FOUCAULT AND THE NATURAL SCIENCES

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1. Introduction

The philosopher who would look to Michel Foucault's investigations of the prison and sexuality for insight into the natural sciences confronts several initial obstacles. Foucault's own concerns were explicitly focused upon what he once called the "dubious disciplines," psychology, sociology, and other fields whose status as sciences have been fiercely contested; he aimed to produce "a genealogy of the modern soul" (DP 29). When explicitly asked whether his studies of power/knowledge might extend beyond the human sciences, Foucault was guarded. In a 1977 interview, for example, he said,

> if, concerning a science like theoretical physics or organic chemistry, one poses the problem of its relations with the political and economic structures of society, isn't one posing an excessively complicated question? Doesn't one set the threshold of possible explanations impossibly high? (PK 109)

Later, he seemed to draw distinctions between power, which characterizes actions upon the actions of others, and "capacities," which denotes knowledge and control of things (SP 217-19, WE 47-49). This suggests that Foucault accepted that there are important differences between the natural and the human sciences as more or less unified epistemic and political practices. Gary Gutting has recently suggested quite persuasively that, "with regard to the well-established natural sciences, Foucault seems content to accept the approach of Bachelard and Canguilhem" (1989, p. 255), an approach which does not problematize the practices which organize disciplined investigation, in the way that Foucault's own studies do.

Apart from his own intentions, Foucault's theoretical position poses further obstacles to extending his analyses much beyond the specific epistemic regimes which he targeted. He claims not to offer a <u>theory</u> of power, such that the domain of the theory might be expanded by appropriate arguments. Nor does he provide any general account of knowledge, whose scope might include knowledge of things along with self-knowledge and knowledge of others. Foucault self-consciously presented what he called an "analytics" of power/knowledge, which, once again quoting Gutting,

> treats questions of scientific rationality in "regional" terms, eschewing grandly global theories for specific studies of particular disciplinary and chronological domains. (1989, p. 53)

Foucault was highly suspicious, for both political and epistemic reasons, of theorizing which tried to escape the bounds of particular historical configurations.

Despite these initial obstacles, however, I remain convinced that Foucault's discussions of knowledge and power offer important suggestions for how to approach the natural sciences philosophically. Before we give in too readily to the contrary considerations I have just mentioned, it is worth remembering that Foucault's genealogies also problematize any conception of the "human" or of the "subject" of representation and action, such as might ground a principled distinction between the natural and human sciences. Foucault's own studies frequently cross over into aspects of the life sciences which confound any attempt to distinguish sharply human from natural science: anatomy and physiology, taxonomy, and clinical medicine. In any case, a strong epistemic or political distinction between nature and society would clearly be subject to the central motivating question of Foucault's work: "in what is given to us as universal, necessary,

obligatory, what place is occupied by whatever is singular, contingent, and the product of arbitrary constraints?" (WE 45)

But clearly the most important question to be asked is what we would gain in adapting Foucault's discussions of strategies of power and knowledge to try to understand the modern sciences of nature. If such adaptation provides no illumination, the question of its possibility is of little interest; while if it does advance our understanding, objections in principle may be plausibly brushed aside. I have already argued in some detail elsewhere (KP, chapter 7) that Foucault's genealogies of power/knowledge can be effectively mobilized to disclose specific features of the practices of the natural sciences and their political engagement. In this paper, I will raise two further considerations which were at best implicit in my earlier discussion. First, I will claim that Foucault's critique of the problematic of sovereignty in political theory has an important parallel in epistemology and philosophy of science. Second, I will argue that Foucault points philosophy of science more effectively toward a dynamic understanding of knowledge. Together, these two themes promise a significant reconceptualization of knowledge.

2. Knowledge and Power Revisited

To see the point of this reconceptualization, I first need to recapitulate and extend some of the argument from Knowledge and Power. Although "modern" science has its canonical origins in the Copernican Revolution and its Newtonian consolidation, I looked to the "Baconian sciences" of chemistry, electricity, heat, life, and earth, which came of age in the 18th and 19th Centuries, for a crucial transformation which paralleled Foucault's discussions of more dubious sciences.[1] Foucault had emphasized the interdependence of the discursive practices of criminology, psychiatry, pedagogy, and the like, with the nondiscursive disciplinary practices which made their objects of study newly available for investigation. I argued that the discursive and theoretical practices of these new sciences were inconceivable without the manifold phenomena made available through the construction or isolation of controlled "microworlds" in laboratories, clinics, and field sites.[2] The subsequent advances of science in almost all fields involved the novel construction or refinement of phenomena as much as the theoretical modelling which more typically engages philosophers of science; indeed, I insisted upon the mutual reinforcement of theoretical and experimental practices.

The parallels were close between the intertwining of discursive and nondiscursive practices in the natural sciences and the disciplines which were the focus of Foucault's studies. In both cases, a change in scale was crucial, as objects and events were opened to far more detailed scrutiny in their behavior and microstructure. Such detailed understanding was the consequence of new forms of surveillance and tracking of things, coupled with the careful

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1. Although I disagree on significant issues with their more philosophical conclusions, Shapin and Shaffer [1985] give an excellent historical account of Robert Boyle's work on the air pump as one of the earliest significant such "Baconian" developments.

[2] I use "phenomena" in the special sense suggested by Hacking [1983], in which phenomena are clear, discernable, and reliable manifestations in the public world, whether found or made.

documentation and retrieval which made knowledge accessible and control relentless. Typically these surveilling practices were applied to things enclosed, partitioned, separated, and purified to manifest new forms of behavior or old forms more strikingly. Their classification and theoretical articulation was in accord with these various dividing practices, which produced standardized or normalized objects with patterns of deviance and distortion. The objects of investigation do not remain docile and silent, whether in the disciplines studied by Foucault or the natural sciences. They are constrained to produce signs, which are to be validated in authoritative interpretations. The Catholic and psychoanalytic confessionals were Foucault's classic cases of forced signification, but the natural sciences have also produced myriad ways in which things are forced to "speak." In the book, I suggested the examples of radioactive labeling, cloud and bubble chambers, X-ray crystallography, and the various forms of chromatography, spectroscopy, microscopy, and telescopy, but the inventiveness of scientific work has proliferated such techniques well beyond these classic cases. On the one hand, such practices enable things to reveal themselves, but on the other hand, these disclosures only count as genuine within the authoritative interpretive constraints which distinguish data from artifacts or noise.

In my argument, laboratories and field sites thus joined prisons, asylums, hospitals, barracks, factories, and schools as disciplinary "blocks" from which new forms of knowledge and constraint emerged together. But the emergence of these practices from their relative isolation within such blocks is an important part of their constitution as bearers of knowledge. How do the capabilities and phenomena disclosed in laboratory manipulations come to count as knowledge of things which circulate (often in quite different guise) in other contexts? I argued, in effect, that the extension (in the semantic sense) of scientific concepts and theories is predicated upon the achieved or promised extension (in the spatiotemporal sense) of experimental capabilities beyond the laboratory.[3]

To understand my point, it is useful to see its connection to a more familiar view about the content of scientific theories. Thomas Kuhn, Nancy Cartwright, and Ronald Giere have all argued that the content of theories cannot be adequately expressed propositionally, but is instead located in models (Kuhn's "exemplars") which explicate the theory by showing what it says about various kinds of situation. Understanding the theory is knowing how to extend the canonical models in an indefinitely open way; the range of possible extension of the models is the extension of the theory.[4] What I add to this view is the claim that the elements of the theoretical models are only attached to real objects through laboratory disclosures and the ability to extend or project them into the world. This semantic achievement is often overlooked, but it is crucial to the intelligibility and epistemic success of science, and is often problematic, as several influential studies have shown. Thus, for example, Ludwik Fleck documented the complex achievement through which a condition of the blood made manifest in the Wasserman reaction

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[3] In chapter 5 of my [1987], I argued that the resulting view of semantics and ontology is not antirealist, but rather undercuts the presuppositions shared by scientific realism and the standard instrumentalist and constructivist antirealisms. This argument is too long and complex to reproduce here.

[4] Kuhn [1970], Cartwright [1983], Giere [1988].

came to count as knowledge of syphilis, and Bruno Latour traced some of the struggles required for Pasteur's cultures of bacilli to represent anthrax.[5]

There is a further parallel here between natural scientific knowledge and Foucault's study of power/knowledge in the prison which I failed to recognize in Knowledge and Power. Foucault noted that "prison 'reform' is virtually contemporary with the prison itself: it constitutes, as it were, its programme" (DP 234). The systems of knowledge and constraint which constitute and control delinquency have always fallen far short of their goals; and the prescription for reform, Foucault notes, has always been more of the same. Failures represent the inadequate extension or improper use of the normalizing practices which govern incarceration and constitute delinquency as an object of knowledge; more complete knowledge, and more detailed normalization will supposedly rectify its shortcomings. Now there may seem initially to be a sharp contrast in this respect between natural scientific knowledge and the disciplines which make up the field of criminology. The history of natural sciences and laboratories is comparatively one of success, such that the standardization of scientific phenomena is not typically marred by any kind of "recidivism." But once we recognize that even natural scientific knowledge is constituted by a promissory extension of its laboratory-based capabilities to any objects or events within its projected domain, the analogy reappears. For the projected solution to any failures is always more research, and more stringent application of the procedures through which things are made scientifically accountable. The adaptation of the laboratory and the re-formation of the world to become more thoroughly knowable scientifically are as intrinsic to the natural sciences as social and institutional reforms have been to the prison.

When we recognize the semantic and epistemic significance of this extension of disclosive capabilities outside of various disciplinary blocks, laboratories included (what Foucault once called the "swarming" of the disciplines (DP 211-212)), we can see how the interweaving of knowledge and power runs through the natural sciences as well as the dubious disciplines. Extending knowledge outside the context of the laboratory typically requires also extending the materials and practices which made possible the disclosure and tracking of laboratory phenomena. The world we inhabit is riven with enclosures, partitions, and purifications, marked by measurements, counts, and timings, and tracked by new forms of visibility, documentation, and accounting, all in order to make scientific knowledge possible. The things within it have become analyzable and interchangeable stocks of resources, and our dealings with them have become more tightly coupled and interactively complex.[6] Both the configuration of our political life, and many of the conflicts which arise within our politics, are shaped by these practices which are part of the growth and reaffirmation of natural scientific knowledge. Or so I argued in Knowledge and Power. Of course, as Foucault himself would have insisted, these are not just constraints; they are productive of such things as wealth, mobility, health, or military force, as well as knowledge.

But it might still be objected, as perhaps Foucault himself might have objected, that there

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[5] Fleck [1979] and Latour [1988].

[6] For a detailed discussion of the meaning and significance of interactive complexity and tight coupling, see Rouse [1987], p. 230-31, or Perrow [1984].

is a basic difference between expanding capabilities over things and expanding power. However, even if one insists on limiting power to the shaping of human action or the possibilities for intelligible action, this does not effectively remove the connection between power and natural scientific knowledge. Recall the forms of visibility and surveillance which were proposed in Bentham's model of the Panopticon. Not only the prisoners were to be subjects of the panoptical gaze, which also reflects back upon the occupant of the central tower. A visitor can tell at a glance whether the observer has been vigilant, by seeing whether all is in order with the prisoners. The same is true of the new forms of visibility and constraint developed in laboratories and fieldwork, and extended indefinitely outside the microworlds they embody. People must conform to the disciplines of the laboratory in order for the knowledge and capabilities developed there to be sustained and extended. And the extent of their, our, conformity is readily visible in the functioning of those capabilities themselves.

3. Epistemic Sovereignty

What I have said so far is basically recapitulation and commentary upon my use of Foucault's work in Knowledge and Power. In that book, however, I did not thematize some of the most radical implications of my arguments for philosophical accounts of knowledge, implications which also deepen the uses I would like to make of Foucault's discussions of power/knowledge. The place to begin is with what I shall call the problematic of "epistemic sovereignty."

At several points, Foucault situated his own reflections within the tradition of political theory in terms of a challenge to the tradition's orientation toward the problem of sovereign power:

> At bottom, despite the differences in epochs and objectives, the representation of power has remained under the spell of monarchy. In political thought and analysis, we still have not cut off the head of the king. (HS 88-9)

Foucault notes that in order to understand sovereignty as a political problematic, one must look to the origins of the monarchy. Although modern political theory posits the question of legitimating a sovereign political power as the "original" political problem, Foucault reminds us that the actual role of the modern state, initially located in the person of the sovereign, presupposed a complex prior network of power relations. It is worth quoting this passage at some length, for we shall have occasion to refer back to it.

> The great institutions of power that developed in the Middle Ages--monarchy, the state with its apparatus--rose up on the basis of a multiplicity of prior powers, and to a certain extent in opposition to them: dense, entangled, conflicting powers, powers tied to the direct or indirect dominion over the land, to the possession of arms, to serfdom, to bonds of suzerainty and vassalage. If these institutions were able to implant themselves, if, by profiting from a whole series of tactical alliances, they were able to gain acceptance, this was because they presented themselves as agencies of regulation, arbitration, and demarcation, as a way of introducing order in the midst of these powers, of establishing a principle that would temper them and distribute them according to boundaries and a fixed hierarchy. Faced with a myriad of clashing forces, these great forms of power functioned as a principle of right that transcended all the heterogeneous claims, manifesting the triple

> distinction of forming a unitary regime, of identifying its will with the law, and of acting through mechanisms of interdiction and sanction. (HS 86-7)

The sovereign was a unifying agent, standing above the various conflicting powers as impartial referee, and guarantor and protector of legitimacy in the form of law, to be enforced against those subordinate powers which overstepped its bounds. Of course, as Foucault suggests, this was a promise which no actual monarch could fulfill, since the monarchy was itself a player in the power struggles which it supposedly stood above as neutral arbiter. Hence, the subsequent critique of the monarchy in political theory deployed this conception of the sovereign's role against its nominal occupant.

> Criticism of the eighteenth-century monarchic institution in France was not directed against the juridico-monarchic sphere as such, but was made on behalf of a pure and rigorous juridical system to which all the mechanisms of power could conform, with no excesses or irregularities, as opposed to a monarchy which, notwithstanding its own assertions, continuously overstepped its legal framework and set itself above the laws. (HS 88)

In the end, sovereignty came to represent not a real position within actual political struggles, but an analytic construct with respect to which those struggles were to be assessed. Even the tactics employed by actual sovereigns to secure popular recognition of their legitimacy were themselves to be assessed for their own conformity to principles of right, from the disembodied standpoint of sovereignty.

Foucault did not argue that sovereignty ceased to be at issue through the political transformations which he claimed to discover in the 18th and 19th Centuries. Rather, he argued that the political forms and practices of sovereign power remained in place, but that they were gradually invested by and ultimately sustained on the basis of power relations which functioned on a different scale. A crucial feature of sovereign power is that while there are no limits to its proclaimed scope (all actions, persons, and goods are in principle subject to the sovereign), in practice, its capacity to exercise power is discontinuous and solely constraining. The sovereign can prohibit actions, kill or imprison persons, and tax or confiscate goods, but its productive abilities are quite limited. Increasingly, he argued, the sovereign apparatus came to be dependent upon what he called the "capillary" power relations through which various "goods," knowledge, health, wealth, and the like were actually constructed or enhanced: "the ancient right to take life or let live was replaced by a power to foster life or disallow it to the point of death" (HS 138). Thus, in political theory, he argued that theories of sovereignty overlooked the many ways in which power was deployed outside the framework of the state apparatus or class domination; he also claimed that the theory of sovereignty failed in its own terms, since it could not adequately grasp the ways in which sovereignty itself came to be constituted and exercised through tactics on a different scale which were not at the sovereign's disposal.

Yet virtually all of the dominant political theories worked within the framework of sovereignty, differing only in where sovereignty was to be located: in the people and their representatives, in the ownership of the means of production, in social elites, or in patriarchy. As Foucault notes, even more radical critics of law and sovereign power did not escape the problematic of sovereignty (today, we might think of Critical Legal Studies in this role):

> A much more radical criticism was concerned to show not only that real power escaped

> the rules of jurisprudence, but that the legal system itself was merely a way of exerting violence, of appropriating that violence for the benefit of the few, and of exploiting the dissymmetries and injustices of domination under cover of general law. But this critique of law is still carried out on the assumption that, ideally and by nature, power must be exercised in accordance with a fundamental lawfulness. (HS 88)

I shall soon return to the question of how Foucault proposed to break outside the political problematic of sovereignty, as well as why he thought the modern exercise of power could not be adequately understood unless such a break were made. But I must first explain the significance of this detour through political theory in the course of a discussion of natural scientific knowledge.

Although Foucault insisted that knowledge is always intertwined and mutually reinforcing with relations of power, his discussions of power/knowledge never explicitly included an analytics of knowledge comparable to the general reflections upon power to be found in Part Four of History of Sexuality, Volume I, Part One of Discipline and Punish, and elaborated upon in various interviews and lectures. Yet I want to suggest that it is possible to construct a parallel discussion of sovereignty as an epistemological problematic, whose critique is also undertaken in Foucault's work. I will also argue that this implicit challenge to epistemic sovereignty is important for understanding the practices and achievements of the natural sciences.

All of the central issues of political sovereignty are reproduced in epistemology: the constitution of a unitary regime, based upon legitimacy through law, established from an impartial standpoint above particular conflicts, and enforced through discontinuous interventions which aim to suppress illegitimacy. The problematic of epistemic sovereignty is fundamentally located in the standard contrast between knowledge and belief or assertion. Knowledge arises from a confusing multiplicity of conflicting assertions which circulate through a wide range of communicative interactions. Knowledge is a unified (or consistently unifiable) network of statements which can be extracted from the welter of confused and conflicting contenders and legitimated in accord with rules of rational method, the epistemic surrogate for law. Here is where the figure of the epistemic sovereign is theoretically important. Sovereignty need not be located in any actual sovereign knower, any more than political sovereignty requires a monarch. But just as the sovereign power must be one which could consistently be embodied in a single will, sovereign knowledge must be consistently representable in a single coherent propositional system.

Like the political sovereign as arbiter among competing powers, epistemic sovereignty is projected as an impartial referee among conflicting claims. The establishment and especially the deployment of the rational methods of evaluation which distinguish sovereign knowledge from subordinate assertions must in principle be impartial among particular substantive statements.[7]

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[7] The typical philosophical response to claims that method and adjudicating evidence are theory-laden has not been to abandon the standpoint of sovereignty, but to reconstitute it at a different level. Hence, one finds accounts of rationality at the level of the research program or scientific domain (Lakatos, Laudan, Shapere), or at the level of metatheoretical explanation of

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Assertions are rationally justifiable only so long as they can be independently shown to accord with the law.

The binary categories invoked by the sovereign power in the name of law also have clear epistemic counterparts. From the standpoint of rational legitimation, statements are true or false, warranted or unwarranted, rationally permissable or forbidden. And although the question of the rational legitimation of statements is in principle appropriate at all times and places, its application is episodic. The cumbersome procedures of impartial rational evaluation are not deployed to produce assertions, but only to assess them in retrospect, and then only in very limited circumstances. There has always been a close theoretical parallel between the court of reason and the court of law, and in both institutions, the vast majority of possible cases are either never arraigned or else plea bargained. Few criminal cases are tried, and perhaps even fewer statements and their justifications are rationally reconstructed before the tribunal of reason.

Epistemology as a discipline constituted by the problematic of sovereignty has been organized around four basic issues. First and foremost is the question of where epistemic sovereignty is to be located. For the dominant liberal tradition, any rational person may represent the sovereign. The law, in the form of rational method, can be applied by anyone who can place him or herself in the impartial, rational standpoint. Marxism offers an alternative placement of epistemic sovereignty: there is an epistemically privileged class, whose standpoint alone enables the rational critique of ideology. Post-Kuhnian philosophy and sociology of science have revived communitarian conceptions of sovereignty, which situate the rational evaluation of belief within a shared form of life. Even the various forms of relativism are tenaciously located within the problematic of sovereignty, which enable them to recognize or confer equal epistemic "rights" upon individual or cultural worldviews.

There is a second, distinct question concerning the level at which epistemic sovereignty is to be deployed: can statements be rationally assessed one by one, or must method intervene only at the level of the theory or research program? A third question concerns the final form of the unification of knowledge. Does the systematic, sovereign unification of knowledge require reduction to a single vocabulary, or does it permit autonomous regions of knowledge at irreducibly different levels of description?

Of course, the fourth and final question is ultimately the crucial one. What constitutes legitimate exercise of sovereign epistemic judgment? What methods of epistemic adjudication could legitimately claim the force of law? And here, as with the political theory of sovereignty, the question must be kept rigorously distinct from considerations of how judgments are actually made or enforced. For just as the sovereign power and its legislation is always in principle subordinate to the law, the reigning practices of adjudicating knowledge claims must themselves be subjected to rational scrutiny.

4. Beyond the Problematic of Sovereignty: The Dynamics of Knowledge

As I noted above, Foucault's principle arguments for rejecting the problematic of sovereignty within political theory were that many politically important phenomena could not be

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theory-dependent instrumental success (scientific realism).

adequately understood in its terms, and indeed that those phenomena were in the end constitutive of the modern institutions and practices of sovereignty themselves. I want to suggest a similar line of argument against the way epistemological reflection has been shaped by the notion of sovereign knowledge. The practices of natural scientific research cannot be adequately understood in terms of the legitimation of a unified regime of knowledge, and indeed the actual certification of knowledge is shaped by those practices which transgress the analysis of epistemic sovereignty. But the parallel goes deeper than just the basic structure of the argument. I want to suggest that many of the fundamental themes of Foucault's analytics of power will have analogues in a more adequate reflection upon scientific knowledge.

Foucault's analytics of power was supposed to transgress the limits of the categories of political sovereignty by restricting inquiry to how power is exercised. Power was to be understood not as a thing possessed, but as a dynamic network of relations. My introduction of the notion of epistemic sovereignty was intended to suggest that we might take very seriously Foucault's insistence on the intertwining of knowledge with relations of power, and consider in similar ways how to transgress the categorial limits of sovereign knowledge. What could it mean to ask about the "how" of knowledge in lieu of what knowledge is or why it is legitimately knowledge? What, in short, must be done in epistemology in order to cut off the head of the king? And why would such an epistemological regicide be important for understanding the natural sciences?

My account will focus initially upon some of Foucault's more general remarks about power, as indications of what it would mean to bypass the issue of political sovereignty. However, I will not attempt an exposition of Foucault on power; instead, I will try to show how some of his central themes can be adapted to understand scientific knowledge. I shall consider six points: 1) power is dynamic; it is not a commodity, an institution, a structure, or any other sort of <u>thing</u> (hence it is also not something possessed by agents, classes, or institutions), and it only exists through its exercise; if there is stability over time in power relations, it is because these relations are reenacted and reproduced: "[power] is the name that one attributes to a complex strategical situation in a particular society" (HS 93);

2) power is disseminated throughout the body politic; power relations are material, and locally situated, and hence, as Foucault once put it, power is omnipresent "not because it has the privilege of consolidating everything under its invincible unity, but rather because it is produced from one moment to the next, at every point, or rather in every relation from one point to another. ... It comes from everywhere" (HS 93);

3) these disseminated power relations become linked or opposed to one another tactically and strategically: "these relations find support in one another, thus forming a chain or a system, or on the contrary, disjunctions and contradictions which isolate them from one another" (HS 92)

4) power is always contested: "the existence of power relations depends upon a multiplicity of points of resistance [which] play the role of adversary, target, support, or handle, [and which] are present everywhere in the power network" (HS 95);

5) power needs an "analytics" instead of a theory; it does not constitute a self-contained domain, but is better understood as one way of looking at the same phenomena which could also be seen in other terms; hence, "relations of power are not in a position of exteriority with respect to other types of relationships (economic processes, knowledge relationships, sexual relations),

but are immanent in the latter" (HS 94);

6) power is productive; it does not merely tax, prohibit, or abolish various social goods, it helps produce or constitute them.

Stated so briefly, this list is undoubtedly oracular and cryptic, and could be dismissed as a repetition of one of the most infuriating aspects of Foucault's written style. I trust, however, that this litany will seem less obscure once we have considered how we might understand knowledge as likewise dynamic, disseminated, strategically linked, contested, analytical, and productive.

A dynamic understanding of knowledge may seem initially strange. Whatever one wants to say about power, surely knowledge is something possessed by a knower, and transmitted or exchanged through communicative interaction. Indeed, the content of knowledge (both the propositions known, and the evidence and reasoning which warrants them as knowledge) may seem to be independent of particular embodiments in texts, utterances, or thoughts, and of the specific history through which those propositions came to be known.

To understand scientific knowledge in this way, however, as an ideal, ahistorical content which a knower grasps or possesses, is to overlook the complex practical achievements through which scientific domains become accessible. Only within such a complex practical field, shaped by the availability of functional and reliable equipment, and a variety of subtle technical and theoretical skills, do electrons, viruses, tectonic plates, or quasars become possible objects of knowledge or discourse. Thus the propositions in which sovereign knowledge is supposedly expressed get their sense from a complex and heterogeneous field of practices and capabilities.

Foucault has discussed extensively how the body, the individual soul, and the population are constituted as possible objects of knowledge, and how sexuality and delinquency are organized as fields of knowledge. Individuals become knowable only through detailed practices of classification and documentation. Populations require different practices, most notably the tangled interconnection between categorization, counting, and statistics. Sexuality and delinquency have different kinds of history, shaped by patterns of association and strategies of intervention. Recall, for example, Foucault's claim that sexuality as a field of possible knowledge emerged from the 19th Century identification and association of

> four privileged objects of knowledge, which were also targets and anchorage points for the ventures of knowledge: the hysterical woman, the masturbating child, the Malthusian couple, and the perverse adult. Each of them corresponded to [a] strategy. (HS 105)

The natural sciences have their own histories of disclosure, through which domains of possible inquiry are also shaped by heterogeneous skills, practices, and equipment. The "gene," for example, becomes available for discussion in quite different ways, and hence as a different object of knowledge, through successively the hybridization studies of Mendel and his contemporaries,[8] the chromosome mappings initiated by Morgan and his colleagues, its molecular identification by Avery and Watson and Crick, and the sequencing and manipulation of genetic elements in recent molecular biology. We are all too familiar with the retrospective reconstructions through which we have come to understand Mendel, de Vries, Morgan,

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8. For an account of Mendel which emphasizes the continuity of his researches with those of contemporary plant breeders, both in terms of his research practices and skills, and his goals, see Olby [1979].

McClintock, Avery, Crick, Berg, and Genentech to be talking about the same thing. There is of course a sense in which this reconstruction is not incorrect. But it required the excision or transformation of many of the forms of practice and knowhow which at various points helped constitute knowledge of the gene.

I spoke in Knowledge and Power of the importance of local knowledges in this respect. "Genes" emerge as the objects of possible discourses through often arduous accumulations of capabilities and insights in specific contexts (e.g., specific laboratories with their own projects, protocols, and materials, but also specific experimental systems such as drosophila, maize, and bacteriophage). This knowledge cannot be extended to other locations, or related objects, without complex and subtle mutual adaptations. Laboratory practices and equipment themselves, and the knowledge they embody, must be standardized, simplified, and adapted to new purposes, while the working environment (both material and conceptual) to which they are extended must also be modified to accommodate them. I think it is useful to understand these gradual transformations, reproductions, extensions, and mutual alignments of local knowledges as strategic. Out of a confusing array of interacting projects, practices, and capabilities, there gradually emerges an overall pattern or direction (or rather, a plurality of them). Not, however, because this pattern was what was intended, however dimly, all along, but because some practices turn out to reinforce and strengthen one another, and are taken up, extended, and reproduced in various new contexts, while others remain isolated from or in conflict with these emergent strategies, and gradually become forgotten or isolated curiosities. Yet, I argued, these outcomes have little to do with any intrinsic faults of the discarded practices.

An epistemological dynamics takes these strategic alignments to be constitutive of knowledge. Thus, knowledge is not a status which attaches to a statement, a skill, or a model in isolation or instantaneously. Rather, their epistemic standing depends upon their relations to many other practices and capabilities, and especially upon the ways these relations are reproduced, transformed, and extended. Knowledge is temporally diffused or deferred: to take something as knowledge is to project its being taken up as a resource for various kinds of ongoing activity (whether in further research, or in various "applications" of knowledge). In this sense, the word "application" is somewhat misleading, since in the broadest sense we do not first gain knowledge, then apply it; something only counts as knowledge through the ways it is interpreted in use.

Knowledge in this sense circulates, and even the various points at which it is articulated, or even collected and assessed, are caught up in its circulation. What is proposed as possible new knowledge, whether in informal discussion or initial publication, has an element of tentativeness about it. What is gathered together in retrospective judgment is always oriented toward a further advance, and shaped by that projection.[9] What I would now conclude from my argument in Knowledge and Power and a subsequent paper is thus that there is no place where epistemic sovereignty is actually located. The scientific literature itself is always continually reorganizing what is known as a resource for further investigation; it is also always contested. Yet philosophical attempts to stand outside or above the contested recycling of knowledge

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[9] I argue in more detail for the temporal situatedness and dispersion of all articulations of scientific knowledge in [1987], chapter 4 (especially p. 120-25), and in [1990].

always verge upon irrelevance. As I have argued elsewhere,[10] if a judgment from a philosophical standpoint of supposed epistemic sovereignty were to conflict with the ways knowledge claims are taken up and deployed in the course of research, they can only be vindicated within the contested strategic field in which knowledge claims are transformed, reproduced, or left behind.

I need to say more about this claim that scientific knowledge is always contested, the parallel to Foucault's insistence that power always confronts resistance.[11] Once it is recognized that knowledge only exists through its reproduction and circulation, the importance of conflict becomes evident: conflict focuses and directs that circulation. Knowledge is developed in an agonistic field, and will typically be contested in very specific respects. And it is precisely in those respects that knowledge will be developed and articulated most extensively and precisely. Where there is (possible) resistance, new and more powerful techniques will be sought, more precise and careful measurement will be provided, and theoretical models will be refined to eliminate or bypass possible sources of inaccuracy or unrealistic assumption. These various refinements are themselves new knowledges, and often in turn provide further new directions or problems for research. Hence, around the specific points where knowledge is resisted, there emerges a whole cluster of new local capabilities and their extension into new contexts. But the contrary is also true: where knowledge goes unchallenged, where a claim "goes without saying," there is little or no articulation or development. And where previous resistance vanishes, knowledge also ceases to proliferate.

The forms taken by resistance to knowledge cannot be easily reduced to traditional epistemic categories. Obviously, knowledge can be resisted because there are gaps in the data, dubious assumptions in the theoretical models, or countervailing evidence. But it can also be resisted because the procedures and capabilities for its articulation and development are too expensive, environmentally unsound, cruel to animals, politically sensitive, of too little or too much interest to the military, unprofitable, and so forth. Philosophers have often tried to separate considerations internal to knowledge from those which impinge upon it from the outside. The

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[10] Rouse [1990].

[11] I am using the term "resistance" in a broader sense than might be expected. Obviously, there is resistance to a knowledge claim when there are people who refuse to accept it, and attempt to counter it by producing counterevidence or other arguments, or even by trying to bypass it or studiously ignore it. But there is also resistance to a claim when the purported objects of that claim do not behave in accordance with it. It is important not to separate these two aspects of resistance to knowledge too sharply, because of the ways they reinforce, and even constitute one another. What counts as successful accord between knowledge its objects is often itself contested, and the outcome of such conflicts is typically the result of successful negotiations (both negotiating with those who oppose the claim about the standards of success, and renegotiating the practices and procedures through which the objects of knowledge make themselves manifest). The concept of "resistance" one needs to understand the dynamics of scientific knowledge is one that does not respect any sharp distinction between actions by people and behavior by things. Detailed arguments for such a conception of "resistance" are provided by Latour [1987] and Pickering [1989].

distinction is almost always bound up with a conception of epistemic sovereignty: only those issues which are codified in terms of method, the sovereign law in the realm of knowledge, count as "internal."

Yet the discovery of the local knowledges and their dynamics through which epistemic sovereignty is exercised undercuts any attempt to make such a distinction. The sense of a claim and the ways in which it is articulated and deployed in further research and development depend upon considerations which transgress the boundaries which would constitute sovereignty in the realm of knowledge. All of the small local decisions about research materials, equipment, procedures, funding, personnel, skill development, and the like shape the actual development of the knowledges which invest and underwrite the sorts of knowledge claims which philosophers typically investigate. The actual justifications offered for these decisions typically interchange and balance supposedly internal and external considerations. Thus, a physicist may argue for a particular experimental strategy against its competitors by claiming that it is cheaper, provides a less diffuse particle beam, takes best advantage of the skills of available personnel, might interest new funding sources in the military, is more reliably established in the literature, would be adaptable to a variety of experiments, and would leak less radiation and thus counter the recently vocal objections by local environmental groups. These heterogeneous concerns and reasons function together in the shaping of knowledge.

This heterogeneity of knowledge and resistance to it thus points to the inadequacy of that aspect of epistemic sovereignty which presents knowledge as a distinct domain of investigation, which would be the object of a theory. Foucault's analytics of power was a recognition that power was not a more or less enclosed domain of objects, but a collection of strategies for codifying and intervening in things which could also be organized in overlapping and countervailing ways under other headings (economic, epistemic, sexual,[12] etc.). Knowledge should be similarly thought of as a strategic intervention rather than an isolable domain.[13] Understanding knowledge dynamically takes us into considerations which would "properly" belong to other domains if the world presented itself in such discrete bundles. But an adequate

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[12] Anyone who doubts that a useful approach to understanding science could not plausibly be organized under the heading of sex should look closely and imagine extrapolating the discussion of the sexuality of particle accelerators and detectors in Traweek [1988].

[13] Fuller [1989] has made a similar point, in objecting to what he calls the "textbook fallacy": the family, the economy, cognition (or "science"), education, etc., may be naively introduced to students as if they were discrete domains, when in fact they are overlapping categorizations. Thus, he points out that even in the context of textbook naivete,

> it is unlikely that a discussion of the family will be restricted to the formation and maintenance of gemeinschaftlich bonds. In addition, the reader is likely to find an analysis of the family as an economic unit, as a vehicle for transmitting political ideology, and the like. (p. 16)

One should add that in the end, such analyses of the family cannot be confined to discrete subsections either. And of course Fuller shares my principal point that it would be an error to think that knowledge can be isolated as a sovereign realm any more than can the family.

understanding of knowledge (even scientific knowledge) in all its local proliferation and heterogeneity regularly transgresses the boundaries of epistemic propriety. One could add, of course, that the same is true of other kinds of interventions. An investigation of economics or sexuality would have much to say about science, and could not be confined to considerations "external" even to knowledge narrowly construed. There is, after all, much to be said about the value and the pleasures of methodological rigor.

In concluding this introductory survey of a Foucauldian epistemological dynamics, I trust I do not need to say a great deal about the senses in which knowledge is productive. The ongoing practices in which knowledge is embodied are also increasingly the site of the production of health, wealth, military force, etc. I use the word "production" advisedly. From within the circulation of knowledge (re-)production, there emerge new ways to be healthy (low cholesterol and high fiber, adequate T-cell count), new forms of wealth (most obviously in the form of access to and control of information), and new projections of destructive force. There also emerge, not accidentally, a proliferation of new knowledges. For the extension of Foucault's analytics of power to an epistemological dynamics shows more clearly how the continual expansion of scientific knowledge and its associated controls and constraints is not merely incidental, but is integral to the ways in which knowledges circulate and are validated. Indeed, this is the parallel to the complicity between the prison and its reform which Foucault observes to be integral to modern practices of confinement. One might say that the laboratory also embodies a dream of a "complete and austere institution."

5. Legitimation and the Spectre of Relativism

I want to conclude with a brief reflection upon a likely source of resistance to a dynamic, non-sovereign epistemology.

Foucault has often been chastised as an arch-relativist, who denies any grounding to the legitimation or critique of power or knowledge.[14] My attempt to bypass or overcome the problematic of epistemic sovereignty may seem to suffer from the same, possibly self-defeating incapacity. A post-sovereign epistemology would presumably offer no standpoint, outside the contested domain in which conflicting and heterogeneous knowledge claims circulate, from which to assess what one ought to believe, including whether one ought to believe the assertions of post-sovereign epistemology.

There is, however, a slippery inference underlying this fear that the actions of tyrants and the beliefs of fools can no longer be effectively countered. This is the inference from there being no epistemic sovereignty, no privileged standpoint for legitimating knowledge, to all knowledge claims being equally valid, however wacky or offensive they may be. But the latter sort of relativism is not only not entailed by the denial of epistemic sovereignty, they are mutually inconsistent. Relativism is an assertion of epistemic sovereignty, which proclaims the epistemic "rights" of all knowers or knowledges. The most fashionable forms of epistemic relativism today, which are also those frequently and mistakenly associated with Foucault, are those which

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[14] Such criticisms have been articulated most influentially by Taylor [1986], Habermas [1986], and Fraser [1989], and are sufficiently widespread almost to go without saying in many contexts (e.g., Putnam [1981]).

dismiss all claims to objectivity or truth as merely masks for power. But such claims are the exact epistemological parallel to the radical critique of law as itself a form of violence, which Foucault insisted always "assumes that power must be exercised in accordance with a fundamental lawfulness." (HS 88) To make this assumption, whether about power or knowledge, is to remain committed to a conception of sovereignty, from which such fundamental lawfulness can be rightly assessed.

What, then, does a post-sovereign epistemology have to say about the legitimation of knowledge? The crucial point is not that there is no legitimacy, but rather that questions about legitimation are on the same "level" as any other epistemic conflict, and are part of a struggle for truth.[15] In the circulation of contested, heterogeneous knowledges, disputes about legitimacy, and the criteria for legitimacy, are part and parcel of the dynamics of that circulation. Understanding knowledge as "a strategical situation" rather than as a definitive outcome places epistemological reflection in the midst of ongoing struggles to legitimate (and delegitimate) various skills, practices, and assertions. Recognizing that the boundaries of science (or of knowledge) are what is being contested, epistemology is within those contested boundaries.

An example will clarify my point. What does it mean to say about a recently prominent family of biological claims, that creationism has now been shown to be false? The standard epistemological interpretation of this claim is that it promises to stand above the myriad claims for and against creationism and assess which actually belong to the unitary regime of knowledge. A post-sovereign epistemology would take this sentence to be a commitment to marshal available evidence sufficient to demonstrate to anyone audacious enough to challenge this claim that their challenge fails. Now the sovereign epistemologist will immediately ask about the standards of success and failure in any such ensuing contest. The challenger cites scripture, the defender responds with data from fossils and breeding experiments. And the worry is that, without a sovereign standpoint to determine which appeals and standards are relevant and legitimate, scripture is just as good as data.

But this conflict among competing standards will appear irresolvable only when one removes the conflict from any real setting, in which there are interested parties and something at stake. In any real conflict, there is a burden of proof,[16] which is sustained by a strategical alignment of people and things which can be relied upon to support and enforce that burden.[17]

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[15] A closely connected view about the "level" of analysis can be found in some versions of "disquotational" accounts of truth, for which "p is true" is materially equivalent to "p" (see Horwich [1990], Fine [1986], Rouse [1987, chapter 5].

[16] Fuller [1988], chapter 4 offers an illuminating discussion of the role of the burden of proof in scientific and philosophical argument, and the ways in which the burden of proof can be shifted.

[17] I take this notion of an "alignment" to be a commentary upon Foucault's discussion of networks or chains of power/knowledge and their strategic and tactical interaction, but the term itself is taken from Thomas Wartenburg [1990], whose account of the dynamic and

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Epistemic conflict is always shaped by the goods, practices, and projects whose allocation and pursuit are at issue, and by the institutions and social networks which are organized around those pursuits. In such real contexts, there are constraints upon which arguments and evidence will count as relevant and persuasive, based upon the need for support from others and for reliability from things. It matters what will count as persuasive to others who occupy strategic points in the circulation of knowledge and argument, and it also matters how things will manifest themselves in the contexts in which their behavior is recognized to be relevant.

It is crucial to recognize, however, that the alignment which determines the burden of proof and the standards which must be met is subject to challenge. Not long ago, creationism was readily dismissable as irrational, crackpot science, by appeal to standards which were recognized as relevant and decisive by a powerful social network which controlled access to the educational system, and to the other social goods to which adequate (or at least certified) knowledge of biology provided access. But this appeal was not "merely" a recourse to power; implicated in it was the history of the discovery and interpretation of fossils and other geological data, of political practices and goods surrounding religious life, of the institutional organization and placement of science, and so forth. This complexity and its dynamics are evident in the ways in which the proponents of creationism tried, with some success, to alter the epistemic and political alignment which denied their views any serious recognition.

Indeed, the recent prominence of this example testifies to the partial effectiveness of their resistance to the dominant alignment. For the new creationists did not meekly accept their allotted place and vainly reassert the superiority of religious belief to science. They tried to claim the epistemic and political resources of science on multiple fronts: challenging the connection between fossil data and dominant interpretations of evolutionary theory, citing philosophical disputes about the demarcation of science, transforming their own views to resist attacks upon their "unscientific" character, and turning against their opponents their objections to using political power to enforce scientific belief. Of course, they also mobilized a religiously committed political base and chose a sympathetic venue (legislatures and courts in states with strong ties to Christian fundamentalism and relatively weak ties to scientific and educational establishments). Their strategies were an interesting mix of trying to subvert or coopt elements of the dominant epistemic alignment which established and enforced the rationality of belief in Darwinian theory, and trying to create alternative alignments (Christian schools, creationist research and textbooks, etc.) which would enable them to bypass it.

Their initial successes in this strategy compelled defenders of mainstream biology to confront arguments and respond to strategies whose dismissal previously went virtually without saying. This response in the end was largely successful, as there were effective counters to many of the new creationist strategies and arguments. As a result, one still need not consider scripture in most contexts in order to assess or advance biological knowledge. But new arguments, new

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[17](...continued)
heterogeneous character of social power has interesting parallels with the epistemological dynamics I have been developing here. Wartenburg's own view, while developed in original and insightful ways to which I am indebted, is closer to Foucault's position than his own interpretation of Foucault would suggest.

knowledges (about the epistemic gaps in the Darwinian orthodoxy, about the creationist resistance, about religion, science, and politics), and new alignments were created in the course of these responses; resistance partially refocuses the organization of knowledge even when it substantially fails to overturn its target.

It is useful to compare this example with that of recent feminist challenges to sexist orthodoxies in many disciplines. Like creationism, feminist critiques could once be dismissed in most contexts without having to take them seriously. When articulated, the dismissal rejected not just their specific contributions to knowledge, but the very possibility of such contributions, which could only represent the illegitimate intrusion of religion or politics into knowledge. Like creationists, the feminists combined a new program of research with resourceful appropriation and redirection of elements of orthodoxy, and the creation of alternative alignments which reduced their dependence upon unregenerate opponents (feminist presses and journals, professional associations and graduate programs, but also a variety of more straightforwardly political alliances).[18] The feminists have been rather more successful than have creationists, despite considerable remaining opposition. But this success must be understood in simultaneously epistemic and political terms. Their arguments were more persuasive. Sexism and gender have shown themselves to be more resilient and readily manifest objects of inquiry than is biblical creation. And the new feminist alignments made it more difficult to ignore or dismiss their arguments, avoid their vocabulary, or refuse to certify their achievements.

Were the feminists more rational, or more warranted in their claims, than were the creationists? Yes. But that judgment does not stand above the fray as an assessment of the unsituated rationality of each set of arguments and conclusions. That judgment is itself a move in ongoing epistemic struggles, which both draws upon and reinforces the successes and failures of each view. My own arguments, and allusions to arguments, were responses to the burden and standards of proof which I take to be effective in the context in which this is written; in their small way, they also aim to reinforce or transform the standards to which they appeal.

The moral for epistemology is, I hope, clear. The turn to a non-sovereign epistemological dynamics does not replace argument or a concern for truth with power and domination, even while insisting that argument and claims to knowledge are never politically innocent. The contested circulation of opposing knowledges, which cannot be consistently combined into a unitary framework of propositions, is a struggle for truth. Truth matters. Precisely because it matters, truth is often fiercely contested. And if we cannot stand outside that contest to assess it from a neutral standpoint, this does not mean that all claims to truth can be put forward on an equal basis. Knowledge claims are historically, socially, and materially situated in contexts which govern what can be intelligibly and seriously asserted, and how much or what kind of argument is necessary to support it. But such epistemic contexts are always in flux; their boundaries and configuration are continually challenged and partially reconstructed, as epistemic alignments shift. And these alignments are always intertwined with alignments of power and political resistance. To recognize this interconnection is not to devalue knowledge or science for

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18. Wartenburg [1990] offers a very informative account of such feminist strategies as part of a discussion of new social movements, to exemplify the insights offered by his dynamic account of power.

political purposes, but to take seriously the stakes in struggles for knowledge and truth, and to place epistemology and philosophy of science squarely in their midst.

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