Cultures of Science

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1 Introduction

In sociology and political science, one can still find uses of the culture concept in the sense of shared norms and values. Likewise, one sometimes finds the use of the term "culture" as restricted to cultural institutions such as religion and the arts. In contrast, in anthropology and cultural studies the term "cultural" is generally used to refer to the broad systems of meanings that structure and are structured by discourse and practices. Although norms and values may be included in the broader sense of culture, there are two significant differences. First, the idea of culture as systematic structures and networks of meaning subsumes that of culture as norms and values. Second, the view that norms and values are shared and regulative of a group is no longer widely accepted. Instead, norms and values are seen as unevenly distributed and often hotly contested.

In science and technology studies (STS), many scholars use some version of the culture concept in their work. In the sociology of science, Robert Merton articulated a series of norms and values that could be understood as one description of the culture of science (1973). For example, he argued that scientists follow the norm of universalism; that is, they judge each other on the basis of the quality of their work rather than nonfunctional attributes such as physical appearance or social origin. Constructivists criticized Merton's characterization of norms as an occupational ideology that is only evidenced partially in the social action of scientists (Mulkay 1976). Instead, a view has emerged that the systems of meanings and values associated with modern science are contested. In this sense, the constructivist critique of Mertonian norms is consistent with the anthropological concept of culture as understood from the 1970s to the present.

Because the culture concept draws attention to both explicit and implicit semantic and emotional categories that both shape practices and discourse and are modified by strategy and history, all social action includes a cultural component. Some cultural meanings or systems are obviously specific to a geographical region or social institution, whereas others are broader "imaginaries" (or, as an earlier generation called them, "patterns" and "configurations") that can be found across social fields.

2 Overview

This review will use the phrase "cultural analysis" as an umbrella term that covers many different ways in which the culture concept is used in the study of modern science. This section will review five prominent groupings in STS: the cultural history of early modern Western science, the cultural interpretation of science, non-Western knowledges and comparative sciences, lay knowledges and the publics of science, and the culture-knowledge-power nexus.

2.1 Culture as Historical Shaping Factor

Historians and sociologists have long studied the problem of why the form of knowledge that is today recognized as modern, cosmopolitan science emerged in Western Europe after the fifteenth century. Here, the culture concept is used in a comparativist tradition that explores differences in institutions and underlying systems of meaning across geographical regions of the world. The question of the relationship between modern science and early modern European culture situates this type of STS research in the historical sociology of European modernity, a research field that attempts to explain the particular transformations of European societies from the Reformation to the Industrial Revolution and then to explain the ways in which Western European modernity was and was not taken up in other world regions. From this perspective "modernity" in the scientific field is interwoven with historical transformations across other social fields, including the development of corporate capitalism and colonialism, religious pluralism and freedom of conscience, egalitarianism and legal universalism, the transformation of Western gender and kinship relations, the differentiation and autonomization of social fields, and individualism and parliamentary democracy.

Although historians have demonstrated the continuity between early modern European science of the sixteenth and seventeenth centuries with prior centuries of Western and non-Western science, there have also been attempts to distinguish a specifically modern, Western variant of natural knowledge based on principles such as formalism, mechanism, and empiricism. Likewise, historians and social scientists have explored institutional characteristics such as relatively independent universities and research societies in early modern Europe, and they have studied the role of general cultural practices in truth-telling that were important in the formation of scientific research communities (Shapin 1998, Ben-David 1991). Other research shows that although the early modern scientific field in Europe flourished because of some degree of institutional autonomy from the church and state, it also served instrumental and ideological functions, ranging from providing research with applications for military and industrial problems (Hessen 1971) to ideological support of dominant religious organizations (Jacob 1988) and concepts of masculine domination (Keller 1985, Schiebinger 1989).

Michel Foucault's early work (1970) suggests other ways in which general cultural categories enabled and constrained early modern scientific thought. He argued that early modern science was characterized by a shift from the analysis of resemblances, akin to the Renaissance symbolism studied by Frances Yates (1972), to the creation of taxonomies that represented the world in tables of similarity and difference. By focusing on the sciences of life, language, and wealth, Foucault arrived at a more general analysis of early modern science than definitions based on the principles of formalism and mechanism. He also suggested that in the nineteenth century there was a second shift, in which sequences defined by relations among elements became central to the epistemic order. Similar to Hessen's analysis of the transition from the reversible world of Newtonian mechanics to the temporal world of thermodynamics, Foucault developed a general analysis of temporality under the rubric of "succession." One could also extend Foucault's analysis by exploring underlying epistemic patterns of subsequent periods, such as the emphasis on equilibrium and closed system dynamics in the modernist sciences from the late nineteenth to the early twentieth centuries (including empiricism, functionalism, and structuralism), and the growing emphasis on self-organization and open systems in the second half of the twentieth century (Hess 1995).

2.2 Cultural Interpretation of Science

A second use of the culture concept in STS involves the cultural interpretation or critique of science. One might think of this use of the culture concept as a type of comparativism but not focused on the problem of the origins of modern science. Instead, this type of cultural analysis studies the language of scientists in comparison with that of other scientists or with general cultural codes. The interpretation of meanings involves mapping symbols or signifiers, often using techniques developed in structuralist anthropology and linguistics but generally less formal than in the structuralist anthropology of the 1960s and 1970s.

The cultural interpretation of science includes the study of the relationships between semantic distinctions employed in scientific thought and the broader cultural meanings associated with those distinctions. For example, gendered cultural codes were evident in the relationships that biologists developed for the "master molecule" theory of genetics, that is, the assumption that the DNA in the nucleus produces the RNA that produces protein. Biologist Barbara McClintock challenged the master molecule view by arguing for a reverse causal pathway from the environment to the gene, a view that has been associated with her social position as a marginalized woman scientist (Keller 1983). Likewise, in the 1930s the African American marine biologist and embryologist Ernest Everett Just developed a model of the cell that favored the role of genes in the cytoplasm of the cell. The position was related to broader conflicts between embryologists and geneticists and to a longer history of controversy between nucleocentric and cytyoplasmic approaches to inheritance. Gilbert suggested that for Just the issue had additional meanings due to his position as an African-American scientist with a life history of suffering from racist treatment (Gilbert 1988, 1989).

The cultural interpretation of science can also include studies of the impacts of new theoretical concepts, methods, and technologies on broader cultural codes. Donna Haraway (1991) deployed the image of the cyborg (a hybrid of human and machine) to describe the breaching of traditional cultural boundaries, including those of human and animal, organism and machine, and physical and nonphysical that have occurred with the sciences of the late twentieth and early twenty-first centuries. Likewise, Sarah Franklin and Margaret Lock drew attention to the "new forms of life and death" such as cloned sheep, transgenic mice, immortal cell lines, and brain-dead bodies (2001). In the new cultural understandings of biology, descent has lost some of its primacy of place for the construction of biological relationships. Even the biological sciences have increasingly recognized that the swapping of genes across species boundaries, a feat of modern technoscience, also occurs among some bacterial species.

2.3 Non-Western Knowledges and Comparative Sciences

Another significant area of cultural analysis involves the study of the relations between Western science and other knowledge systems. From this perspective the Scientific Revolution of sixteenth- and seventeenth-century Europe was only a phase in the ongoing exchange of Old World knowledges among Europe, the Middle East, and Asia, which accelerated with the European conquest of Moslem territories in the eleventh century. Studies of the circulation of knowledge in Old World societies prior to the Scientific Revolution in Europe suggest that the global centers of learning and knowledge innovation were located in different places, from China and India to the Middle East and Europe, and the cycle may be shifting back to Asia (Harding 1998, Hess 1995, Prasad 2012, Raj 2007).

One can draw a hasty conclusion from the literature that although non-Western Old World sciences influenced early modern Western sciences, the latter soon became separated from the other knowledges due to their increasing reliance on experimentalism and the formalism of mathematical and mechanical models. To borrow a phrase from Karl Marx (1977), there was a primitive accumulation of scientific knowledge as colonial expeditions captured and translated the other knowledges of diverse societies and brought them home. In some cases, the colonization of other knowledges was quite systematic and intentional, as occurred in the scientific expeditions that accompanied Dutch colonists in the New World. Although in laboratory-based, formal sciences the primitive accumulation became less important over time, the interaction between non-Western knowledges and cosmopolitan scientific knowledge has continued in other sciences and in technology development (Eglash et al. 2004). For example, pharmacological research has benefited from the continual mining of local ethnobotanical knowledges, and likewise there are ongoing exchanges between scientific psychologies and those associated with Asian religious traditions.

Another aspect of the comparative study of sciences involves differences within cosmopolitan, modern science across world regions, such as Japanese and American physicists (Traweek 1988) or primatologists in India, Japan, and the West (Haraway 1989). This work has led to understanding of different cultural styles even within transnational research fields, and it has shown how theoretical concepts, methods, and choices of problem areas vary across national research communities.

2.4 Lay Knowledges and Public Engagement

Another area of research with respect to the cultures of science involves the study of lay knowledge, which can be mobilized into alternative perspectives on mainstream scientific knowledge through social movements. The topic again can include cultural analysis by focusing on the meanings that scientific knowledge has for both individual lay publics and mobilized lay publics.

One issue that emerges in the study of lay knowledges and lay publics is the differential value placed on some areas of scientific research. STS researchers have shown that social movements can play a role not only in stopping some kinds of scientific research (such as weapons research) but also in encouraging new research fields to grow and prosper (Hess 2007, Jamison 2001). Scientists have also responded to general social movements by founding new research fields or public-interest organizations that attempt to shift the boundaries of scientific research in directions that address social problems raised by social movements (Moore 2008). As a result, the political meaning of scientific research to scientists can change as a result of their interactions with lay publics and social movements.

The generative dimensions of social movements and the public engagement with science are especially evident in movements that are focused on the design and diffusion of new technologies and products. For example, industrial opposition movements, such as the movement against genetically modified food, seek to stop a particular technology or design from broad diffusion. Although they rarely achieve a full moratorium, such movements often trigger design changes and innovation as industry responds to movement demands. Furthermore, industrial opposition movements are frequently connected with support for an alternative technology, because it is difficult to have a credible social change agenda of opposition if one has not also articulated an alternative. In some cases the alternative technologies develop from lay knowledge and do-it-yourself cultures. Both industrial opposition movements and alternative technology movements can generate scientific and technological innovation (Hess 2007).

One concept that has emerged in the political sociology of science and public engagement is “epistemic modernization.” The term describes the increasing legitimacy that social-change organizations have in their relations with scientists and policymakers. The result of the increasing legitimacy is the inclusion of new perspectives in the definition of research problems and the construction of concepts and methods. The scientific field, like elections and courts, becomes a battleground in which social conflicts in the broader society both shape outcomes and are shaped by it (Moore et al. 2012). The historical changes imply that although organizations outside the scientific field increasingly recognize the importance of scientific research and associated technological innovation, their increased interest in science has also coincided with a decline in the capacity for scientists to control the representation of scientific knowledge outside the scientific field and the agenda-setting politics within it. Kelly Moore (2008) referred to the change as the “unbinding” of scientific authority from scientists. In other words, it is increasingly legitimate for industries, governments, and social movements to have their views about desirable research agendas and even to have their own experts who represent their views. Here, the cultural analysis of science points to long-term changes in the way publics perceive the scientific field and the way in which the scientific field changes in response to public engagement.

2.5 Culture, Knowledge, and Political Power

Another type of cultural analysis of modern science involves the study of how modern science and technology have affected political power and political culture. These studies can be considered to include cultural analysis because they attend to changes in the underlying systems of meaning and values that are have emerged in the relations between the political field and modern science and technology. Two examples of this kind of approach will be reviewed here: the risk society and biopower.

Although Ulrich Beck’s (1992) work may not generally be thought of as cultural analysis, it does focus on underlying changes in systems of meaning that guide political discourse and practice. He argued that the problems of modern society had created a new type of human-generated risk in comparison with the risk of natural disasters (bad weather, disease, etc.) of previous historical eras. The modernist optimism that science and technology are capable of solving technical and social problems has dissipated with the recognition that they also have generated increasing risk and danger, such as problems that have arisen from toxic exposure and greenhouse gases. Furthermore, the solutions to technological problems have also created second-order problems, many of which have become intractable. For Beck, the problem is caused by a technocratic or scientistic form of modern politics, which has tended to privilege the role of experts in public policy and to use expertise to foreclose broader political debate. Scientific and technical expertise becomes both more important to politics and more contested. The analysis of the risk society is intended to open up the conditions for a revitalized democratic politics that questions the privileged position of expert knowledge and enables decision-making that includes lay perspectives and greater public participation.

Michel Foucault (1976, 1980) developed another influential approach to the problem of how science and technology have transformed politics. He argued that political power before the modern period of European history was largely negative in the sense that it was based on the principle of subtraction, that is, the government's right to take away life and property. Doctrines of human rights and the rule of constitutional law that emerged in early modern Europe placed limits on the traditional concept of sovereign power. In its place, a more generative form of power emerged with the purpose of administering and governing life. This form of power had two poles: disciplining the body and regulating the population. The use of spectacle, such as the public execution of criminals, to support power was displaced by surveillance and discipline, which regulated choices and channeled behavior. Likewise, the governing mentality shifted from the sovereignty of the prince to the provider of prosperity via political economy. A wide range of sciences, technologies, and techniques emerged to support and define this new form of power. Foucault's work therefore drew attention to the sciences of population, psychiatry, psychology, economy, and administration as central to the new, modern form of power.

Work by anthropologists and cultural studies scholars on biology and society have extended Foucault's analysis of power by exploring how the biopolitics of both the management of populations and the individual techniques of bodily health changed in the early twenty-first century, specifically as a result of the new knowledges and technologies associated with molecular biology and genomics. For example, Paul Rabinow suggested that surveillance has undergone diversification from the policing of groups and individuals marked as dangerous or ill "toward projecting risk factors that deconstruct and reconstruct the individual or group subject" (1996: 100). Like Beck, Rabinow draws attention to the problem of risk that is generated by new knowledges, but for him risk factors reorder human populations and identities and also suggest new behavioral norms and medical interventions. Whereas Beck focused on the breakdown of the capacity of institutions to respond to technological risk and uncertainty, Rabinow placed more attention on the responses of populations to new categories of risk, such as genomic knowledge of risk factors of individuals for diseases. As in the work of Franklin, Locke, and other anthropologists who study the effects of new knowledges on cultural categories, Rabinow explored how new knowledge reshuffles biological categories of human populations and social identities. As a result, advocacy groups have formed based on people who have no other relationship than sharing a particular gene associated with a disease.

3 Problems

Of the many ongoing problems and issues explored by scholars in the cultural analysis of science, this section will focus on three examples that suggest different approaches to the cultural analysis of modern science and technology: ignorance, scientists and publics, and molecularization.

3.1 Ignorance

Scientific ignorance can include positive non-knowledge such as future research agendas, negative non-knowledge such as areas of research deemed unimportant or unworthy of study, and nescience, or areas of knowledge that can only be known in retrospect after a surprise (Gross 2009). One example of the study of ignorance in science is “undone science” as a form of negative non-knowledge. Undone science is the systematic tendency of the scientific field to produce lower levels of knowledge deemed valuable by public-interest organizations and grassroots social movements (Frickel et al. 2010). Sometimes local, lay, or non-Western knowledges serve as the basis for the identification of undone science. For example, community groups may have local, lay knowledge about toxic exposure and its possible connections with disease that are ignored by industrial organizations and public-health officials. Likewise, non-Western and alternative-medicine practitioners utilize a set of concepts, herbal interventions, and psychospiritual techniques that are considered negative knowledge within the biomedical research field. As a result, studies of non-knowledge and nescience are connected with work on non-Western and lay knowledges.

Studies of ignorance have implications for STS work on policy, especially attempts to change the technocratic tendency of policymakers and scientific advisors to underestimate nescience and focus instead on quantifiable and narrow interpretations of ignorance such as risk (Wynne 2008). The technocratic approach to ignorance tends to underplay public concerns with unknown side effects and dangers that could occur with new technologies. Research on undone science also tends to highlight how social movements and civil-society organizations more generally seek changes in research agendas to reflect public concerns about issues such as safety and environmental impacts.

Research on aspects of ignorance such as undone science are examples of the cultural analysis of science in the sense that they attend to knowledge that does not exist. Whereas a traditional form of the cultural analysis of science focuses on existing scientific knowledge and associated technologies, this approach draws attention to the systematic construction of absences of knowledge and, in the case of nescience, the discovery of ignorance through surprises. The work also draws attention to the construction of boundaries between desirable and undesirable knowledge and between the known and unknown. It therefore opens up the cultural analysis of science to a cartography of knowledge and ignorance.

3.2 Scientists and Publics

Another problem area in the cultural analysis of science involves the study of the relations between scientific knowledge and knowledge associated with lay publics. For example, scientific researchers sometimes form partnerships with lay organizations when they deploy the methods of community participation in the design and execution of research projects. For some areas of environmental and health research, the issues are so sensitive that ethical research protocols require considerable community participation. As a result, scientists negotiate research protocols with community members, and they may also negotiate research questions and some of the methodology (Brown 2007; Farkas 1999, 2002; Leydesdorff and Ward 2005; Walchelder 2003).

Close to community-based research but somewhat distinct from it is a kind of research that involves social movement organizations or other advocacy organizations that convince scientists to take up a research problem that they identify as of particular interest. As Phil Brown and colleagues (Brown et al. 2004, Brown 2007) have explored, one prominent example occurs with patient advocacy groups that struggle to gain recognition for a presumptive disease that is not recognized by the dominant networks of the health-care and biomedical research fields. There are tremendous opportunities for scientists who undertake such research, but there are also career risks that accompany a choice to document a syndrome or disease that may be scientifically controversial. The relationships that emerge between scientists and advocacy organizations can come together in what Brown and colleagues call "boundary movement" organizations that enable coalitions of citizens and scientists to form. The relationships often require negotiation, and the resulting research project can involve what Adele Clarke calls a "quid pro quo" arrangement in which advocates and scientists reach a compromise on the research agenda (Clarke 1998, 2000). As she has shown in her study of the negotiations between birth-control advocates and scientists, the two may negotiate a research problem that satisfies the scientists' needs for research that has value in their research field and that also satisfies, at least partially, the goals of advocates for better contraceptive technologies. Scientists also respond more generally to concerns raised by social movements by forming public-interest science organizations or starting new research fields such as environmental toxicology (Moore 2008, Frickel 2004).

Where advocacy organizations have the funding to sponsor the research, they can exhibit considerable control over the research agenda. In some cases they have won positions on funding panels and the governance of research funding (Epstein 1996). In the relatively large and wealthy organizations associated with social movements, such as the mainstream environmental organizations in the United States, it is financially feasible to sponsor research and even hire scientists to work as staff. The resulting "civil society research" can include peer-reviewed publications by scientists who serve on the staffs of environmental organizations (Hess 2009).

Although activist and advocacy groups, as well as broader social movement organizations, often want to see more research done to answer questions of undone science, they have also emerged to criticize or stop research. For example, antiwar groups have mobilized to try to convince scientists not to undertake some kinds of scientific research, animal rights groups have mobilized to try to stop some forms of research with animals, and religious groups have opposed stem-cell research. Here, the role of activist and advocacy groups, or more generally civil society organizations, is to identify unwanted science and to open up public debate about the desirability of reducing or eliminating research in some fields. Such interventions are often highly antagonistic and unwelcome, especially when scientists see their work as in the public interest. For example, scientists involved in biomedical research often use animal subjects, and they have been threatened by animal rights groups. In some cases, the more moderate groups work with scientists to negotiate standards for more humane treatment of animals in the tradition of certification movements mentioned above (Frickel et al. 2010; Moore 2008; Gusterson 1996, 2004; Kempner et al. 2005).

Whereas a traditional approach to the cultural analysis of publics and sciences would involve interpreting the systems of meaning of lay publics, either in their lay knowledges or in their understandings of scientific knowledge and technology, this problem area has drawn attention to the agency of publics and the interactions of scientists with their publics. It suggests a continual trafficking of knowledge between lay publics and scientific researchers rather than a simple appropriation of lay knowledge or a simple diffusion of scientific knowledge from experts to publics.

3.3 Molecularization

An example of a current problem in the cultural analysis of biopower and science is the study of molecularization. Paul Rabinow and Nikolas Rose have become known for advancing the study of biopower by arguing that is has become “molecularized,” that is, inflected by biotechnologies and genomics. This problem area provides an example of the cultural analysis of modern science and technology that builds on the previous work of Foucault but extends it to include biotechnology.

As Rose argued, old biopolitical strategies that focused on the hygiene of the population and eugenic interventions into its reproduction have been replaced by individual responsibility for personal health. In turn, the molecularization of populations coincides with the decline in the responsibility of the state for individual welfare and the neoliberal emphasis on self-responsibility. For example, patient groups self-organize to enhance the responsibility of patients for the course, treatment, and policies related to their diseases. Biopower has become postdisciplinary or at least less disciplinary in the sense of shedding the surveillance and disciplining functions of the older forms of biopower (Rabinow and Rose 2003, 2006; Rose 2001).

In a qualification of the molecularization thesis, Sujatha Raman and Richard Tutton (2010) argued that the monitoring and control of population have continued to be an important aspect of biopower, such as in the control of infectious diseases. They added that molecular knowledges and technologies are also enrolled in the population-oriented programs of nation-states and transnational organizations. They also argued that patient groups and social movements have adopted positions against biomedicalization and do not always fit the model of self-responsibility. They argue instead for an approach that attends to the obduracy of structure, the implications of biopower for the reproduction of inequality, and the continuity of population-based approaches to biopower.

Both approaches suggest how the cultural analysis of science and technology is changing as a result of attention to the new problems raised by molecular technologies. The work is cultural in the sense that it attends to underlying systems of meaning and values that are associated with personal practices, biomedical institutions, and public policies.

4 Summary

The study of the cultural aspects of science is quite broad with tendrils that involve the history of science, feminist and antiracist science studies, and the public understanding of science. A common ground is a comparative perspective that begins with the assumptions, research agendas, concepts, and other aspects of a scientific research field and then explores the explicit and implicit meanings embedded in those practices through comparison with another perspective. The other perspective can be from within the general scientific field (such as another discipline or science in another country, or science by men and by women), or it can be from outside the scientific field (such as lay knowledge, a broader cultural code, a non-Western knowledge system, or the perspectives on research agendas offered by mobilized publics). However, much research in the cultural analysis of science goes beyond a comparison, either explicit or implicit, to the study of interactions and communication across cultural divisions. Those interactions result in new hybrid knowledges and scientific innovation. When practiced with discipline and caution, the cultural analysis of science can also bring out hidden assumptions and meanings that scientists themselves may not recognize, and it can provide new perspectives on research agendas by pointing to areas of undone science.

5 References

5.1 Suggested Reading

here is no single best journal, author, or collection of essays for the cultural analysis of science. Instead, one is best making a selection about what kind of use of the cultural concept and what kind of problem is most interesting, then following out the sources cited in this essay. Of general value are the English-language handbooks of STS (Hackett et al. 2008, Jasanoff et al. 1994).

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