Lecture 17
Science, Culture and Society: Meanings, Interests, Values and the Modern State – Part I

A newly invigorated synthesis is under way in science and technology studies (STS), one that gives as much attention to broad sociological questions concerning organizational, institutional, and state forms of power as it does to more micro-issues raised by the focus on epistemological questions. The effort has been evident for some time in the work of a wide range of STS scholars, such as Bruno Latour, John Law, Steven Shapin, Karen Knorr-Cetina, and Donald McKenzie. It is currently reflected in organizational studies (for instance, the work of Diane Vaughan), in the sociology of science (for instance, the work of Thomas Gieryn), and in analyses of socio-technical networks. More recently, Sheila Jasanoff and others have laid out an expansive research agenda around the theme of the "co-production of science and social order." Such work is not only forging productive dialogue between STS and broader sociological traditions but also opening up opportunities to reconnect with earlier research that has much to offer contemporary social scientists.

As well as Merton's early work on the institutionalization of a new technology-centered science in seventeenth-century England, and Boris Hessen's work on the relationship between Newtonian mechanics and industrial capitalism, Edgar Zilsel's "The Sociological Roots of Science" has generated a great deal of renewed interest. Originally published in 1942, Zilsel's article was reprinted in 2000, with commentary, in *Social Studies of Science*. Zilsel linked the development of capitalism directly to the birth of the new experimental science in the sixteenth and seventeenth centuries, suggesting that the rise of craft knowledge with respect to literary knowledge created a new synthesis of theory and practice. Zilsel's analysis centrally informs my elaboration of the concept of engine science, since it shows the importance of the *integration* of practical mathematics (mechanics), engineering, and theory in the development of a specifically modern and crucially Baconian science. The idiom *engine science* foregrounds ingenuity and design, material technologies of inquiry, and power and control as key to the success of the new science. However, while Zilsel suggested that the new synthesis resulted from a "breakdown of social barriers." An aristocracy of the intellect eventually subordinated engineering to theory, viewing the latter as the wellspring of scientific knowledge and the former as its "mere application." But STS has shown that abstract theory and practical engineering stand in a dynamic and dialectical relationship in modern scientific practice, that the power and success of modern science lies in this relationship, and that it is a relationship crucially mediated by the language of mathematics. Science is no longer conceived in terms of purity (the idea of "pure science") and is not reducible to any one of these three key elements, each of which at any moment in history is a specific and semiautonomous cultural formation. The conceptualization of science as "impure" opens up new ways of thinking about the question of the relationship between science and the

state. The purpose of this chapter is to introduce my conceptualization of that relationship, explain how a cultural analysis of science reveals the unique character of *modern* states, and discuss the implications for how we thing about the state.

Science, Culture and Causality

Science is a transformative collective activity rooted in local communities of meaning and extended over time through various strategies and technologies to the level of a social movement and social institution. Collective action in the domain of science confronts certain problems with respect to more explicitly political organizations, unfolding within a moral economy that constantly reconstructs its past in the face of immediate obstacles. In this process science constructs an ideology of legend, remembering its past in terms of heroic and stoic individuals struggling against irrationality, ignorance, and obfuscation. Local articulations of what science is and what it offers emerge in relation to wider social conditions, not least of which are the demands and expectations of statecraft and the need for any particular vision of science to secure the blessing of government (no matter how begrudgingly). As political power was centralized in the early modern state, scientific practitioners were confronted by new limitations and opportunities. Experimentalists were forced to defend their natural philosophy against philosophical, political, and religious enemies, but they did not do so simply in the negative sense of resistance. The early experimental philosophers actively pursued new opportunities to align their designs with religious precepts and political realities. They spoke of mathematics as the language of God, and of God himself as a designing engineer. They offered up scheme after scheme for the "Empire of Man over Nature," and more specifically for the aggrandizement of the state and the invigoration of economic development. Their capacity to deliver on these claims in the short term is not the issue here: the point, rather, is to explain how the culture of the new science moved from a local form of collective action to an institutionalized culture that caused the emergence of a state form that was without precedent in world history.

Triangulating Culture: Discourse, Practice and Materiality

All three dimensions of cultural formation – discourse, practice and materiality – can be granted their peculiar agential power, though in a manner, and this is a crucial point, that does not theoretically subordinate one dimension to the other.

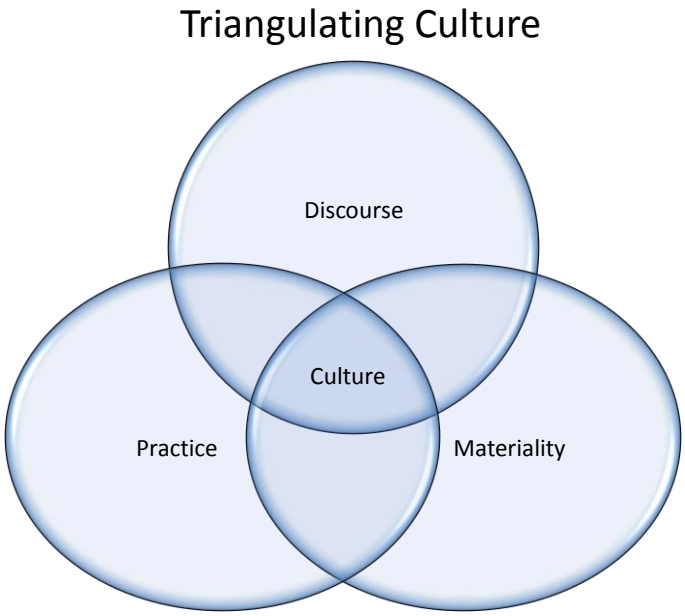

Figure 1: Triangulating Culture

The relative agency of discourse (symbolic meaning, representation, and cognitive structure), practice (social activity variously organized), and materiality (constructed environments, spaces, and technologies) in processes of cultural formation can be treated as an empirical issue to be settled in each case by research. The Royal Society of London (1660), for instance, is an organizational form of collective action that mobilizes resources and becomes a powerful catalyst of new webs of discursive meaning. But in the approach I am proposing, culture does not thereby become secondary to organized action and resource mobilization. Rather, organizational culture becomes the primary agent with respect to the growth and institutionalization of meaning in a particular context and at a particular moment in history, for example, as it did in England in the 1660s. The collective action that led to the organization of the Dublin Society (1683), on the other hand, can be better understood as an organizational instantiation born of meanings that were already becoming institutionalized. In the English case, the organization was the forcing house of meaning; in the Irish case, the organization was established more through what DiMaggio and Powell call "mimetic processes." As I hope will become clear, these distinctions are particularly important if one wishes to understand the

material dimensions of science and the state. Figure 1 seeks to illustrate the distinctions in terms of *centers of gravity*, an analytic concept that maintains reference to embeddedness and internal relatedness.

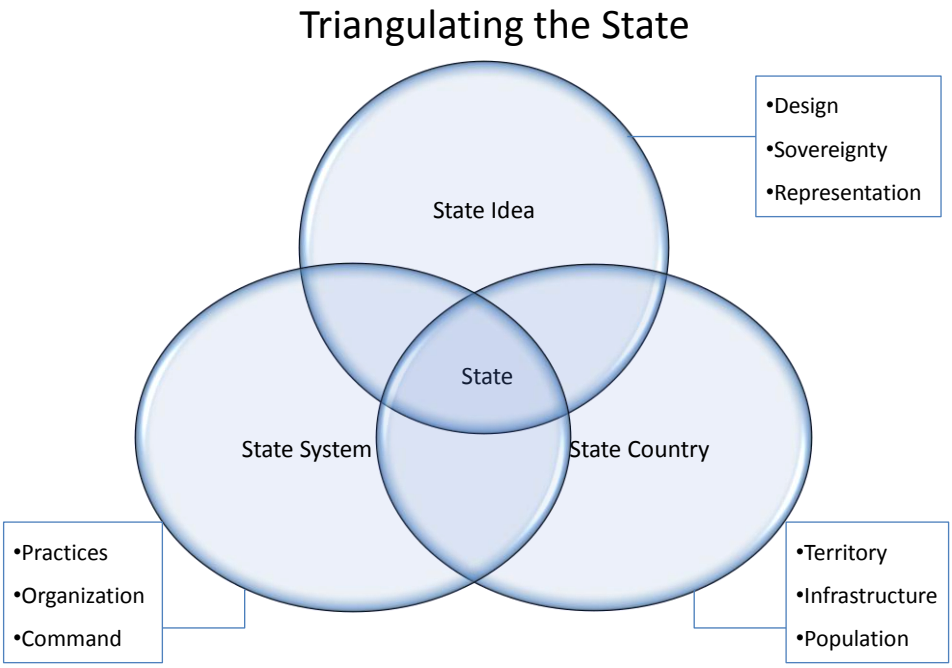

Figure 2: Triangulating the State

I should perhaps anticipate a likely criticism: that by expanding the concept of culture beyond the bounds of the cognitive or discursive in order to include practice and materiality, I have drained it of any specific theoretical efficacy. Or to put it another way, making culture embrace everything ensures that it can explain nothing. The solution cannot avoid either ontological or epistemological issues. Ontologically, it seems impossible to conceive of practices (variously organized) as anything but cultural.

Skill, and the tacit knowledge that goes along with it, is a revealing example. Developing an observation made by both Michael Polanyi and Thomas Kuhn, Harry Collins has demonstrated that not only is tacit knowledge distinct from abstract knowledge in that it is acquired in practice rather than through formal communication, but also in many cases it is in principle impossible to communicate other than through practice. One cannot learn, for instance, to be a carpenter or surgeon from a book. Knowing how much pressure to put on a knife in order to cut through the skin of a body without cutting too deep and causing damage to organs is a knowledge that can be gained only by practicing with actual materials. Thus, practice must have its own cultural agency; it must be a form of communication that is embodied and tactile, experiential in the most material sense of the term.

With respect to the material world a similar argument can be made. The material world created and transformed by cultural discourses and practices (institutionalized and organized)—whether tools, instruments, engines, buildings, landscapes, and so on—is indisputably cultural, not simply in the meanings such a world has for social actors, but also because humanly transformed materiality embodies cultural designs, aspirations, and objectives, materializing and structuring discourses and practices. Lyn Lofland, for instance, illustrates how the materiality of an urbanscape exerts power over social interaction, structuring action in ways that could not be achieved by purely symbolic means. Similarly, Chandra Mukerji has demonstrated the importance of the material culture of Versailles in the construction of Louis XIV as the Sun King and indeed of France as a new Rome. It was not simply that the gardens functioned as a symbol but also that they served as forces that structured interaction in a manner that served symbolic articulation. And Susan Davis has shown how the great thoroughfares of modern cities provided the material conditions of possibility for the development of disciplined "parades" and "demonstrations" as new forms of political action.

The point I wish to make here, however, is that I do not advocate a conceptualization of culture that uniformly and homogeneously applies to "everything."While from an ontological perspective it is impossible to deny the internality of culture with respect to practice and humanly transformed materiality, analytically useful distinctions can still be maintained. Applied to the state, the triangulation method results in distinctions/connections among the state-idea, the state-system, and the state-country.