway—see Gould, *Rocks of Ages*, 55–57.
15. Ibid., 58–59.
16. Jean Pond, "Independence: Mutual Humility in the Relationship between Science & Christian Theology," in *Science and Christianity: Four Views*, ed. Richard F. Carlson (Downers Grove, Ill.: InterVarsity Press, 2000), 81. Pond's demarcation of science

Pond concludes, concurring with Gould and Einstein, that the NOMA approach resolves conflict between science and religion: "If we maintain an independence between science and theology, if we allow each the proper authority within its own field, many of these problems are avoided."[17]

While avoiding conflict between science and religion is a desirable goal, the ethical implications of NOMA are what concern us here. According to NOMA, science and religion, facts and values, are distinct domains, each having its own methods for how to practice, rules for what is permissible, and criteria for what counts as good. And because these mutually independent domains are equal in status, it would be inappropriate either to apply the methods of science to religion and ethics or to apply the rules of religion and criteria of ethics to the practice of science. In this way, scientific practice is free, not only from ecclesiastical encroachment but also from accountability to any values that originate in any domain outside science: Science as such is autonomous, accountable only to its own rules. Now, it may be that many scientists do not consciously practice their profession according to a strict dichotomy between scientific methods and human values. Still, NOMA's demarcation of science and religion/ethics into mutually independent domains does effectively rationalize such a dichotomy.

from theology is implicitly premised on a distinction between physical nature and human history—science can be cleaved from theology because science deals with physical nature but God acts in human history. This distinction is dubious, both scientifically and theologically. According to the theory of evolution, which Pond endorses, human history is bound up with natural history. Thus, while NOMA must exclude God from natural history, Pond's distinction would leave human evolution open to divine action. And according to the witness of scripture, God has acted in human history by manipulating physical nature—most notably, from a Christian perspective, in Jesus Christ, in whom God assumed bodily form in the created order. Pond's distinction thus calls into question the orthodox doctrine of the Incarnation.

17. Pond, "Independence," 103.

Going forward, I am concerned primarily with the ethical implications for scientific practice of the division of moral labor between scientific means and religious ends. I will thus bracket, for the purpose of this essay, the question of whether science and religion are actually as distinct in their respective methods as NOMA claims. Recent work on science and religion has pointed to significant parallels between scientific methods and theological methods concerning the role of paradigms, use of models, testing/selection of theories, and so on, contrary to the NOMA thesis.[18]

The Myth of Neutrality

The so-called value-independence of science exemplifies the attitude that C. P. Snow called the "myth of the ethical neutrality of science." Snow, who rejected the myth, describes it as follows:

> Whether [scientists] like it or not, what they do is of critical importance for the human race. Intellectually, [science] has transformed the climate of our time. Socially, it will decide whether we live or die, and how we live or die. It holds decisive powers for good and evil. *That* is the situation in which the scientists find themselves. They may not have asked for it, or only have asked for it in part, but they cannot escape it. . . . There is of course one way to contract out. . . . It consists of the invention of categories—or, if you like, of the division of moral labor. That is, the scientists who want to contract out say *we* produce the tools. *We* stop there. It is for *you*, the rest of the world, the politicians, to say how the tools are used. The tools may be used for purposes which most of

18. See Ian G. Barbour, *Religion and Science: Historical and Contemporary Issues* (San Francisco: HarperCollins Publishers, 1997), 106–36, and Alister E. McGrath, *Science and Religion: An Introduction* (Oxford: Blackwell Publishers, 1999), 144–76.

> us would regard as bad. If so, we are sorry. But as scientists, that is no concern of ours. This is the doctrine of the ethical neutrality of science.[19]

Erecting disciplinary boundaries along a sharp fact/value dichotomy, as Einstein outlined and Gould affirmed, effectively frees scientific practice from the yoke of moral reflection. For, consider: If science per se is about only facts, then good science is to be judged solely by professionally defined standards and criteria that measure only the correctness and accuracy of the methods used for ascertaining and explaining the facts; thus, to do good science one need not be burdened with questions of the value of one's research, either the moral permissibility of one's methods or the social implications of one's conclusions. It is a short step from such thinking to the myth that good science is always morally innocent: If one's responsibility as a scientist is circumscribed by narrowly defined professional standards and criteria of success, and hence scientific research per se is not accountable to moral standards or social criteria, then it must be that the methods and content of one's science are ethically neutral—that is, science is innocent insofar as and to the extent that it satisfies those professional standards and criteria and is corrupted only through evil uses by social choices. Implicit in this attitude is a division of moral labor between science and all other spheres of human responsibility: Science is an ethically neutral and thus professionally autonomous sphere, within which scientists are to be concerned only with the question of means, that is, the production of knowledge and technique, while the question of ends or values, that is, how knowledge and technique are to be used, falls to other spheres within society.

This attitude is not merely harmless theorizing. Many atomic physicists involved in the Manhattan Project did accept, and some genetic scientists involved in the Human Genome Project have since accepted, the myth of ethical neutrality. The consequent division of moral labor in the practical attitudes of scientists manifests itself in various divisions—pure versus applied science, scientist as researcher versus scientist as citizen, science versus democracy—each of which implicitly presupposes some form of the fact/value dichotomy.

Even after Hiroshima, J. Robert Oppenheimer, the scientific director of the Los Alamos National Laboratory during the Manhattan Project, held to such a division of moral labor. When asked several years later to give an account of his participation on the scientific panel that advised President Truman's Interim Committee on how to use the atomic bomb and which cities to target, Oppenheimer divorced his expert advice from moral responsibility for the ultimate decision: "What was expected of this committee of experts was primarily a technical opinion on new questions," a task that presumably carried no further responsibility than merely being factually accurate in one's predictions.[20] It's not that Oppenheimer saw no connection between the physicists' work and

19. C. P. Snow, "The Moral Un-Neutrality of Science," in *The New Scientist: Essays on the Methods and Values of Modern Science*, ed. P. C. Obler and H. A. Estrin (Garden City, N.Y.: Anchor Books, 1962), 128–29, original emphasis. See also Roberta M. Berry, "Eugenics after the Holocaust: The Limits of Reproductive Rights," in *Humanity at the Limit: The Impact of the Holocaust Experience on Christians and Jews* (Bloomington: Indiana University Press, 2000).

20. Quoted in Robert Jungk, *Brighter than a Thousand Suns: A Personal History of the Atomic Scientists* (San Diego, Calif.: Harcourt Brace, 1958), 209. In the words of Arthur H. Compton, another member of the expert committee, the panel gave a "technical reply to a technical question" (ibid., 182). Realize that the scientific panel was estimating the range of destruction and the number of persons killed by the bomb and recommending a target city that would maximize those effects.

the destruction wrought by the bomb. He did, and he saw atomic scientists themselves as having lost their innocence as a result. However, he saw all of this as having no implication for how scientific research itself is to be done. He viewed moral reflection on values as incompatible with the very practice of science itself, which is aimed at facts. Answering questions of means and asking questions of ends, he says, are mutually exclusive (or "complementary"); and this exclusivity limits the scientist's sphere of professional responsibility to just the facts. Oppenheimer writes:

> No scientist can hope to evaluate what his studies, his researches, his experiments may in the end produce for his fellow men, except in one respect—if they are sound, they will produce knowledge. . . . The true responsibility of a scientist, as we all know, is to the integrity and vigor of his science. . . . If the professional pursuit of science makes good scientists . . . it is doing a great deal, and all that we may rightly ask of it.[21]

The upshot of the fact/value dichotomy for Oppenheimer is a division between the scientist as researcher in the laboratory and the scientist as citizen in society, which comprise two "complementary" aspects of one person who has separate spheres of responsibility but whose first responsibility is always to science.[22]

Edward Teller, who earned the epithet "father of the hydrogen bomb," also divided the scientist's work ethic from the social impact of scientific research. In a July 1945 letter to physicist Leó Szilárd, who served as the moral conscience of the atomic science community, Teller released scientists from responsibility for any military-political decision to drop the atomic bomb (to which he objected) even before Hiroshima. Teller wrote:

> The accident that we worked out this dreadful thing should not give us the responsibility of having a voice in how it is to be used. This responsibility must in the end be shifted to the people as a whole and that can be done only by making the facts known. This is the only cause for which I feel entitled in doing something: the necessary lifting of the secrecy at least as far as the broad issues of our work are concerned.[23]

After the war, fearing domination from a totalitarian Russia, he held that the imperatives of absolute freedom of research and patriotic duty compelled the atomic scientist to employ his or her technical expertise in pursuit of nuclear physics to its utmost potential for developing both energy and weapons. It is not that he felt the scientist had no responsibility toward humanity; he did. Scientists, Teller felt, should at least promote democracy (for the sake of both humanity and science). But this should not in any way encumber the unimpeachable imperative and unrestricted freedom of scientific research.[24] Decades later, just before the costly and precarious nuclear arms race collapsed under its own weight, Teller held to

21. J. Robert Oppenheimer, "Physics in the Contemporary World," in *The Open Mind* (New York: Simon and Schuster, 1955), 88, 90–1, 92–3.
22. For a fuller examination of Oppenheimer's views on the responsibility of the scientist, see S. S. Schweber, *In the Shadow of the Bomb: Oppenheimer, Bethe, and the Moral Responsibility of the Scientist* (Princeton, N.J.: Princeton University Press, 2000).
23. Quoted in Tamara L. Roleff, ed., *The Atom Bomb* (San Diego, Calif.: Greenhaven Press, 2000), 205.
24. Edward Teller, "Atomic Scientists Have Two Responsibilities," *Bulletin of the Atomic Scientists* (December 1947): 354–55.

his original view that the scientist is responsible only for increasing and disseminating knowledge without limit; responsibility for answering questions about the value and uses of science in a democratic society, in his view, falls to the general public:

> Now as then, my argument is for knowledge and against ignorance. Now as then, I offer no detailed proposals as to how the knowledge, once acquired, should be used. Scientists have the responsibility to make knowledge available and to explain its possible applications. The decision as to which uses should be adopted, now as then, should belong to the entire community. That is indeed the main principle on which a democratic society rests.[25]

This historical recollection aims *not* at condemning particular scientists for the hard *choices* they made in complex and ambiguous circumstances, but rather at uncovering and critiquing the *attitudes* by which those scientists understood themselves and their research in relation to moral ends. An honest history teaches that a division of moral labor underwritten by a fact/value dichotomy that insulates science from external critique and disburdens the scientist of moral responsibility for the uses of research tends to cultivate a cavalier attitude toward social concerns.[26] When faced with moral questions about the atomic bomb during the last days of the Manhattan Project, Enrico Fermi, who built the first chain-reacting atomic pile, was known to reply: "Don't bother me with your conscientious scruples! After all, the thing's superb physics!"[27] And Oppenheimer, amid Cold War questioning of his political loyalty, said of the hydrogen bomb once the Korean War had begun, "It is my judgment in these things that when you see something that is technically sweet you go ahead and do it and you argue about what to do about it only after you have had your technical success."[28] (To gauge the moral callousness of such an attitude, simply imagine such words in the mouth of Nazi SS physician Dr. Josef Mengele regarding his eugenic studies of twins at Auschwitz: "Don't bother me with your conscientious scruples! After all, it's superb biology!")

Such an attitude was not simply a creature of the Cold War era but also appeared in the context of the Human Genome Project. Walter Gilbert, who won the Nobel Prize in Chemistry for developing novel techniques of DNA sequencing, wishes to separate the potentially negative social impacts of molecular genetics from the mandate of scientists to pursue knowledge unencumbered by moral debate. Gilbert, tacitly bracketing out the social aims that led the U.S. government to fund the "big science" project in the first place, casts the Human Genome Project as a pure "science for knowledge's sake" endeavor of discovery that evidently needs no external justification. Gilbert writes:

> To work out our DNA sequence is to achieve a historic step forward in knowledge. . . . The human genome project can be viewed as a purely technological effort to obtain the DNA sequence, put it into a computer data base, and study it. . . .

25. From Edward Teller, *Better a Shield Than a Sword*, excerpted in Roleff, *The Atom Bomb*, 212.
26. There were exceptions in the Manhattan Project, in particular Leó Szilárd, who functioned as the moral conscience of the atomic scientists. Few were swayed by his arguments and efforts, however. See Jungk, *Brighter than a Thousand Suns*, 171–90.
27. Quoted in Jungk, 202.
28. Quoted in Ibid., 296.

> The genome project is an application of scientific technology to produce a certain end—the information content of the genome.[29]

Correspondingly, though aware of the possible social problems created by this new knowledge, Gilbert sees these potential impacts as outside the scope of the Human Genome Project, as problems concerning the general public, and not the proper responsibility of science itself: "Gene typing and genetic mapping could also have very strong social effects. However, the problems posed by the knowledge are not insurmountable and can be dealt with in a democratic society."[30] Because the human genome is the self-justifying holy grail of biological science, and because it is society's responsibility to answer the hard questions, moral values and social criteria should not constrain genetic research and, hence, potentially harmful impacts should pose no obstacles to discovery.

James D. Watson, codiscoverer of the double-helical structure of DNA and former chief of the NIH's National Human Genome Research Institute, is aware of the recent eugenic past of human genetics in the Western democracies and sensitive to the social-ethical implications of genomic research and thus has advocated for legal protection of personal genomic information. Watson, however, appears to be motivated more by the desire to protect science from the backlash of a fearful society than by the desire to protect society from harmful uses of science: "The acquisition of human DNA information has already begun to pose serious ethical problems. . . . We need to explore the social implications of human genome research and figure out some protection for people's privacy so that these fears do not sabotage the entire project."[31] It thus seems that, as Watson sees it, the point of attending to the social implications of scientific research through public policy is to maintain the professional autonomy of scientific research.

Beyond the Myth

The upshot of the myth of ethical neutrality and the corresponding division of moral labor is the insulation of science per se from moral critique, the creation of a domain of action within which scientists may work without moral ambiguity and thus with professional autonomy. This view of the value-neutrality and professional autonomy of science, which is widely held among scientists, is beginning to be challenged from within the scientific profession.[32] My aim in this essay is to critique these twinned claims along four axes of analysis: ethical, epistemological, ontological, and theological. I will consider science as the practice of a profession, as the pursuit of knowledge, and as a form of power. Each axis of analysis, from its own angle, will reveal an axiological dimension of science.[33] The first two angles of critique—ethical and epistemological—will, for the most part, retrace familiar ground and thus will not delve into detail. The third and fourth angles of critique—ontological and theological—will cover new ground.

29. Walter Gilbert, "A Vision of the Grail," in *The Code of Codes: Scientific and Social Issues in the Human Genome Project*, ed. D. Kevles and L. Hood (Cambridge, Mass.: Harvard University Press, 1992), 83, 90, 92.
30. Gilbert, "A Vision of the Grail," 95.
31. James D. Watson, "A Personal View of the Project," in *Code of Codes*, 172–73.
32. For example, Kristen K. Intemann and Immaculado de Melo-Martin, "Regulating Scientific Research: Should Scientists Be Left Alone?" *The FASEB Journal* 22, no. 3 (2008): 654–58.
33. It is beyond the scope of this essay to explore the possible interdependency between these respective axiological dimensions of science.

Beginning from the ontological analysis of science as power, I will establish a vantage point from we can ethically assess the scientific pursuit within the horizon of Christian faith.[34]

Science and Values: Ethical Critique

Professional Ethics

From the perspective of science as a professional practice, the division of moral labor is suspect; it ignores the institutional entanglement of science in society and the financial dependence of science on society, which have become inescapable aspects of the actual practice of contemporary science.[35] Kristin Shrader-Frechette has developed a "trustee model" that sets the epistemological pursuit of science in the context of the social responsibility of the specialized professions. Because scientific researchers constitute a professional class that receives special benefits from society—education, training, and resources—there is an implied or tacit contract that obligates scientists to do research to promote scientific knowledge and to be a wise steward of that knowledge for the public good. Because of their specialized training, which is afforded to a privileged few in society, scientists have a near monopoly on specialized knowledge upon which society depends. This monopoly gives scientists a power over society at large and, hence, a corresponding social responsibility: "Along with specialized knowledge, power and benefits . . . come special responsibilities."[36] Society thus "entrusts" science with the pursuit of knowledge for the good of society as a whole and not just for science as a self-contained and self-justifying endeavor.

William May has articulated a similar view with regard to professional responsibility.

> Why do professionals owe service to the common good? . . . Normally, the state licenses them. The society expects professionals to state publicly their own standards of excellence, to conform to those standards individually, and to enforce them upon colleagues within the guild. Further, modern professionals wield a public power that vastly exceeds that of their predecessors in the professions. What they do today fatefully affects human flourishing. Professionals have even less reason than their predecessors to construe their power in purely private, entrepreneurial terms.[37]

May's observation concerning professional standards adds an important point. The licensing process in consulting professions such as medicine, law, and accounting both implies the act of trust that society makes in permitting the professional to practice and identifies the basis of that trust: the ethical accountability of each profession to public criteria that not only reflect the internal standards of competent practice peculiar to the professions but also project

34. Robert Proctor, *Value-Free Science? Purity and Power in Modern Knowledge* (Cambridge, Mass.: Harvard University Press, 1991), also challenges the value-neutrality of science by analyzing science as a form of power, but from a secular perspective.

35. See Leslie Stevenson and Henry Byerly, *The Many Faces of Science: An Introduction to Scientists, Values & Society* (Boulder, Colo.: Westview Press, 1995), and Douglas Allchin, "Values in Science and in Science Education," in *International Handbook of Science Education*, ed. B. J. Fraser and K. G. Tobin (Dordrecht: Kluwer Academic Publishers, 1988), 2:1083–92.

36. Kristin Shrader-Frechette, *Ethics of Scientific Research* (New York: Rowman & Littlefield, 1994), 25.

37. William F. May, *Beleaguered Rulers: The Public Obligation of the Professional* (Louisville, Ky.: Westminster John Knox Press, 2001), 21.

the societal aim of the common good that is the very reason for the professions' existence. The consulting professions, practiced properly, thus include an essential sense of fiduciary responsibility, which reflects the fact that certain aspects of the common good have been entrusted to specialized professionals on behalf of general society. Historically, the scholarly professions, including the sciences, have not been subject to public licensure.[38] Perhaps the institution of a (voluntary) public license for scientific research—say, a "Certified Public Scientist" designation administered by the American Association for the Advancement of Science—might mitigate the divorce of research objectives from public goals and stimulate a sense of fiduciary responsibility to the common good in scientific practice.

Christian Ethics

The division of moral labor in professional practice is suspect also, and especially, from a Christian ethical perspective. Consider the "two office" or "two vocation" version of "two kingdom" ethics, which the Protestant tradition has emphasized. According to this view, every lay Christian has two callings: the common calling of all believers to serve brothers and sisters within the church and a special calling of each one to serve neighbors within society by the practice of a profession or trade or by holding civic office. No calling is more "holy" or "worthy" than another, for all are ordained by God, such that to fulfill one's professional duty is to render obedience to God. This, in itself, is not problematic. The problem surfaces when we inquire about the ethical standards that apply to these respective vocations.[39] Thus, the "two vocation" view holds that science, one of the specialized professions, may be practiced as a Christian vocation. Okay so far. Now suppose we were to adopt the division of moral labor and apply it to scientific research as a Christian vocation. This division (à la NOMA) would imply that a Christian who practices her profession properly as a scientist does not consider moral ends or religious values in the context of her scientific research but does her scientific research according only to the standards proper to science as such.

Dietrich Bonhoeffer rejected a division of moral labor that would narrowly circumscribe one's Christian duty within the private sphere and advance an ethic foreign to the gospel for one's professional vocation in the public arena. He insisted that the Christian vocation and its particular, gospel-rooted ethic must encompass the whole of life: "Vocation is responsibility and responsibility is a total response of the whole man to the whole of reality; for this very reason there can be no petty and pedantic restricting of one's interests to one's professional duties in the narrowest sense. Any such restriction would be irresponsibility."[40] In this same spirit, Duane Friesen has argued that there can be no appeal to professional specialty as a buffer from accountability to criteria and responsibility for ends that transcend one's vocational domain:

> If we are to approach a profession from a Christian point of view, we need a place to stand, a framework for assessment

38. On the similarities and differences between the consulting professions and the research professions, see Michael D. Bayles, *Professional Ethics* (Belmont, Calif.: Wadsworth Publishing, 1981), 7–11.

39. Concerning the Protestant idea of Christian vocation and the problem of the ethical standard for public vocation, see Paul Ramsey, *Basic Christian Ethics* (Louisville, Ky.: Westminster/John Knox Press, 1950), 153–90.

40. Dietrich Bonhoeffer, *Ethics* (New York: Macmillian, 1955), 254.

> that transcends both the standards of competence provided by a profession as well as our own personal standards of success and satisfaction. Without that transcendent framework, the workspace becomes an autonomous sphere of life no longer subject to interpretation within a world created and sustained by God. The workspace can then easily become an occasion for the expression of the demonic rather than service to the neighbor or the common good.[41]

What Friesen writes concerning the professions in general applies to science in particular: From a Christian perspective, the internal standards of competent science are relevant but insufficient for practicing science as a vocational service to society in accord with Christian duty.

The view of Jean Pond, cited above, illustrates the point. Defending the mutual independence of science and theology (NOMA) from a Christian perspective, she addresses a common objection: "Christians who maintain an independence between science and faith are sometimes accused of being 'bifurcated' people. That is, our lives are compartmentalized. The religion compartment operates on Sunday—in church—but on Monday the science compartment takes over as work resumes in the laboratory."[42] Pond, a biologist, answers this objection not by refuting compartmentalization but by observing that the Sunday/Monday divide is common to all Christians in specialized professions: "I've never understood why a job in science should be much different than a job in, say, major league baseball. We operate according to the commonly accepted rules of science just as baseball players have a set of rules in baseball."[43] That compartmentalization is common practice, however, is precisely the problem; that any specialized profession, science included, should understand itself as simply operating by "its own rules" is inadequate as a Christian perspective of professional practice.

The ethical critique of the division of moral labor may be stated more generally. As H. R. Niebuhr pointed out, it is only by an exercise of intellectual abstraction that one can claim that ethics and values constitute a demarcated domain and thus a peculiar vocation, a specialized activity separable from other human activities. Existentially, ethics by way of value choices pervades all human activities. Science, like all human activities, therefore, is morally ordered; the only question is what that moral ordering is. Niebuhr writes:

> The question the moralist raises is not whether such science is in conflict with morality, but whether such science is adequately aware of its own moral character and whether scientists are sufficiently philosophic or comprehensive in their outlook so as to be able to order their activity as moral within the whole complex of human personal activities.[44]

Niebuhr cites commitment to knowledge as a good, the discipline of self-criticism, and faithfulness in truth telling as characteristics of the moral ordering of science.

41. Duane K. Friesen, *Artists, Citizens, Philosophers: Seeking the Peace of the City; An Anabaptist Theology of Culture* (Scottdale, Pa.: Herald Press, 2000), 219.
42. Pond, "Independence," 90.
43. Ibid., 90–91.
44. H. Richard Niebuhr, *Radical Monotheism and Western Culture* (New York: Harper & Row, 1960), 136.

Epistemology of Science: Science as Knowledge

The fact/value dichotomy underlying the division of moral labor is suspect also from an epistemological perspective. The fact/value dichotomy finds its philosophical sources in empiricism, which, following the eighteenth-century philosopher David Hume, takes the "is-ought" distinction as a categorical truth. Philosophy of science over the second half of the twentieth century thoroughly criticized and almost uniformly rejected strict empiricism and its dogmas, whether of the positivist or falsificationist variety, and the associated fact/value dichotomy.[45] In short, any epistemology that would be descriptively accurate of both the history and contemporary practice of science must acknowledge that scientific methodology is value-structured to at least some degree. This axiological aspect of science appears in several interrelated forms: the "theory-ladenness" of observation, the logical analysis of "crucial experiments," the underdetermination of theory by evidence, and, consequently, the inevitable role of cognitive values in theory choice.[46] While the value-structure of scientific methodology need not undermine the epistemological objectivity of scientific theories, nonetheless the acceptance of any particular theory in science does imply the prior (or concurrent) acceptance of certain value judgments.[47]

This epistemological critique has been augmented by sociological inquiry that has exhibited the interrelation of epistemology and sociology in science. Perhaps the most common form of the myth of ethical neutrality is the dichotomy of "pure versus applied" science, where "pure" science is value-neutral because it pursues knowledge for its own sake while "applied" science is value-structured because of the explicit social, economic, or political aims and interests of the institutional and corporate contexts in which it gets done. The notion of "pure" science, however, is disingenuous from the beginning, not only because of the institutional relationships of science to social sources of support already noted but also because so-called pure science has its own normative sociology—an institutionally organized, value-structured social system (e.g., the peer-review process)—that is integral to science being a knowledge-seeking enterprise.[48] Robert Merton characterized the "ethos" of science not as value-neutral but rather as embodying

45. On the background, and collapse, of the fact/value dichotomy, see Putnam, *The Collapse of the Fact/Value Dichotomy*, 7–45.

46. See Pierre Duhem, *The Aim and Structure of Physical Theory* (Princeton, N.J.: Princeton University Press, 1982), Willard V.O. Quine, *From a Logical Point of View* (Cambridge, Mass.: Harvard University Press, 1953), Norwood Russell Hanson, *Perception and Discovery* (San Francisco: Freeman, Cooper & Co., 1969), Michael Polanyi, *Personal Knowledge: Towards a Post-Critical Philosophy* (Chicago: University of Chicago Press, 1962), Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd ed. (Chicago: University of Chicago Press, 1970), and W. H. Newton-Smith, *The Rationality of Science* (London: Routledge & Kegan Paul, 1981).

47. I thus concur with the late Ernan McMullin that the value-structure of science does not necessarily militate against objectivity in science. See McMullin's essays, "Values in Science," *Proceedings of the Philosophy of Science Association* 2 (2003): 3–28, and "The Shaping of Scientific Rationality: Construction and Constraint," in *Construction and Constraint: The Shaping of Scientific Rationality*, ed. E. McMullin (Notre Dame, Ind.: University of Notre Dame Press, 1988), 1–47. See also my own essays, "Formalism, Ontology, and Methodology in Bohmian Mechanics," *Foundations of Science* 8, no. 2 (2003): 109–72, and "Underdetermination, Realism, and Theory Appraisal: An Epistemological Reflection on Quantum Mechanics," *Foundations of Physics* 35, no. 4 (2005) 669–95.

48. See Henry H. Bauer, *Scientific Literacy and the Myth of the Scientific Method* (Urbana, Ill.: University of Illinois Press, 1992), and Frederick Grinnell, *The Scientific Attitude*, 2nd ed. (New York: Guilford Press, 1992).

four norms—universalism, communalism, disinterestedness, and organized skepticism—that link together the value-structured sociology of the scientific profession and the knowledge-seeking aim of the scientific pursuit.[49]

Ontology of Science: Science as Power

The philosophical critique of the value-neutrality of science goes deeper than epistemology. For, ontologically, science is a form of power of control exercised over, and by means of, the capacities of nature. The exercise of the power of control, scientific and otherwise, is never morally neutral because it always *presupposes* one's *right* to do so. And, as E. A. Burtt emphasized, such unreflective presupposition of right and exercise of power of control in science tacitly reflects underlying value commitments regarding scientific knowledge that are unconsciously and uncritically adopted from one's historical and social setting.[50]

Unlike technology, which manipulates previously known potentialities, moreover, science is the power of creating new technologies, new ways of controlling—intervening in and manipulating—the capacities of nature.[51] Science brings into existence *new possibilities* for human action, both good and evil, and thereby effectively chooses not for itself alone but for all humanity by making the realization of certain human choices possible in the first place. Thus, the question of the values or ends of science is implicit already even in so-called pure research. Science, because it is a form of power of control, is value-structured by its very essence and not only because of its consequences. The fact/value dichotomy, therefore, fundamentally misunderstands the nature of the scientific endeavor: Science is neither a disembodied collection of knowledge claims nor an abstract method or procedure, but a web of concretized beliefs and embodied practices that is both enabled by and dominant over, both servant and master of, nature.[52] Hence, the myth of ethical neutrality is a nonstarter. Here, Francis Bacon is a better reference point than David Hume for understanding science: In science, Bacon noted at the beginning of *The New Organon*, "Human knowledge and human power meet in one."[53]

Even Einstein seems to have failed to realize fully the enduring lesson of the Manhattan Project. In the wake of Hiroshima Einstein proclaimed a duty of scientists to realize actively the aim of peace,[54] yet at the same time he told his young assistant: "Yes,

49. Robert K. Merton, "The Ethos of Science," in *On Social Structure and Science* (Chicago: University of Chicago Press, 1996).

50. E. A. Burtt, "The Value Presuppositions of Science," in *The New Scientist*, 259: "We tend to assume that science will continue to be what it has come to be, and will continue as before to employ its familiar presuppositions and methods; the problem of avoiding destruction through science is, we think, the problem of securing wise moral control over the applications of scientific discovery that affect human life for weal or woe. . . . My major contention will be that the very theoretical foundations of science as well as its practical applications reflect certain value-commitments of which we are largely unaware. . . . In the course of this analysis I shall try to show that our zealous endeavor to create a "value-free" science—which seems so essential a requirement of objective scientific method—has meant simply that the values dominating our thinking have retired to the arena of our underlying assumptions, where they can maintain themselves against critical appraisal by being so completely taken for granted that no one's questioning attention is focused upon them."

51. Ian Hacking, *Representing and Intervening* (Cambridge: Cambridge University Press, 1983), famously argued for scientific realism on the basis of the power of science to increase our control over nature through the development of new interventions into the capacities of nature.

52. See Grinnell, *The Scientific Attitude*, and Polanyi, *Personal Knowledge*.

53. Francis Bacon, *The New Organon* (New York: Macmillian, 1960), 39.

54. Einstein, "A Message to Intellectuals," in *Ideas and Opinions*, 148: "We scientists, whose tragic destination has been to help in making the methods of annihilation more

now we have to divide up our time like that, between politics and our equations. But to me our equations are far more important, for politics are only a matter for present concern. A mathematical equation stands forever."[55] Nuclear physics, though, for all practical purposes did change politics forever; for knowledge confers power of control, and such power and the moral-political question of its use endure as long as the knowledge is preserved. The advent of knowledge of nuclear fission and the production of the atomic bomb set before all humanity a dilemma it previously did not have, it did not knowingly choose, and for which it was unprepared, a dilemma that has foreclosed the future possibility of a world order over which nuclear holocaust and nuclear terror do not loom as menacing threats. Until we destroy our equations by destroying ourselves (perhaps, tragically and ironically, through the very use of such knowledge), nuclear weapons will remain a permanent scientific-technological achievement with which, at least for the foreseeable future, every global politics must negotiate.[56]

The sequencing and mapping of the human genome, too, will cast a long shadow over the possibilities and choices of future generations. Instead of whether the next generation will have a future, however, the political question to be negotiated will be in whose image the next generation is to be made and who is to decide. We are no better prepared for such dilemmas than we were for those foisted upon us by the atomic bomb.[57] We have seen a fictional preview of our eugenic future in the film *Gattaca*—a society divided by genetic endowment, created not by state coercion but by parental choice via in vitro fertilization and embryonic genetic selection. We also get a representative sample of our eugenic future in the ongoing practice of eugenic abortion by parental choice. The ready availability and normalized use of prenatal diagnostic tests for inherited diseases such as Tay-Sachs and Down Syndrome prior to the development of complementary therapeutic capabilities has opened up the (assuredly unintended) possibility of such technology being employed clinically in the service of the elective abortion of children diagnosed in utero with "genetic diseases," a possibility that has thus burdened medical professionals and expecting parents with new and profound moral dilemmas.

Any scientific achievement that either opens or forecloses significant possibilities for human life and community to flourish or decay already constitutes a moral choice that implies an enduring responsibility of which the scientist cannot disburden himself or herself by simply invoking a division of moral labor and saying, "That's not my business." Consider the case of prenatal genetic diagnosis. While the researchers who develop these capabilities are themselves not *culpable* for (and may well be greatly troubled by) eugenic abortions based on prenatal genetic tests, they are *responsible* (at least in part, especially given the present legal regime of liberal abortion rights) for creating a situation in which the realization of such "reproductive choices" is made possible by medical technology. Whereas culpability may end with conscious intention and foreseeable consequences, responsibility does not. This, of course, was the implicit message of Mary Shelley's *Frankenstein*: Dr. Frankenstein remains responsible for the "monster" he has created, whether or not he intended his creature to use its powers for destruction. Thus, as I see it, the same researchers who

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gruesome and more effective, must consider it our solemn and transcendent duty to do all in our power in preventing these weapons from being used for the brutal purpose for which they were invented. What task could possibly be more important for us? What social aim could be closer to our hearts."

55. Quoted in Jungk, *Brighter than a Thousand Suns*, 249.

56. See Walter M. Miller Jr., *A Canticle for Leibowitz* (New York: Bantam Books, 1959).

57. See Berry, "Eugenics after the Holocaust."

develop prenatal genetic diagnostics have an ongoing responsibility to both pursue complementary therapeutic capabilities and secure restrictions on the use of such diagnostics in the meantime.[58]

As Richard Bube writes, moreover, because "every advance with the potentiality for good has a potentiality for evil that is probably proportional to the good," this is a responsibility that scientists must consider from the *beginning* of their research, and not only at the end: "Since scientists are the *producers* of the potentiality for good or evil, their responsibility does not begin only when the potentiality has been brought into existence, but it begins back when the potentiality is still only an unrealized speculation."[59] This leads Bube to pose the following test question for responsible science: "If a scientist would not approve the *use* of a process or device *if* developed, shouldn't he refuse to work on its development?" One might counter that it is impossible for scientists to actually know the practical potential of scientific research, for good or evil, at the point of initial discovery. That may be so in some cases. But in the case of nuclear physics, at least, the potential for vast destructive power, and the political implications of that power, was realized almost immediately upon the discovery of nuclear fission.[60]

Once we recognize science as essentially power of control and also acknowledge the ontological ambiguity of human existence—that we are both subject and object, actor and patient, mind and body—this philosophical critique can be taken a step further to bring ontology back to ethics. Because human persons are both observers of and participants in nature, every power of control gained over nature is power of control gained over human beings, their lives and welfare. Even if ostensibly undertaken "disinterestedly" as the pursuit of knowledge as an end in itself, science is always already the potential for subverting humanity as an end, for converting the human person into an instrumental means to other ends, including knowledge itself. Thus, far from fulfilling the myth of ethical neutrality, science cannot escape the paradox of ethical ambiguity—that although science is a project of human freedom, it always already generates (the potential for) action against human dignity.[61]

The ontological analysis of science as power of control carries ethical implications for not only science but also philosophy of science. Social-constructivist antirealist philosophies of science interpret scientific theories—including theoretical physics—as mere social phenomena, as free constructions constituted by human relations rather than as true or false representations of the world constrained by an external, independent physical reality. To scientists the realism/antirealism debate may seem a harmless verbal dispute among philosophers and sociologists. The real consequences of a social construct, however, are quite different than those of a true representation: The former confers at most the social power of prejudice, whereas the latter confers material power to control and destroy. A social-constructivist antirealist philosophy of science would thus lead to a very different appraisal

58. Francis S. Collins, who developed the genetic test for cystic fibrosis and led the Human Genome Project in the United States, has indicated sensitivity to the ethical dilemma posed by diagnostic capability without therapeutic capability—see *The Language of God: A Scientist Presents Evidence for Belief* (New York: Free Press, 2006), 241–42.

59. Richard H. Bube, "A Crisis of Conscience for Christians in Science," *Perspectives on Science and Christian Faith* 41 (1989): 11–19.

60. See Jungk, *Brighter than a Thousand Suns*, 71ff.

61. See Simone de Beauvoir, *The Ethics of Ambiguity* (New York: Citadel Press, 1976), 99: "Thus one finds himself in the presence of the paradox that no action can be generated for man without its being immediately generated against men."

of scientific responsibility if the only weapons science could devise were categories of social prejudice. Of course, insofar as scientific theories do reflect and reinforce social prejudice and thereby legitimate oppression, science is culpable; and sociological (as well as feminist) critiques of science are certainly helpful to the extent that they expose the sources and effects of such bias in science.[62] But is it not a serious offense to the memory of the victims at Hiroshima to say that all that theoretical physics contributed to their horrific deaths was a social construct? This raises the question: Can there be an ethically responsible social-constructivist antirealist philosophy of science that does justice to the victims of science-enabled violence? In any case, the upshot here is that not only is a value-free (empiricist-positivist) epistemology of science premised upon a sharp fact/value dichotomy inadequate, but so also is a value-full (social-constructivist) epistemology that makes no fact/value distinction at all. For, as Hilary Putnam observes, while the fact/value *dichotomy* fails, there is nonetheless a genuine *distinction* to be maintained between fact and value even if there is an "entanglement" of fact and value in scientific knowledge.[63]

Science and Power: Theological Critique

Theology of Power

I have already noted the ways in which science is power. Science wields intellectual power of knowledge concerning nature's capacities as well as technical power of control over nature's capacities. It is also a social power that shapes cultural understandings, influences public policy decisions, and drives economic development. The institutionally structured and hierarchically organized profession of science is itself a cultural power analogous to government, military, and financial institutions and organizations.

The Apostle Paul's language for the multifaceted "powers" that rule our world may be interpreted as naming the spiritual ethos of political, economic, and cultural systems and institutions.[64] These powers are good because they were originally created by God; as part of the created order, however, they participate in the Fall of creation precipitated by sin and rebellion. Yet, insofar as they are created by God they are redeemable as part of the restoration of creation through the death and resurrection of Jesus Christ. Hence, the three-fold judgment on the powers: the powers are good, the powers are fallen, the powers are being redeemed. The "domination system" through which fallen power functions in this world structures power in such a way as to favor the strong over the weak, the rich over the poor, the educated over the uneducated, the ruler over the ruled, those with defense systems over those vulnerable to attack.[65] Control, especially by way of coercion and violence, both psychological and physical, is the way of the domination system. The domination system, bent on control, is a rebellion against God's Kingdom, which is a domination-free order (as manifest in the *Magnificat* and the Beatitudes).

62. See Barry Barnes, *Scientific Knowledge and Sociological Theory* (London: Routledge and Kegan Paul, 1974), David Bloor, *Knowledge and Social Imagery* (London: Routledge and Kegan Paul, 1976), and Evelyn Fox Keller, *Reflections on Gender and Science* (New Haven: Yale University Press, 1985).
63. Putnam, *The Collapse of the Fact/Value Dichotomy*.
64. I follow the line of interpretation by Hendrik Berkhof, *Christ and the Powers* (Scottdale, Pa.: Herald Press, 1977), John Howard Yoder, *The Politics of Jesus* (Grand Rapids, Mich.: Eerdmans Publishing, 1992), and Walter Wink, *Engaging the Powers* (Minneapolis: Fortress Press, 1992). The term "powers," which refers here to the collection of Greek words used by Paul (*exousiae, dunamis, stoichieia*) is variously translated as "authorities," "dominions," "principalities" and "powers."
65. "Domination system" is Wink's interpretation of the biblical term *kosmos*, usually translated as "world."

Now, science is a cultural expression of what Aristotle called "the natural desire to know," and the human knowing and technique as well as human organization involved in scientific practice are capacities created by God as much as they are in relation to other human activities. Thus, science as power—intellectual, technical, social, and institutional—participates in both the goodness of creation and the fallenness of creation, alongside the other fallen powers of our world. Because it is rooted in capacities originally created by God, science as multifaceted power is both good and redeemable, even though as fallen it holds potential for evil in our world. From a theological perspective, therefore, the myth of ethical neutrality is all the more a nonstarter because science participates in the Fall of creation. Science, though not value-neutral, is not evil but ambiguous: Science is good, fallen, and redeemable, all at once.

Science as Fallen Power

Science, as both a social institution and a research endeavor, is caught up in multiple facets of the domination system. As a culturally based social institution, science has been allied historically with the domination system linking race, gender, class, and geography that favors—politically and economically—white over nonwhite, male over female, elite over common, and north over south. This alliance between scientific power of control and social power of control has produced scientific theories (particularly concerning race and gender) that distort the reality of nature and betray the prejudices of the privileged.[66] As a research endeavor, by reason of its need for public-sector funding or private-sector patronage, a considerable constituency of science is caught up in the military-industrial complex, which links scientific research and arms manufacturers (typically subsidized by taxpayers through appropriations via the Departments of Defense and Energy) with U.S. foreign policy that often favors corrupt governments in developing countries, enriching arms manufacturers and propping up repressive rulers at the expense of both the basic welfare of the domestic poor and the human rights and democratic aspirations of the dispossessed and disenfranchised of the developing world.

This theological critique of science can be extended beyond the intersection of science with society. Understanding science as a form of power of control, and not simply as an abstract set of knowledge claims, and recognizing that the powers in our world are fallen open science to theological critique precisely at the hinge of the myth of ethical neutrality and the division of moral labor—the utilitarian conception of science as a value-neutral means to independently validated ends. The Fall of creation implies that power, in whatever form or however used, is not value-neutral from the start but rather already participates in fallen structures via the domination system prior to our instrumental uses of power for human ends. Power of control, therefore, far from being an unequivocal good, is not even an innocent instrument corrupted only extrinsically by evil uses such that it is only the ends of action that call for evaluation. Because power of control is fallen and thus already "bent" toward domination from the first moment we utilize it, it can never be considered in its mere instrumentality but is always in need of theological critique. Utilitarianism is thus

66. See Dava Sobel, *Longitude* (New York: Penguin Books, 1995), James D. Watson, *The Double Helix* (New York: W. W. Norton & Co., 1980), Stephen J. Gould, *The Mismeasure of Man* (New York: W. W. Norton & Co., 1996), Daniel J. Kevles, *In the Name of Eugenics* (Cambridge, Mass.: Harvard University Press, 1995), and Evelyn Fox Keller and Helen Longino, eds., *Feminism and Science* (Oxford: Oxford University Press, 1996).

a nonstarter: There can be no separate evaluation of means and ends, or justification of value-neutral scientific means by value-laden social ends, because the scientific means are already fallen and, hence, always potentially corruptive and destructive of the social ends.

Because science is a power of control and thus participates in the Fall of creation, and because the fallenness of power lies beyond the competence of human technique to overcome it, science cannot "save" itself from the Fall by its own power. Even if science were conceived in utilitarian terms as a neutral means to human ends, therefore, it is always in need of justification on grounds that transcend the ostensible human ends it serves. Thus, the instrumental use of scientific means for social ends requires ethical justification on theological grounds over and above the epistemological criteria of scientific practice. Science that is successful in its own terms and by its own criteria, even science that ostensibly serves social ends, cannot be considered morally innocent; there are some things that science must not do, because there are some uses of power that are wrong, no matter how useful they might seem to human judgment. NOMA is thus a nonstarter: The separation of science into a self-regulating domain free from theological critique effectively assumes that successful science is morally innocent, which is precisely what cannot be assumed on account of the Fall.

If we now combine the ontological ambiguity of human existence with the fallenness of worldly power, we may argue: Because (a) human beings belong to the created order, (b) power within the created order is fallen, and (c) science as power is both enabled by the capacities of the created order and enables control over the created order, it follows that science is always already, though not irredeemably, implicated in the moral ambiguity of a fallen world. All human projects, science included, are undertaken in a fallen world—a world in which power is already structured by political, economic, and cultural forms in such a way that power of control functions with an "inertial" tendency favoring "haves" over "have-nots," a tendency of power to accumulate power for its own sake that must be consciously recognized and actively resisted. Because in a fallen world all power of control is thus "warped" in favor of the strong over the weak, rich over poor, and so on, science, too, functions along a "gradient" toward the domination of humanity. Despite scientists' best intentions of serving human ends by scientific means, therefore, they cannot escape responsibility for the uses of scientific knowledge. Science, like all human activity in a fallen world, is in need of redemption even if it proves itself successful in enhancing or enabling our control over nature. Indeed, because fallen power is structured in favor of domination, the very ideal of control, whether in science or politics, requires theological critique.

Responsible Science: A Christian-Critical Perspective

Christians and Christian institutions should not abandon the practice of science because of its fallen nature, as if we could escape the Fall by avoiding science. At the same time, without sacrificing the integrity of our faith, we cannot practice science as if it were exempt from the Fall. On account of the theological critique of science as fallen power, responsible science from a Christian perspective must be accountable not only to values that transcend the scientific pursuit (the common good) but also to values grounded in transcendent reality (God's Kingdom). We might thus say that responsible science requires the "transvaluation" of science, the

evaluation and ordering of science according to transcendent values. To implement the transvaluation of science, Christians who practice science and Christian institutions that support scientific research ought to do so only within the boundary values of God's Kingdom (human dignity and nonviolence) and should seek to orient science toward the inverted priorities of God's Kingdom (good news for the poor). In Christian practice, *responsible* science thus entails: the *renunciation* of certain areas of scientific research; the *ransoming* of science from evil uses; and the *reorientation* of research priorities.

Science and the Kingdom

Whereas the myth of ethical neutrality locates science in the timeless realm of Platonic ideas, the theological critique of science as fallen power properly locates it between the historical horizons of creation and redemption. The evaluation of scientific practice and the corresponding judgment of responsibility in science, therefore, ought not to be abstracted from eschatology, from the coming fulfillment of God's Kingdom. From a Christian perspective, it is ultimately Kingdom values by which science, as means and end, must be judged. Within the eschatological horizons of beginning and end, there are two landmarks that indicate the divine purpose in the created order—God's creation of the world and God's redemption of the world—and thus two "boundary values" that demarcate the ethical limits of human power: the dignity of the human person created in the image of God[67] and the nonviolent way of the cross by which God is redeeming "all things" through Christ's victory over the fallen powers. As soon as we adopt Kingdom eschatology and look to Jesus as the Incarnation of the Kingdom, the one in whom Kingdom ends and worldly means are perfectly fitted, it becomes clear why powers of control are to be held in suspicion: No worldly power of control, no matter how benevolently exercised, not even when wielded by Jesus, can fulfill the Kingdom. Hence, just as Jesus resisted the temptation to temporal control by material power to establish the Kingdom, so also the human exercise of power must resist the temptation to domination through science.

This eschatological judgment begins with recognizing that the scientific pursuit is not an absolute value and, hence, that freedom of research is not an unconditional imperative. Responsible freedom, including the freedom of research, must serve ends transcending both freedom and science—the common good and, above all, God's Kingdom. Moreover, one might define "God" operationally as "the source of one's values and the center of one's loyalties." Thus, to insulate science from theological-ethical critique as a self-justifying project by declaring knowledge to be an end in itself and, hence, the source of an unimpeachable imperative is, for the Christian, tantamount to idolatry, the setting up of a competing kingdom. As Niebuhr put it, "It does not seem entirely a figure of speech to say that sometimes for some of the devotees of science, if not for scientists themselves, the scientific method has become a god."[68] Instead, the Christian who practices and uses science responsibly must also be able to critique it from an eschatological perspective that encompasses and judges both

67. By "dignity" I mean that the individual human person possesses a transcendent worth, a worth that is not founded upon either material value or human interest and that cannot under any circumstance be subordinated to human freedom of choice for the sake of expedience.

68. Niebuhr, *Radical Monotheism*, 85. Niebuhr characterizes such a view as a form of henotheism.

the methods and aims of science according to Kingdom values. So, while responsible Christians need not abandon science, neither must they serve science as an absolute value and autonomous project.

Renunciation in Science

The first step in transvaluing science according to God's Kingdom is to acknowledge that some scientific pursuits transgress the boundary values of human dignity and nonviolence and are thus "out of bounds." Just as during his temptations and trials, Jesus renounced controlling, dominating, and violent forms of power because of their inherent incompatibility with God's Kingdom, fidelity to God's Kingdom requires renunciation where the scientific means and ends are inherently incompatible with Kingdom values and goals. Not all powers are created (e.g., God's own creative power) or were put under human responsibility for the sake of preparing the way of the Kingdom (e.g., the power of life and death). Therefore, the very exercise of, or even claim to, such power by human beings *already* indicates an evil—an unjust usurpation of God's prerogative—such that there is no possible virtuous exercise of such power.

So, it is no moral credit to us when on occasion we refrain from exercising a power that was not within our rightful claim in the first place; the only morally responsible action worthy of praise is the renunciation of claim to that power, not the prudent or restrained use thereof. For example, when SS Commandant Amon Goeth follows the advice of war profiteer Oskar Schindler to show restraint and (temporarily) "pardons" one of the Jewish prisoners in his slave labor camp rather than summarily executing him, his action does *not* express virtue, because the power to kill was not within his moral right to exercise to begin with; unless he renounces claim to that power, his action expresses only further self-indulgence.[69] The morally responsible exercise of power, scientific or otherwise, begins with the reverent humility that ancient Hebrew poets called "the fear of the Lord"—acknowledging that we are not God and thus have limited claims to legitimate power. The upshot for our purposes is this: Science in the service of a power that human beings have no moral right to exercise in the first place (namely, research complicit in undermining human dignity or enabling violence) is *already* an evil and ought to be renounced from the beginning, not merely restrained after its evil use. There thus are limitations to invoking Paul's instruction to the Christians at Corinth as a guide for responsible scientific research—"'Everything is permissible,' but not everything is beneficial. 'Everything is permissible,' but not everything is constructive." (1 Cor 10:23)—precisely because (as Paul himself would acknowledge) *not everything* is permissible in the first place.

Taking into consideration the boundary value of the dignity of the human being created in the divine image leads us, first, to renounce science in the name of controlling domination over human life. Human cloning, for example, grasps at God's sovereign creative power over life: It seeks to recreate the human being in human, rather than divine, image. It would effectively convert the human being created for serving God's Kingdom into an instrument of human interests by shaping human biology in accord with human social, economic, and political values. Cloning would thus undermine human dignity by eroding the transcendent value

69. Thomas Keneally, *Schindler's List: A Novel* (New York: Simon and Schuster, 1993), 212ff.

of the human person. Even cloning a child for the ostensibly humanitarian purpose of having a donor match to cure a rare disease would undermine human dignity: The clone would be conceived as a means to her sibling's welfare. It would not express virtue for scientists to clone one human being and then show restraint either by refraining from doing so again or by refusing to divulge knowledge of the technique or by seeking to have it banned by law. There is no way to undermine human dignity in moderation—the only morally responsible course of action is renunciation.

Another renunciation along similar lines should be made in the case of cryogenics. Cryogenics is an attempt to achieve victory over death—the indefinite prolongation of human life—by scientific means. From the perspective of Christian eschatology, hope for conquering death is anchored in the promise of a glorified and incorruptible body made possible through the death and resurrection of Jesus Christ, not the technological manipulation of the natural and corruptible body. Thus, scientific innovation aimed at overcoming death via biotechnology cuts directly across Christian faith by anchoring hope in science—in nature-enhanced human power of control—rather than in God's sovereignty over life and death as witnessed by resurrection. What Gilbert Meilaender writes concerning human experimentation in general applies as well to cryogenics research:

> Placing our hope in the forward march of medical research, we deceive ourselves into imagining that it could be redemptive, that it might overcome the sting of death. . . . But the march of progress within human history is not itself redemptive, and God ultimately deals with suffering in his own mysterious way. . . . Christians, therefore, have no good reason to [completely] renounce the cause of medical research, but our commitment to it ought to be a chastened one, liberated from the fear that makes an idol of our hopes.[70]

The scientific pursuit of cryogenic technology, in effect, denies the limits of our creaturely finitude and thus makes an idol of natural duration, substitutes natural duration for glorified life as our eternal destiny.

Taking the boundary value of nonviolence into consideration, second, leads us to renounce science in the service of destruction. Nuclear weapons research (*all* weapons research, I would say) is inherently incompatible with the fulfillment of the Kingdom, in which swords are beaten into ploughshares, not vice versa. One might argue that nuclear weapons research could be subjected to an international political order that would restrain their production and use within rational and just limits. Such a view, however, projects the wrong eschatology: Christian hope is anchored in Christ's victory and his coming Kingdom, not in human rationality or institutions (not even the United Nations). Regarding the atomic bomb, in particular, the only morally responsible action would have been to renounce the right to *make* such a weapon, not merely to make it and then, as advocated by a small group of scientists in the Manhattan Project, transfer the right to use it to an international political body.[71] The implication here is that finishing the atomic bomb, testing it, and then leaving responsibility for its use to an unwitting society was an act of extreme self-indulgence by (the majority of) the Los Alamos scientists, especially their leader, J. Robert Oppenheimer.

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70. Gilbert Meilaender, *Bioethics: A Primer for Christians* (Grand Rapids, Mich.: Eerdmans Publishing, 1996), 108–9.
71. I refer here to the famous "Franck Report," reprinted in Jungk, 348–60.

Renunciations along similar lines may also be called for concerning some new classes of technologies because of their inherent destructive potential. Bill Joy, cofounder of Sun Microsystems, expresses deep concern over the emerging technologies of the twenty-first century—genetic engineering, nanotechnology, and robotics—each of which carries the possibility of self-replication, a potential for destruction even beyond that of nuclear weapons, raising the prospect of human extinction species via uncontrolled self-replicating technologies. After considering and rejecting ways of developing shields against such prospects as cures almost worse than the disease, Joy questions a scientific pursuit unbound by limits and proposes that such research be restricted or even renounced altogether:

> The only realistic alternative I see is relinquishment: to limit development of the technologies that are too dangerous, by limiting our pursuit of certain kinds of knowledge . . . if open access to and unlimited development of knowledge henceforth puts us all in clear danger of extinction, then common sense demands that we reexamine even these basic, long-held beliefs. . . . It is this further danger that we now fully face—the consequences of our truth-seeking. The truth that science seeks can certainly be considered a dangerous substitute for God if it is likely to lead to our extinction.[72]

Joy's concern echoes that of Niebuhr and Meilaender cited above: The latent danger in the scientific pursuit of self-replicating technology is not only degradation and destruction of humanity, but idolatry—the fabrication for ourselves of a power to replace God. Joy thus calls for a humbler science, a pursuit restrained by conscience and guided by wisdom, which in his view tell us to limit research: "It would seem worthwhile to question whether we need to take such a high risk of total destruction to gain yet more knowledge and yet more things; common sense says that there is a limit to our material needs—and that certain knowledge is too dangerous and is best forgone."[73]

Extending the theological-ethical critique of power to scientific means also points to the renunciation of certain experimental methods. The end of knowledge by itself cannot ever justify the scientific means used to acquire it. No matter how useful the knowledge that we seek is by human measures, the methods of science still need to be critiqued according to Kingdom values beyond utilitarian and pragmatic criteria. Considering again the boundary values of human dignity and nonviolence, research methods that cause suffering or loss of life, restrict human freedom or degrade human life, or cause environmental destruction must be closely scrutinized and perhaps rejected.

Consider some examples. Experimental methods directly causing, or likely to cause, loss of human life must, of course, be renounced outright. Because freedom is an essential facet of human dignity, experimenting on human subjects who have not given informed consent or who cannot understand the risks of the experiment (e.g., children and the mentally handicapped), give consent, or refuse it (e.g., prisoners or comatose patients) must also be strictly renounced. Without the right of informed consent, human subjects become nothing more than another laboratory instrument or material, a denial of their God-given dignity. Furthermore, any experimental situation subjecting human beings to degrading

72. Bill Joy, "Why the Future Doesn't Need Us," *Wired* 8.04 (April 2000).

73. Ibid.

conditions (e.g., humiliation, intentional infliction of pain for no other purpose or infliction of pain disproportionate to the purpose, or deprivation of basic needs such as food, water, shelter, or sleep) must be rejected even if informed consent has been obtained. For the Kingdom calls us to lift up the lowly, bind up wounds, and supply basic needs.

Ransom of Science

Beyond recognizing that scientific pursuit is not an absolute value but is accountable to transcendent values, such that some scientific means and ends must be renounced for the sake of the Kingdom, the transvaluation of science can point us toward the redemption of fallen science. From a Christian perspective, we should refrain from judging as intrinsically evil anything that God has created and intended for human responsibility. Not even nuclear physics, which has given us terrible weapons of mass destruction, is beyond redemption. In a fallen world, nonetheless, we might assess scientific knowledge—in particular, science containing an inherently practical potential for mass destruction or undermining dignity—an initial moral debt that any uses must repay to the benefit of humanity. To use a theological metaphor, such scientific knowledge in a fallen world is in a state of "original sin" and cannot be redeemed by believing that, as Edward Teller put it, "knowledge in the end will be turned into blessing" by the goodness of human intentions.[74] Teller's faith is theologically adequate only if we assume that God will bless whatever well-intentioned human beings do in the name of knowledge. That such an assumption is false is precisely what the Fall is about in the first place. Instead, such science must be "ransomed" by "sacrifice," freed from captivity to evil by service for the good of humanity in the name of the Kingdom.

Because of the moral ambiguity in which science participates, the ransom of science that has destructive or degrading potential from original sin requires the continual evaluation of both means and ends for conformity to Kingdom values. Consider nuclear physics and human genetics. Both of these sciences, which have inherent potential for mass destruction and undermining dignity, not only inherit original sin but also have incurred an actual moral debt, due to the actual use of that potential in nuclear and eugenic holocaust. Thus, the very knowledge of nuclear fission/fusion or of the human genome would already be in need of being ransomed, a debt only compounded by the atrocities of Hiroshima and Auschwitz.[75]

Regarding the ransom of nuclear physics, we must ask whether nonviolent applications that serve Kingdom values of peace and well-being—for example, civilian energy production and nuclear medicine—are paying the initial debt over and above the enormous liability incurred at Hiroshima and via the arms race, or whether these applications are only compounding the debt through problems such as nuclear waste. Regarding the ransom of human genetics, we must ask whether good applications that serve Kingdom values of justice and healing—for example, exonerating via DNA testing those wrongly convicted and sentenced to death and applying cellular therapy for genetically linked diseases—are paying

74. Teller, "Atomic Scientists Have Two Responsibilities," 356.

75. I use "Auschwitz" here to indicate the Nazi program of race "purification," which was the apogee of eugenics in the twentieth century. Concerning the eugenic policies of Nazi Germany and their precedents in the United States, as well as the eugenic goals of the scientific study of human heredity, see Kevles, *In the Name of Eugenics*.

the initial debt over and above the enormous liability incurred at Auschwitz, or whether such applications as genetic enhancement, genetic discrimination in insurance and employment, and embryonic stem-cell research are only compounding the debt.[76]

Could this redemptive process ever be finished by human effort? No. As long as the basic discovery and knowledge remain, so does the potential harm in a fallen world. Neither nuclear physics nor human genetics will be fully redeemed by human effort but will remain morally ambiguous, and thus in need of theological critique, short of the final consummation of the Kingdom by Christ.

Reorientation of Science

Should we, recalling Hiroshima and Auschwitz, withdraw our trust in science and simply cease doing research? No. At the very least, science and technology have enabled—one might even say, have become indispensable to—the Christian mission of justice to the poor, suffering, and oppressed; and this is a responsibility we should not abdicate, even (and especially) in a fallen world. The scientist Richard Bube, a Christian, echoes this point:

> Although there are certainly areas of human development where a simple cessation of activity is the informed response of Christians in science, it is clear that the general responsibility of Christians and the Christian community to meet the needs of the people in the world cannot be met by advocating a simple end to all science. If, in fact, science did not exist, Christians would have to invent it in order to be faithful to their call to be stewards of the earth for God and their fellow human beings.[77]

If it is within our power to use science and technology to do justice for the poor, suffering, and oppressed, then we ought to do so, insofar as our choice of science-enabled means upholds the dignity of the human person created in the image of God and conforms to the nonviolent way of Jesus.

The choice between a value-neutral science and a value-structured science is not available to us. Once we have recognized that science is not, nor could be, a value-neutral project, the key question for Christian responsibility thus becomes which values should structure scientific research. While living in the "meantime" between the horizon of original creation and the horizon of final redemption, and having set the moral limits of responsible

76. It is assumed here, but not proved, that these latter applications negatively affect human dignity. The undermining of human dignity involves treating the human person as having only instrumental value for human purposes rather than respecting the human person as having transcendent value in God's Kingdom. In the case of cloning human embryos for stem cell research, for example, the threat to human dignity is quite direct. Embryos are first "manufactured" and then treated as "repositories" of "natural resources" to be "harvested" or "mined." Once their usefulness is exhausted, they are "discarded" as "waste." In other cases (e.g., genetic enhancement and discrimination) the threat to human dignity is less direct and thus needs extended supporting argument. Concerning the legal and ethical implications of genetic enhancement and discrimination, see Roberta M. Berry, "From Involuntary Sterilization to Genetic Enhancement: The Unsettled Legacy of *Buck v. Bell*," *Notre Dame Journal of Law, Ethics & Public Policy* 12 (1998): 401–48, and "The Human Genome Project and the End of Insurance," *University of Florida Journal of Law and Public Policy* 7 (1996): 205–56. Regarding the manifold social, ethical, and legal implications of genetic information, one will usefully consult Daniel J. Kevles and Leroy Hood, eds., *The Code of Codes: Scientific and Social Issues in the Human Genome Project* (Cambridge, Mass.: Harvard University Press, 1992).

77. Bube, "A Crisis of Conscience for Christians in Science."

science according to the boundary values of human dignity and nonviolence, we should further seek to reorient scientific research toward the inverted priorities of God's Kingdom.

God's Kingdom is an "upside-down" kingdom. The kingdoms of this world, structured by fallen power, favor strong over weak, rich over poor, "first" over "last." In the Kingdom of God, however, the power ratios are inverted: The weak are lifted up from the dust, and the strong are pulled down from the thrones from which they have oppressed the weak; the poor are filled with good, and the rich who have filled themselves are sent away empty; those who have been put behind others are made first, and those who have put themselves before others are made last.[78] This inverted ordering of Kingdom priorities has been dubbed the "preferential option for the poor" in Christian social ethics.

As we observed above, science as fallen power has often both reflected and reinforced the power priorities of worldly kingdoms. As Kingdom power overturns the perverted ordering of worldly priorities, so the transvaluation of science according to a preferential option would seek to reorient science toward the benefit of those who have been "put down," "put out," and "left behind" by fallen power. This would mean the redirection of research toward objectives such as: enhancing our capacity for food production for the world's hungry; finding cures for "neglected diseases" that afflict the poor peoples of developing nations;[79] designing appropriate technologies for developing nations; and so on.

Consider here what might seem a scientific discipline far removed from such concerns: cartography. The science of mapmaking seems value-neutral enough—it is simply about the objective representation of physical features of the terrestrial surface, right? Not quite. For elementary geometrical reasons, the projection of a spherical surface onto a flat surface introduces distortions, such that every flat world map will have inaccuracies. But not every world map is inaccurate in the same way—the distortions depend on the mapmaker's choices and thus, implicitly, on the mapmaker's values. Picture in your mind the world map that most of us first encountered in middle school social studies class. This map, known as the Mercator Projection, has several limitations in accuracy, most obviously the extreme exaggeration of land sizes near the poles (Canada, Greenland, Antarctica, etc.). What is less obvious is the implicit bias of this map's appearance: The distortion of land size increases as you move from the equator toward the poles, such that Europe and North America appear proportionally larger than equatorial Africa and South America. Now focus your mind's eye to the center of the map. What's there? Western Europe. Why is that? Because this sixteenth-century map was made for the purpose of guiding the navigation of European traders to tropical ports in service of the new mercantile strategy, by which European nations sought to augment domestic wealth and international power by military control of material resources in foreign locales, a strategy that provoked wars and promoted colonialism.

Although a significant advance in nautical cartography, the Mercator Projection not only reflects the geographical bias of its Flemish maker but also reinforces the assumed superiority of those whose interests it was designed to serve. And that, Denis

78. Donald B. Kraybill, *The Upside-Down Kingdom*, rev. ed. (Scottdale, Pa.: Herald Press, 1990).
79. Carlos M. Morel, "Neglected Diseases: Underfunded Research and Inadequate Health Interventions," EMBO Report 4 Supp. (2003): S35–S38.

Wood argues, reveals how any map works: Maps serve interests that the map itself masks.[80] Suppose, then, that we were to reorient cartography according to a preferential option—and thus choose a mathematical projection that, say, implicitly recognized the equal value of people living in the equatorial regions by representing their land sizes in equal proportion to the land sizes of those living in Europe and North America. One map we might end up with is called the Gall-Peters Projection, which represents equal areas on the earth's surface with equal areas on the world map, such that Africa is seen as much larger than Europe, which it actually is. The point here is not about choosing a perfect map; no map is perfect—the Gall-Peters Projection still seriously distorts the polar regions. The point, rather, is that once we acknowledge that there is no value-neutral map, the question is which values maps should serve. Having become conscious of the values implicit in all maps, Christian cartographers should seek to "unmask the power" of maps and design maps that not only represent terrestrial facts but also serve Kingdom goals.

Even if we restructure science according to a preferential option, we must remain mindful of the ethical ambiguity of scientific research: every scientific achievement in a fallen world, even science that is well-intentioned for human benefit, will have its shadow side. The reorientation of science will thus require a reassessment of progress. Wendell Berry has aptly written:

> Nobody seems to be able to subtract the negative results of scientific "advances" from the positive. . . . If science has sponsored both an immensity of knowledge and an immensity of violence, what is the gain? . . . We need to require from our teachers, researchers, and leaders—and attempt for ourselves—a responsible accounting of technological progress.[81]

In effect, Berry is calling for a new type of history of science that observes a responsible accounting of progress, accounting for life lost and communities destroyed as well as knowledge gained and technique mastered. In economic metaphor, in good conscience we can no longer continue to "externalize" the actual human costs of scientific-technological progress. An example of responsible accounting of scientific-technological progress is the recent report by the World Commission on Dams, which acknowledges that "dams have made an important and significant contribution to human development, but in too many cases, the social and environmental costs have been unacceptable and often unnecessary."[82] Take, for another example, genetically modified crops, over which there is considerable controversy. There is no question that genetically modified plants have significantly enhanced the ability of subsistence farmers in developing nations to grow crops to feed their families. A responsible accounting of this scientific progress, however, would ask whether improvement in food production capability to match increases in world population does justice for the poor and hungry peoples in the developing world and liberates them from cycles of famine and poverty exacerbated by civil war and political corruption, or whether such scientific progress

80. Denis Wood, *The Power of Maps* (New York: The Guilford Press, 1992).

81. Wendell Berry, *Life Is a Miracle: An Essay against Modern Superstition* (Washington, D.C.: Counterpoint, 2000), 70, 91,136.

82. "Dams and Development: A New Framework for Decision-Making," Final Report, World Commission on Dams, November 2000, available at www.dams.org.

serves to entrap them in a new form of global economic slavery to biotech companies in the developed world that enrich themselves at the expense of wild crop varieties, local agricultural techniques, and sustainable rural communities.[83]

To implement this reorientation of science, I propose that Christian universities that support scientific research adopt institutional practices that promote responsible science, such as the following. First, institutional review boards should require faculty research proposals and funding requests to address not only the apparent ethical questions concerning research methods, which has become standard practice, but also the potential social impacts of scientific research—and to do so prior to the commencement of research. Second, science departments should require faculty to compile regular reports not only of courses taught, papers published, and dissertations directed, but also how their research results have been utilized by others and the actual social impact of that use. Third, faculty senates and academic deans should exercise a preferential option in their institutional practices of recognition (awards and honors) and advancement (promotion and tenure), giving preferential recognition and advancement to scientists whose research aligns with Kingdom priorities.

As we look beyond renunciation in science toward the ransom and reorientation of science for the sake of the Kingdom, we keep in view a constant theme: humanity and the world are not to be saved by any form or amount of worldly power of knowledge and control—political, financial, scientific, or otherwise. Thus, in seeking to transvalue science in accord with God's Kingdom, Kingdom eschatology limits us to a modest goal: not to save the world by the strength of our science, but to witness faithfully in the world to the Lord of the Kingdom through the right exercise of power via the responsible practice of science.

Responsible Science and Cross-Disciplinary Dialogue

The transvaluation of science in accord with the Kingdom values of human dignity and nonviolence requires that we bring science back into connection with those areas of human thinking and doing by which we receive and appropriate those values. Because it is only from the perspective of transcendence that all human persons acquire real dignity as creatures of God and that principled nonviolence finds its true motivation as an imitation of Jesus, responsible science must be accountable to the transcendent—the eternal and spiritual—as well as the temporal-spatial and material. This points us toward a constructive engagement of science with ethics, philosophy, and theology, disciplines that address themselves to the universalities of human value and cosmic existence.

To be responsible, moreover, science must not only be accountable to the values "over its head," as it were, but also acknowledge the values "beneath its feet." This is the moral claim of *propriety*, as Wendell Berry calls it, which raises several questions that "address themselves to all the disciplines, but . . . do not call for specialized answers."[84] To be responsible in any human endeavor, including science, we cannot act as if we do not inhabit a finite earth at a particular time and place. So, we must ask: What may we do with our abilities to serve our interest at this time that is respectful of our local place and appropriate to our actual condi-

83. See the alternative views of Jeff Stoltzfus and Marion Meyer, both with Mennonite Central Committee, in "Biotechnology: A Technology of Life or Death?" *A Common Place* 6 (November 2000): 8–11.

84. Berry, *Life Is a Miracle*, 15.

tion? To become aware of the question of propriety, science must be reawakened to the "life-world"—the lived reality of everyday experience in familiar surroundings—as the *homeland* of its thinking and doing, as the soil from which its activity, both theoretical and experimental, takes its start and in relation to which the very meaning of science as discovery of the real has its origin.[85] Thus, science must not only engage with ethics, philosophy, and theology but also converse with history, literature, and the arts, those human expressions that disclose the life-world in its manifold particularities, revealing a world shot through with values that motivate our most basic existential commitments before scientific thinking even appears within human consciousness.

If science is to address both transcendence and the life-world, if science is to be both accountable to suprascientific universalities and cognizant of prescientific particularities, dialogue across disciplines within the academy is essential. Berry reaches a similar conclusion: the inadequacy of science's own professional standards to the task of assessing its progress responsibly, he writes, "is a sign of the incompleteness of science in itself—which is a sign of the need for a strenuous conversation among all the branches of learning."[86] This crossdisciplinary dialogue would, ideally, lead to a transformation of science education. It is no longer sufficient to leave students with the impression that scientific research is morally innocent insofar as and to the extent that it satisfies narrowly defined professional standards of competence and criteria of success. Teaching scientific knowledge and technique confers power of control, but knowledge by itself is not wisdom, and technique is not virtue. To confer such power of control to our students without appropriate moral guidance would be irresponsible in this age of unmitigated exploitation by the market and the military of any and every scientific-technological innovation with potential for increasing profits or killing people. Christian universities should thus adopt curriculum standards that require integrating the discussion of the social impact of science, the social responsibility of the scientist, and the ethical conduct of research into all levels of science education, from introductory undergraduate courses to advanced graduate studies.[87]

Summation

Throughout this essay, we have reflected on the question of values and responsibility in science along ethical, philosophical, and theological axes of analysis. We have seen from each angle that science is not, nor could be, a value-neutral project. Whether analyzed as the practice of a profession, as the pursuit of knowledge, or as a form of power, science is structured by values in both means and ends, both methods and goals. The only question for consideration, therefore, is by which values science is to be structured. The overarching theme of the argument presented here is that we cannot in good faith assess the value and responsibility of science by demarcating it from other domains of human value and responsibility through a division of moral labor that leaves science responsible only for itself and answerable only to its own standards

85. See Edmund Husserl, *The Crisis of European Sciences and Transcendental Phenomenology*, trans. David Carr (Evanston, Ill.: Northwestern University Press, 1970) and Maurice Merleau-Ponty, *Phenomenology of Perception*, trans. Colin Smith (London: Routledge, 1962).

86. Berry, *Life Is a Miracle*, 145.

87. This proposal could be extended also to secular institutions; see Erin A. Cech, "Education: Embed Social Awareness in Science Curricula," *Nature* 505 (2014): 477–78 (January 23, 2014).

of competence and criteria of success. Rather than allowing science to be practiced independently within a specialized sphere of professional autonomy, science should be practiced within the encompassing sphere of Christian responsibility. We can exercise the power of science responsibly only when we do not cleave it from transcendent values.

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