SCIENCE, POLITICS AND SOCIAL PRACTICE

Essays on Marxism and science, philosophy of culture and the social sciences
In honor of Robert S. Cohen

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SCIENCE, SOCIETY, AND THE EXPANDING BOUNDARIES OF MORAL DISCOURSE

The public's acclamation of science was in its ascendancy in the post war period of the 1950s. Scientific achievements were credited with carrying the allied forces to victory in Europe and Asia through the development of radar, the modern technological army, and of course the atomic bomb. Governments throughout the industrialized world were now prepared to invest heavily in science as insurance against future threats to their national security. This change in the government's role was a mixed blessing for scientific institutions. Many disciplines flourished from the new riches of public funds. Some new disciplines were formed out of the war effort and the post-war arms race. But it also meant that scientific research in the American academy became heavily politicized. The image of the lone scientist, broadly educated with the grasp of the large picture, working tirelessly in a makeshift laboratory furnished with hand-crafted equipment, pursuing a path to knowledge according to some ineffable sixth sense, was undergoing a great transformation. The new image was of a strategically planned science consisting of teams of investigators, working on large scale projects, competing for limited funds, positioning themselves in a social structure that would insure the continuity of funding through volatile political times.

While the social structure of post-war science was undergoing a transformation, the linkage of that structure with normative functions made it inevitable that the moral status of science would also undergo change. The relationship between science and ethics has been examined by a number of authors (see for example Merton (1949), Haldane (1957) and Cohen (1974)). For purposes of discussion I cite three relevant aspects of science that bear on moral problems. First, the culture of science possesses norms of behavior that are functional to collective disciplinary goals. A scientific ethics provides rules of practice and principles of self governance within the various professions. Second, through discovery of new knowledge and its applications that expand human possibilities, science is continuously adding to the reservoir of moral problems facing society. And, third, the methods, theories or modes of reasoning in science are cited as models for moral decisionmaking,

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normative problem solving, or policy choices. It is not accidental that upon introducing new moral problems, science works toward developing the rational means to manage them. Failing to manage these problems makes science vulnerable to external controls. Modern biology is a case in point. Seeking to serve multiple interests during a rapid phase of commercialization, molecular biology became vulnerable to new forms of external governance. The normative transformation that is taking place in molecular biology is illustrative of general shifts occurring the boundaries of moral discourse between science and society.

AUTONOMY OF SCIENCE

The co-evolution of science and ethics began at least two millennia ago. The nature and character of that relationship has been a subject of continuing scholarly interest pertaining to such questions as: What role has science played in moral reasoning?; how do the ethical norms of science affect the practice of science? Does the normative structure of science provide a model for public life? Can science continue as a self-governing social system?

Perhaps the greatest unity between ethics and science within a system of beliefs can be found in ancient Greek thought. Aristotle posited that virtue was the end to which knowledge was directed; science and morality shared the same end – the contemplation of universal and necessary truths (Ross, 1964), while the greatest virtue was the attainment of moral wisdom. According to MacIntyre (1978, 38) this belief system guarded against conflicts between science and ethics.

During the Middle Ages and through much of the Renaissance the authority of the Catholic Church prevailed on issues of science and ethics. Potential conflicts between science and theology were controlled by a single authoritative view. As the Church began to shift from its Aristotelian orthodoxy accommodating the evidence of the Copernican world view, the protection of science from conflicts with religion was solved by the creation of parallel domains. In areas of moral or theological conflict, science could step aside in deference to ecclesiasticism. The hegemony of the medieval church eventually gave way to scientific authority which blended skepticism, empiricism, and rationality into what John Randall (1926) called "the making of the modern mind." A new culture of science emerged and with it came the methods and ideas to protect that culture from external forms of authority. Thereafter, cultures that have experienced the spectacular growth of science have each faced, in their own way, the dilemmas associated with resolving tensions between scientific interests and public morality.

The new forms of protectionism for scientific practice were expressed in several ways. First, science aligned itself with the most progressive tendencies in society – at the time, industrial entrepreneurship. The moral order was being reshaped by the emergent class of independent capitalists. By associating itself with the new moral order science followed Francis Bacon's dictum that there must be "experiments of light" to discover the causes of things, as well as "experiments of fruit" to apply the knowledge to practical ends (Brown, 1986, 19). Second, science sought to use its own belief structure, the progress it had made in the discovery of physical laws, and the success it had achieved in applying science to technology as a basis of legitimacy for making claims about moral life. The scientists of the Enlightenment believed that a "deductive system of morals comparable to mathematics might be developed" (Randall, 1926, 366). Reminiscent of the unity of science and moral order of the Hellenistic period, the philosopher-scientists of the Enlightenment believed, as noted by Randall (1926, 366), that "The Order of Nature contained an order of natural moral law as well, to be discovered and followed like any other rational principles of the Newtonian world-machine."

Finally, science presented itself as a normative social structure worthy of universal applicability and providing the standard for the moral behavior of lay society. Robert K. Merton's two essays "Science and the Social Order" (1938) and "Science and Democratic Social Structure" (1942) are now legendary in framing the normative conditions of the practice of science. Merton (1957, 595) spoke of an ethos of science as an "emotionally toned complex of rules, prescriptions, mores, beliefs, values and presuppositions which are held to be binding upon the scientist." The widely cited norms in Merton's analysis consist of universalism, communalism, disinterestedness, and organized skepticism. Science was thought to embody its own moral standard and as the "exemplar of applied rationality" (Toulmin, 1980, 59) it was protected from externally imposed standards of moral behavior.

A fourth means through which science sought to protect itself from external control was through a campaign to purge itself of value judgements or non-verifiable claims – commonly known as positivism. The positivist movement in science reached its peak between the First and

Second World Wars. By divorcing itself from ethics and metaphysics, positivists believed that science could be protected from the claims of relativism and subjectivity that plagued secular moral theory (Toulmin, 1980, 45). The French physicist Henri Poincaré (1958, 12) described the separation of domains in his popular book *The Value of Science*.

Ethics and science have their own domains, which touch but do not interpenetrate. The one shows us what goal we should aspire, the other, given the goal, tells us how to attain it. So they can never conflict since they can never meet. There can no more be immoral science than there can be scientific morals.

Even as science proclaimed its independence of values and metaphysics, some scientists were not shy about applying the intellectual fruits of their fields to influence the development of ethical theory. Physicists and philosophers of science, seeking a rational order in moral reasoning, investigated what Northrop (1947) and Margenau (1964, 138) proclaimed was the "complete parallelism between the formal structure of science and that of ethics." Margenau proposed the formal counterpart in ethics of axioms, protocol facts and rules of correspondence – a carryover of the 17th century ideal that a deductive system of moral reasoning could be developed comparable to mathematical physics. Little progress was made in carrying out the formal analogy between science and moral theory, partly, no doubt, because positivism was so thoroughly discredited.

The principal dilemma for science in the aftermath of the Second World War was to establish an independent and self-governing normative structure while at the same time becoming more fully integrated into the practical and economic life of the nation. The goal was met by giving to scientists the major role in the organization of scientific research programs (Smith, 1990). Price (1964, 20) noted that science became "the only set of institutions for which tax funds are appropriated almost on faith and under concordats which protect the autonomy, if not the cloistered calm, of laboratory."

The visible scientists all too often spoke of their profession as having ascended to a higher moral plane than other sectors of society, particularly politics, law, and business. Jacob Bronowski (1965, 70) was one of several notable scientists who popularized this view:

. . . science has humanized our values. Men have asked for freedom, justice and respect precisely as the scientific spirit has spread among them. The dilemma of today is not that the human values cannot control a mechanical science. It is the other way about: the scientific spirit is more human than the machinery of government.

Two benchmark events of the twentieth century that help shape a new social perception of science were the unprecedented collaboration among scientists in the development of the atomic bomb (Sherwin, 1975) and the perverse role that German science played during the Nazi regime (Proctor, 1988). These events shifted the public image of science from purveyor of knowledge to instrument of mass annihilation and geopolitical power. The nuclear physicists had produced without question the weightiest moral problem since human inquiry into the physical world began: should science pursue an area of investigation that could result in the destruction of human civilization?

While science could no longer claim its moral innocence or its impartiality to political power, it continued to find ways to protect itself from external governance and control. To effect this, a dualism was adopted that distinguished between the pure and the impure aspects of scientific work. Building on Bacon's distinction between "experiments of light" and "experiments of fruit," this view asserted that there are two forms of science. Basic or pure scientists produce knowledge; applied scientists or engineers direct that knowledge to uses society or those in power seek to advance. Within this framework the relevant moral question is: How ought we control the application of knowledge when we are obliged to protect its pursuit? When faced with external criticisms about the nature and direction of research, scientists could always fall back on the dualism of inquiry and application. Inquiry, must remain maximally free in this view. This freedom is part of an inferred social contract between the scientific and the political cultures. In contrast, the application of science to human affairs must be subject to the guidance of informed democratic processes.

THE MORAL CRITIQUE OF SCIENTIFIC EPISTEMOLOGY

In the last quarter of the twentieth century, science has experienced new restraints on its self-governance. It has also been the target of a new wave of epistemological and ethical critiques from feminists and environmentalists. The new critics of science began turning a moral lens on the scientific method, not for its weakness of rigor but for harboring implicit values. Among these, it is argued that the choice of research programs and the methods used to carry them out were weighted heavily toward certain problems while neglecting others.

Barry Commoner, a refugee from molecular biology, argued in the

1960s that the current trend of mechanistic reductionism in biology is largely responsible for society's neglect of the environment. According to Commoner (1963) too much attention was given to the study of issues that had no relevance to the proper functioning of the planet as the biosphere was facing serious degradation. Moreover, the reward structure in science was designed to give positive reinforcement to the study of molecular biological processes while neglecting the organismic study of natural systems. Similar arguments were advanced during national debates about the war against cancer. Critics of the viral and genetic paradigms of cancer maintained that science was mobilized in an all out front to find a cure that would not disturb the vast sources of industrial pollution (Epstein, 1978). A second wave of moral and epistemological critique was launched by feminist historians and philosophers who characterized the scientific method as gender-laden. In its most extreme form this critical perspective asserted that mechanistic materialism, patriarchy, and the abuse of nature are reinforcing and collateral belief systems. For example, according to Merchant (1980, 291) "Mechanistic assumptions about nature push us increasingly in the direction of artificial environment, mechanized control over more and more aspects of human life, and loss of the quality of life itself." New studies of gender in science (Keller, 1985) gave a new perspective to the 19th century debates about subjectivity/objectivity, mechanism/vitalism, holism/reductionism. These epistemic ideas were cast in moral categories of misogyny and the degradation of the biosphere. Feminist "standpoint epistemology" was advanced as an alternative to current notions of a value-neutral objective science. The loss of objectivity has moral implications since, as noted by Cohen (1974, 143), its loss negates the "one great quality of the Enlightenment and the humane life" it provides. Not all feminist philosophies are inclined to reject objectivity. While some argue that current scientific conventions produce an androcentric bias in the results of research (Harding, 1986, 25), the possibility was left open for a feminist science with a new set of epistemic and cognitive categories more likely to yield unbiased and objective results. These feminist critiques forged the link between scientific ethics and epistemology.

LIMITS OF SCIENTIFIC INQUIRY

Exercising greater social control over the direction of research that has served class or gender interests has been a theme in the critical writings of marxists, environmentalists, and feminists. But until recently, the idea of free inquiry had never been critically examined within the mainstream of science. That changed when biologist Robert Sinsheimer (1978) raised doubts about several areas of scientific inquiry including isotope fractionation, the search for extra-terrestrial intelligence, and the pursuit of knowledge that could delay the aging process. Sinsheimer argued that since each of these research programs could result in grave outcomes for human civilization there was time to consider restraints on certain lines of scientific inquiry. Simplification of isotope fractionation techniques, for example, likely will result in the easy manufacture of plutonium. This innovation is a sure path to nuclear proliferation, according to Sinsheimer, and would make atomic weapons accessible to terrorist groups. Other examples cited by Sinsheimer had a more tenuous cause-effect relationship.

The discovery of extra-terrestrial intelligence more advanced than our own will have unforseen effects on the psyche of the human race. And, finally, by slowing down the aging process science will be faced with an issue of trans-generational equity in that the outcome of the research would limit the welfare of future societies. Sinsheimer (1978, 30) concluded: "In a finite world, the end of death means the end of birth."

An entire issue of *Daedalus*, the journal of the American Academy of Arts and Sciences was devoted to the limits of scientific inquiry. Fellow biologist David Baltimore offered a rejoinder to Sinsheimer and declared that any restrictions to the free and open pursuit principle in science is a violation of its essential character. Baltimore (1978, 43) commented that "society can choose to have either more science or less science, but choosing *which* science to have is not a feasible alternative."

In this debate the right of government to selectively fund research was not in question. It is generally recognized that scientists do not have an entitlement to receive public funding to pursue their ideas. Nor was this debate about controls over research experiments that might result in hazards to people or the environment. Federal guidelines on human subjects research and genetic engineering was already established.

However, where the targets of restraint are broad areas of inquiry and not simply experimental systems, the stakes for science are high. The greatest threat is that an influential lobby of private interests could prohibit certain areas of inquiry. Recognizing this, Carmon (1985, 47) argues that pure science is analogous to a type of quasi-speech. "Constitutional protection for new forms of scientific exploration and insight deserves no less deference than that which we ought to accord new forms of political protest."

Moral and political agendas do influence the funding of science despite the best efforts by the scientific community to promote the myth about free inquiry. The federal government under the Reagan and Bush years refused to release funds to study fetal tissue transplants for the treatment of Parkinson's disease. Opponents of this research believed that it would both legitimize and increase the rate of abortions in the United States. In another case, a peer reviewed national survey on human sexual attitudes designed to learn more about AIDS transmission and prevention was derailed because explicit sexual questions offended religious fundamentalists.

NORMATIVE STRUCTURE OF SCIENCE

Robert K. Merton's formulation of the four norms of science reinforced among its practitioners the view that science had its own universal moral code. "The scientist came to regard himself as independent of society and to consider science as a self-validating enterprise, which was in society, but not of it (Merton, 1957, 605). Bronowski (1965, 70) spoke of values of science as "the inescapable conditions for its practice." The concept of a "scientific ethic" provides the institutions of science with a virtual shield against intrusion by a public morality of scientific practice.

In the 1970s science was faced with new forms of public scrutiny on issues of ethical conduct. Scientists lost authority to set the moral parameters for experiments with human subjects. Disclosure of abuses in medical, psychopharmacological, and psychological experiments were showcased in federal hearings and eventually resulted in legislation. The most visible and politically sensitive cases includes the administration of live cancer cells to elderly patients without informed consent, psychosurgery on incarcerated persons, unreliable data submitted for drug approval by clinical investigators, and the failure to treat syphilitic patients in the infamous Tuskegee study. As a direct result of the publicity of these and other cases, federal guidelines for human subjects research, quality assurance of scientific data, and institutional human subjects review boards were created (Swazey, 1978).

Animal rights became a formidable mass movement in the 1980s after disclosures about abuses in animal care in federally-funded research facilities. These disclosures and a rise of militancy among animal activists brought stricter government accountability for animal care facilities. Neither of these interventions (protection of human subjects and animals) into the laboratory life of science threatened broad areas of inquiry or the fundamental Mertonian norms. But they did extend public oversight into scientific conduct in areas where there was already prior societal involvement. The new animal rights movement was derivative of the antivivesection groups of the 19th century and the protection of human subjects evolved from the ethical imperatives of the Hippocratic oath in medicine.

When genetic engineering was born in the 1970s, scientists faced the prospect of new forms of social accountability. Now the issue was laboratory hazards involving the application of recombinant DNA techniques. Public concern was over the inadvertent creation of an epidemic pathogen even before there was a demonstrable hazard.

In a series of unprecedented actions, more than a dozen local communities were not satisfied with the scope of the federal government's guidelines and enacted laws regulating experiments that involved cutting and splicing genetic material (Krimsky, 1982). These actions were in direct conflict with the self-governing principles of science. This had been the first biochemical technique that had been subject to multi-nation controls.

In his Conway memorial Lecture delivered in 1928, J.B.S. Haldane (1932, 101) noted that "by complicating life, science creates new opportunities of wrongdoing." Since the discovery of recombinant DNA society has been poised for wrongdoing or ethical transgressions in biology. The protective cloak around the biological sciences securing its internal governance, lifted somewhat in response to abuses in human experiments, was bared free when it entered the new frontier of synthetic biology.

Public intrusions into the practice of biology began because of concerns that research scientists were not in a position to police themselves. Popular discourse exploited literary symbols like Frankenstein monsters and Andromeda strains. After more than a decade of federal oversight of the genetics and biochemical laboratories in universities, many scientists cried false alarm. The public's ethical concerns were refocused from laboratory hazards to other issues two of the most prominent are: eugenics and scientific entrepreneurship. Each of these precipitated a new dialogue on the control of scientific research.

HUMAN GENETIC MODIFICATION

Scientists are rapidly learning how to delete and add functional genes to mammalian cells. This will open the door for molecular eugenics or the modification of the human germ line at the cellular level. If successful, this research could be used on human eggs to improve the human gene pool. The clash in values among social groups over whether scientists should be permitted to engage in human germ line research recapitulates deep moral conflicts in 400 years of modern science. Does progress in scientific research shape what is acceptable moral practice, or does science conform to an independently determined moral code? Will a society now highly suspect and antagonistic to modifying the inheritable genes of humans, eventually accept this process as a new form of control over and liberation from uncertainty in nature.

Another argument against tampering with the human genome is that scientists would be experimenting with the unborn without any possibility of obtaining informed consent. Few would argue today that the human genome is optimally suited for the environment we live in. Our somatic and germ cells are exposed to all sorts of mutagens that are the result of human activities including radioactive isotopes, synthetic organic molecules, and increased UV light due to ozone depletion. But on what basis should we believe that human reason is capable of creating a more optimally suited genome by making pin-point changes in a fertilized human egg? How would we explain to a future germ-line enhanced recipient that his diminished cognitive capacity was an outcome of the effort to improve his life expectancy?

Once science reaches the stage where the techniques for modifying the animal genome have been successfully performed on primates, what will determine whether they will be used on humans? How can society separate the pursuit of objective knowledge about the human genome from the exploitation of that knowledge for political, social, or personal power?

Currently, there is a universally agreed upon informal moratorium on human germ-line manipulation. As of yet, no government is reported to have funded experiments which combine in-vitro fertilization with gene modification. However, like the earth's tectonic plates, the normative boundaries are slowing shifting. There is an uneasy balance between scientific interests and public interests. Initially, scientists found consensus in establishing a moral boundary between somatic and germ cell manipulation, where the latter was prohibited by general agreement, and the former would be carefully monitored under human experiment protocols. However, as techniques for animal germ-line modification improved and as the Human Genome Initiative got underway, a new moral position was beginning to take form in the scientific community.

After a scientific workshop was held on human gene therapy in 1986, the National Academy of Science published a book that outlined four principal categories of human genetic experiments: somatic cell gene therapy; germ line gene therapy; enhancement genetic engineering; and eugenic genetic engineering. The goal of somatic cell gene therapy is to eliminate the clinical manifestation of genetically-caused disease on an individual without affecting the individual's progeny. Germline gene therapy is defined as the insertion of a healthy gene into a human egg. Enhancement genetic engineering refers to the modification of single traits in an individual such as the height of a child. Finally, eugenic genetic engineering applies to the alteration of complex traits involving multiple genes such as intelligence and personality. The shift in the moral boundary for acceptable human gene experiments as illustrated by this classification is from somatic/germ line to therapy/enhancement. While there is a scientific basic for distinguishing between the modification of germ cells and somatic cells, the same cannot be said for the distinction between therapy and enhancement (Krimsky, 1990). Does a person who has high sensitivity to chemical exposure possess "defective" genes in need of therapy or should such treatment, were it available, be considered "enhancing the individual"?

Is extreme shortness an indication of defective genes or part of the normal tail in a population distribution? The boundary between normal and abnormal genes is not rooted in science, but is rather a social construction. Any form of germ line modification will have to face this dilemma and as efforts in this direction are intensified, they will be met with the prospect of greater social control of genetics research applied to modifying the human genome.

MULTI-VESTED SCIENCE

Among the four institutional norms of science cited by Robert Merton, the shared value of disinterestedness embodies the moral commitment to leave aside one's personal interest when investigating the laws of the natural world. In the idealized situation, scientists have only one interest in the outcome of inquiry and that is to ascertain the truth or falsity of a hypothesis. Fraud, Merton noted, was virtually absent in the annals of science as a consequence of this widely shared norm. If the sole interest of the scientist is the pursuit of truth, conflict of interest among scientists must be an oxymoron. As in cases of fraud, such conflicts were traditionally viewed as deviant cases that do not negate the near universality of the norm.

Fifty years after Merton published his thesis, the social relations and structure of science research has undergone significant change. In particular, it is no longer uncommon for academic scientists in certain fields to have consulting relationships with industry, to hold stock in companies related to their work, to hold multiple patents from their research, or to be involved in the development of a new company. These changes in the biological sciences started almost immediately after the discovery of gene splicing techniques just as industrial genetics had gotten underway. And with these changes came a rapid transformation of the norms of the biological sciences (Etzkowitz, 1989, 14).

For several reasons, entrepreneurship in the biological sciences created a more intense public response and media reaction than similar activities in other disciplines. This was surprising to many biologists who viewed the commercial possibilities in molecular genetics as analogous to what had happened in chemistry, physics, computer sciences, and many other disciplines that had something to offer industry. The public seems to expect a higher standard of ethical conduct in the health sciences than it does in other fields. Since the major portion of health sciences research in universities is publicly funded, scientific investigators are considered more directly accountable to the public interest than other fields.

Scientific fraud and conflict of interest were the subjects of numerous media accounts in the 1980s. After a series of hearings, Congress highlighted these issues in a report titled "Are Scientific Misconduct and Conflicts of Interest Hazardous to our Health" (U.S. Congress, 1990). The report cited scientific studies compromised by financial conflicts of interest and questioned the ability of the scientific community to set its own standards of professional conduct.

Once remote from commercial linkages, the biological sciences witnessed a rapid and aggressive rush among leading scientists and their universities to capitalize on the financial expectations of biotechnology (Krimsky, 1991; Blumenthal, 1986). Many new firms were started by scientists who retained their full academic appointments. The notion of "disinterestedness" in science was subject to a new critical inquiry. Can a scientist whose research is funded by a drug company be disinterested in the outcome? What about a scientist who is evaluating the safety or efficacy of a product that his company is poised to manufacture? Should a scientist who has equity in a company be required to disclose the relationship in a scientific publication related to the firm's commercial interests?

These questions, once the purview of professional ethics, now are at the centerpiece of public policy. The suspicion of the "disinterested" scientist was expressed best by the action of two major scientific journals: the Journal of the American Medical Association and the New England Journal of Medicine that require authors to disclose consulting and equity relationships related to their research.

The changing social structure of science and the growth of reciprocal and symbiotic relationships between academic research and commercial development has resulted in a new public examination of the moral status of science. Despite efforts within the scientific and medical community to retain internal control of the ethical behavior of scientists, the scope of public accountability has been widening. Issues once deemed to be in the domain of professional ethics, have become issues of social ethics. Swazey (1978, 140) notes: "there has been a progressive shift in the locus of control from within clinical investigation to extraprofessionally or bureaucratically mandated laws and regulations."

Scientific fraud, conflict of interest, intellectual property, experiments with animals and fetal tissue, and genetic engineering are among new areas where governments have begun to take a more proactive role in monitoring the behavior of scientists. These trends do not imply that scientists are less moral than their predecessors. Rather, scientists are embedded in a new system of social relations that blur the boundaries between pure and applied research, between private versus public science, and between inquiry for knowledge and inquiry for profit. Scientists are faced with more choices and are situated in more varied contexts than they once were. Changes in the normative structure of science are reflections of changes in the nature and organization of research (Etzkowitz, 1989, 27).

It is a popular misconception that the autonomy of science is narrowed as external events encroach on its self-governance. (Nelkin, 1984, 93). The concept of "scientific autonomy" in this context is treated as an entitlement that comes along with being a member of the professional guild. Not only is science treated ahistorically in this way but "autonomy in science" takes on an essentialist status somewhat like a theory of natural rights. I would argue that the moral autonomy of science expressed in such terms as "freedom of inquiry" does not precede the social context within which science is carried out but is derivative of it. This means that the normative conditions of science do not make sense apart from the political and economic context within which science is embedded.

Once remote from the affairs of public life, there is much more overlap between the moral domains of science and society. As scientists and their institutional cultures have become more deeply woven into the fabric of society through military research, federal grants, and entrepreneurial affairs, the spheres of normative behavior have been pulled closer together resulting in a recalibration of the boundaries of self-governance. The independence of moral spheres is no longer functional in the new system of relations. Thus, it is not as if the moral autonomy of science is threatened, rather a new concept of scientific autonomy and public responsibility is emerging.

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