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SCIENCE, MASCULINISM, AND THE GENDER SYSTEM

J.L. LEMKE
City University of New York

Science Within Culture

Science, for my present purposes, is taken to be a system of social practices. As such it is always a part of a larger system of such practices, and no absolute separation can or need be made to say which practices belong to the domain of social activities commonly called science and which do not, if only because all social practices depend upon others and cannot be carried out, at least not on a regular basis, unless those others are also carried out within the same community.

Among the practices of science as a complex constituent of modern European-derived cultures are those in which it talks about itself, and these reflexive, and highly ideological discourse formations privilege some of the activities which constitute the science complex as being more central or fundamental than others. Most often these are taken to be the practices by which people "investigate" phenomena of "the natural world", and investigation means centrally the formulation or definition of what the phenomena are, the posing of specific questions about the features, processes, conditions, and relations of and among phenomena, practices of observation, experimentation, and conversion of their outcomes into communicable forms, and discursive narratives and expositions about the investigations, the outcomes, and, with great caution and even greater faith, about the phenomena themselves.

These practices are carried out and can only be carried out as members of communities, both communities of other practitioners of the notionally central activities of science, and wider communities that make these possible in every detail. "Core" scientific practices link with those which science's ideology about itself marginalizes most obviously in such matters as material support (financial and technological) and social communication (educational and professional).

Specific scientific practices, at least those which are recognizable, repeatable, and repeated from one occasion to another are generally characteristic of communities. So are the resources, both material and semiotic (languages, vocabularies, symbol systems, graphical modes of representation, etc.) of which the practices are deployments, and these are often characteristic not just of the scientific subcommunity but of a larger community which produces its scientific subcommunities. Among the social and cultural practices that are generally characteristic of both the larger and the specialist communities are those of semiotic genres (narratives, descriptions, explanations, arguments, syllogisms, methodological procedures of many kinds) and of particular discourse formations (which are not merely linguistic, but normally include language in the context of language-using activity).

These discourse formations and the activity-types and cultural practices with which they are interdependent inextricably link scientific practices to the culture-specific perspectives, interests, values, attitudes, beliefs, folk-theories, ideologies, politics, and social structuring practices of the wider community.

What science sees as "a phenomenon", what it finds worthy of investigation and effort, how it formulates hypotheses and models, its criteria of valid argumentation and evidence, its modes of discourse construction, its genres, and indeed every detail of its practices and its discourses is linked in myriad ways with networks of social practices that its view of itself would consider completely outside the practice of science as such.

The system of practices of a community forms a material self-organizing system which is itself an integral part of an ecosystem. Because it is impossible to model such an ecosystem without taking into account the meaning-making (semiotic) activities of humans within it, activities which in turn mediate our more energy-intensive couplings to the material environment (our values, our constructed relationships of meaning between cause and effect, goal and action), I call such systems eco-social-semiotic systems, or just ecosocial systems for short. They can only be modeled in terms of their complex, dynamic, self-organizing, autocatalytic systems of coupled material processes, including those which count for us as semiotic practices (Lemke 1994).

In this view of science, it is not possible that science as a system of social practices can be independent of any of the major constitutive systems of practices in the larger community of which it forms a part, and that specifically includes the gender system (those practices which construct material and semiotic relations of gender). I believe that the gender system is a vast and complex system of practices whose effects are both bodily and discursive, and whose semiotic dimensionality is very large. The gender system itself cannot be understood apart from its interdependence with the social constructions we notionally call class and age, nor from folk- and scientific discourse constructions of sex, gender identity, and sexuality (Lemke 1988a).

Matters so large and complex cannot be easily simplified for brief presentation, and in what follows I will have to skip over vast matters that need attending to. I will try to point out along the way which domains I think have been charted out sufficiently to support the arguments I will make, and which remain radically undertheorized, at least for me.

Science and Gender: Two Critical Perspectives

The prevailing ideologies about science are modernist in particular, and masculinist within modern Europatriarchal cultures in general. They are modernist in that they hold that scientific knowledge, or in a weaker claim, scientific methodologies, are capable of transcending the cultures which engendered them, and that they have some sort of universal or necessary character to them. In this view there can only be Science, and not modernist European patriarchal or androcentric science. Modernist claims are essentially imperialistic in their cultural politics; they seek to impose the views of one tiny fraction of humankind in one moment of its history on all people in all times and places. They lack all capacity for cultural self-critique, and because of this, modernist intellectual discourse in general and modern European patriarchal science in particular are blind to their own limitations and to their roles in oppressive social projects.

Whether our project is to weaken scientific support for oppressive social projects and the ideologies that rationalize and justify them, or to enlarge the system of social practices that can be called science in such a way as to enable it to overcome its present limitations, we must develop a cultural, including a gender system, critique of science.

I want to suggest two possible directions in which to develop such critiques.

One of these is an extension of a suggestion (Harding 1986) that physics is an inappropriate model for the paradigm of natural science, that it is an unusual and exceptional science, and that its seeming imperviousness to cultural critique should not be taken to mean that science as a whole shares this apparent invulnerability. Detailed analyses of the interconnections between all aspects of scientific practice and culturally gendered viewpoints and dispositions in the recent history of a science such as primatology (Haraway 1989, 1991), support this, as does the general model of the interdependence of social practices in any community culture sketched above (in detail in Lemke 1994). It thus becomes important to explain HOW and WHY physics might be different in just such ways as to make it much less apparent, and perhaps even less true, that it depends critically on inevitably gendered perspectives.

In fact, I believe that physics as a science is intensively masculinized in its practices, but that the nature of the semiotic objects it has constructed, and the relations among them it has made its domain of discourse, insulates what it says about those objects, over the very long run, from how it operates as a masculinized community. This is not to say that physics escapes its cultural limitations, but it does acknowledge that physics contributes to cultural change in a way which has become, in our particular period of history, less tightly coupled with perennial ideological battles over the discourses that legitimate inequity and oppression, than in, say, primatology. Physics is, however, still very tightly coupled with the material (economic and technological) resources that support inequity and oppression, and that in turn is linked to its intense masculinization.

This suggests that there are in fact two rather different modes of cultural critique at stake here. One depends on the discursive linkages between a specialist scientific discourse and those more general cultural systems of attitudes, values, and beliefs which are ideological critical in a particular community in a particular period of its history. To what extent is discourse about electrons linked to discourse about human social relations? The other depends on the more energetically material linkages between the uses of a specialist discourse and the distribution of material power in a community. To what extent is discourse about electrons linked to the social distribution of coercive power?

I am going to call the first direction for a cultural critique of science and sciences, the Specificationist critique, because I will propose that the ways in which the sciences define their objects constructs a specification hierarchy (Salthe 1985 1989 forthcoming) in which a particular human viewpoint defines the most specified phenomenon in the scientific universe, and all other phenomena are either categorially closer to or further from it in their nature and contemporary relevance to human social issues.

The second direction I will refer to as the Masculinist critique, because I believe that an analysis of how scientific practices and communities participate in the contemporary social construction of masculinity provides the critical link for an understanding of the interrelations of science, gender, and social power in modern Europatriarchal cultures.

The Specificationist Critique

A specification hierarchy is a sequence of nested subsets or categories such that every successive inner (more specified) category inherits all the properties of the outermost (most general, least specified) category, and indeed of each successively more specified category in the hierarchy which also contains it. Think of a system of concentric circles. The outermost is labeled by a small set of properties. Everything within that circle (all the way to the center of the whole system) has these properties. The next circle inwards has all these properties, plus a few more (consistent with those in the outer circle), that make it a more specified proper subset of the original. Everything on in to the center also has these properties, too. Only the ring that lies between the this circle and the outermost one LACKS the additional properties and has only the original ones. And so on down to the center.

This is a very different hierarchy type from the one one which scientific reductionism is based, and which is often confused with it. The usual scientific hierarchy of nature is a compositional or constituency hierarchy (sometimes called a hierarchy of scale) in which the relation between one level and the next is not that of category inclusion (or property inheritance) but one of whole and the parts of which those wholes are said to be made. In science's scale hierarchy of nature, the human scale is in the middle of the hierarchy. Below us are cells, molecules, atoms, electrons, etc. Above us are ecosystems, planets, star systems, galaxies, etc. Strong reductionism is the programme of explaining the properties of say, human organisms, in terms of the properties of atoms and the laws of their combination. This is pretty well a dead programme today, though segments of it continue. Weak reductionism, which takes account of the phenomena of self-organization and the emergent properties of different level of organization, unpredictable from those of the level below, still maintains that one needs to include information about systems at the levels below in order to fully understand those of a higher level.

It is clear however that the scale hierarchy does not also function as a specification hierarchy (though strong reductionism occasionally seems to speak as if it didn't make such a distinction). A cell is not a particular kind of atom, with all the properties of an atom; nor is an atom a particular kind of cell. An organism is only metaphorically or analogically a type of ecosystem, or an ecosystem an organism writ large. These are not the terms of the specification hierarchy of our discourses about nature.

It is possible, however, to construct such a specification hierarchy (Lemke 1994; see Salthe 1985, 1989, Forthcoming, for closely related work) entirely on the basis of the usual categories of scientific discourse in a way which seems to precisely show why it is possible for physics to be less tightly linked ideologically to the semiotic and discursive construction of human social relations than, say, primatology. When I first encountered the suggestion that physics might be in this sense an atypical science (Harding 1986), I immediately thought of the characteristics I had already worked out for such a specification hierarchy and how closely they fit with this analysis.

My interest in the specification hierarchy arose from an attempt to characterize the largest class of physical systems that could show self-organizing behavior and to relate this to the forms of self-organization characteristic of individual development and social and ecosocial systems. I was looking for clues to these latter phenomena that might be found by seeing what properties they inherited from much simpler systems (i.e. how they resembled these systems as more specified instances of the most abstract class of systems that shared the critical properties). I did indeed find such clues (Lemke, 1994).

It would take far too much space here to describe the hierarchy in detail and state all the principles that define each level as a more specified subclass of the level above. I will give a general overview of the results and move on to the implications for a culture and gender critique of science.

In the outermost circle are the phenomena of reversible, linear dynamics of extremely simple systems (electrons, atoms, small molecules; in small numbers), with relatively few degrees of freedom (number of observable parameters needed to characterize the behavior of the system under all conditions insofar as that behavior depends on characteristics of the system itself). This is the domain of classical Newtonian physics, and of most of quantum physics and relativity theory. It is the domain to which physics retreats when under critique, the domain of minimum vulnerability and maximum mathematical precision and experimental demonstrability.

In this domain there is no Past and no Future, all processes are precisely reversible. Excite an atom by raising an electron from its ground state and the electron will soon return to that state, leaving no trace in the atom of this event in its history. The atom after is indistinguishable from the atom before, by all possible tests (and there are experimentally observable consequences of this indistinguishability). Atoms, or electrons, have no histories. They are born (created) and die (annihilation), but they do not age, they do not develop. They have no extension in time. They are individuals without individuality. When two electrons collide there is no way to tell, after the collision, which electron coming out is to be reckoned as the same individual electron that went in (and, again, there are experimentally observable consequences of the indistinguishability). There is no way to follow an electron through its life-history, to even connect one electron at one moment to another at another moment and say they must be the same electron. All electrons are the same electron.

This is a very fundamental point. You cannot "tag" an electron, label it, so that you can tell one apart from another, or trace individuals through collisions and other interactions (including those needed in principle in order to observe the electrons in the first place). Why not? because an electron has only as many degrees of freedom as necessary to specify its behavior (dynamical degrees of freedom, "quantum numbers", parameters of its quantum states), and there are none left over to be used as tags. The same is true of an atom, though the argument gets more complex, but ultimately the point is that the dynamics of these systems (their total dynamics, subject to all conditions and observations) exhausts their degrees of freedom; their behavior and their description span spaces of the same dimensionality.

What kinds of systems then do have histories? can be constructed across time as persistent, distinguishable individuals? Time and history begin with systems with large numbers of degrees of freedom, so large that their collective dynamical behavior spans a much smaller space than their microscopic descriptions, and there are now many non-dynamical degrees of freedom left over to "tag" them as individuals, and even to show the signs of wear and tear, of an individual history. Macroscopic systems treated as statistical ensembles belong to this domain (cf. Prigogine 1980, Prigogine & Stengers 1984), and so very likely do extremely large molecules (proteins, RNA, DNA), though there is clearly a borderland. Individuality becomes possible when what science considers a complete dynamical account for some purpose (enzymatic activity, thermodynamic properties) does not require the maximal specification of the microscopic degrees of freedom (total quantum state) of the system.

Such systems have individuality and history, but they do not necessarily show growth, aging, a developmental trajectory, or self-organization. Still a further specification takes us to a third class of systems, the most general ones which show self-organization (dissipative structures, or dynamical open systems). A flame, a tornado, the jetstream (perhaps) show this degree of specification. Such systems do have a characteristic developmental trajectory as well as individuality and history. But while they develop, they do not necessarily evolve as a type, do not pass on characteristics to the future of their kind, and, correspondingly, their development is not subject to constraints that lead them to recapitulate novel features of the development of earlier individuals of their kind.

We pass then to still a further specified type of system, which I call for convenience "epigenetic systems" which not only spontaneously self-organize, but interact with their environments in such a way that some features of the history of their individual development make similar developmental trajectories more likely in individuals of their kind in the future. And thus there is, in a more than descriptive sense, a "kind" (such as a biological "species", a unit of evolutionary change, as the individual is the unit of developmental history). Epigenetic systems are still far more general than biological systems. A series of 'accidental' dust-devils in a narrow defile might erode landscape surfaces in a way that produces contours which favor the formation of locale-specific dust-devils. Globules of organic polymers engaged in autocatalytic chemical reactions might modify the surrounding silicate clays in ways which tend to favor their latest chemical innovations in successor globules.

Epigenesis is simply development under an environmental guidance that enables the recapitulation of type-trajectories in individual development. It depends on and defines a particular kind of system-environment relationship (of

constituent subsystem to its supersystem) that is already possible in any dissipative structure. Biological systems emerge when the environmental "landscape" that promotes recapitulation of the evolution of the type is internalized, partly in the form of RNA and DNA molecules, and ultimately in many features of the structure of egg cells, the womb-mother environment, and even the social group and material milieu of the community in which conception-to-decay development takes place. It is type-specific developmental trajectories themselves that evolve, in all epigenetic systems, of which biological (and within biological, multicellular to mammalian) systems are further specified classes in the same specification hierarchy.

It should now begin to become clear where all this is leading. Biological systems get further specified ultimately to ecosocial systems including (now a matter of scale hierarchy) human organisms and their modes of cultural transmission and social-environmental shaping of the post-natal developmental trajectories of individual human lives. While my own theoretical preference is to specify towards a center of ecosocial systems, and then perhaps particular types of such systems (an undertheorized domain), the dominant specification hierarchy tends, for ideological reasons, to privilege a single level of the scale hierarchy (organisms, individuals) and to converge at the center on ... what? or should we ask, whom?

It must be clear that a specification hierarchy has to converge on the viewpoint from which it is constructed, and that ultimately is not simply the biological (as opposed to the inanimate), but specifically the human viewpoint, and more specifically the modern European human cultural viewpoint, and most specifically, the modern European middle-class, middle-aged, having-married, having-fathered, having-been-trained-in-science, masculine, male point-of-view. For that is the point of view from which the terms, categories, and distinctions that define the canonical hierarchy have been constructed.

The specification hierarchy defines all of nature in the respects in which it is seen to be critically similar to and different from humans and human viewpoints. Its innermost circles and how they are drawn will depend very sensitively on exactly where its center lies; the outermost circles, while still culturally and historically specific, define objects constituted in such ways that they are least like humans, their relations least like human relations, the processes they enter into least like human practices. Of course, they are not all that far away. All science is fundamentally anthropomorphic in its metaphors and root semiotic practices and genres (such as narratives). But some sciences, like the physics of non-complex systems, have so defined their objects and so developed discourses about these objects as to make them in fact today as little like our culture's discourses about humans as any discourse about anything has so far managed to get.

What is said about systems at the outer ring of the specification hierarchy is minimally connected to our images of ourselves, our notions of relevance to human values and interests. This has not of course always been true. In earlier periods of European culture, discourse formations existed which did not respect these modern divisions (or their implicit precursors), which linked the planets and the stars to human affairs, which tightly coupled the cosmic order to the human social order. It is still just barely possible to do this in matters of cosmological origins, but the orbits of Jovian satellites are no longer in themselves matters of political import, and the larger community would be hard pressed to say if it hoped that there were or were not more than one type of neutrino. No statement about the physical properties of electrons is likely to have, for us today, serious implications about the nature of human beings, or human social values.

The same clearly cannot be said of statements about genes, human development, neurobiology, ecosystems, primate behaviors, or economics. What then are the principal differences, in terms of the specification hierarchy? The objects sciences construct in the outermost ring are without individuality, history, development, epigenetic interdependence with material and semiotic environments. This means that they and the relations and processes into which they canonically enter in scientific discourses about them, are constructed as not time- and place-dependent, as ahistorical, and so as a-cultural as well. Electrons are not normally semiotically construable as having nationality, gender, age, power relations (except metaphorically). Electrons (or for unregenerate modernists, our concepts of electrons) are semiotic and discursive constructions of modern European culture, but they are not constructed in such a way that our other semiotic practices for attributing such human-domain characteristics to them normally apply.

Reciprocally, it is very difficult to build discursive bridges from statements about them to implications for human nature, human relationships, or human values. This is not to say that there are not still many metaphorical processes at work in the origins of these discourses which show human cultural dispositions at work. One can make a connection between the fact that unlike electrical charges attract one another and human heterosexual attraction (or more general

cultural beliefs and norms of attractions by difference or complementarity of qualities) in terms of the metaphors of polarity ("opposite" or "contrasting", which are very culture-specific notions, vs. simply unlike, different, distinguishable), but these are seen as merely metaphorical since the human sense of "attraction" requires individuality, meaning, intentionality, consciousness, will, desire, and many features we do not construe for electrons.

On the other hand, a biological theory that grounds a presumed tendency for people with culturally complementary qualities (light and dark hair, eyes, skin; massive and slight; masculine and feminine; outgoing and shy) to be attracted to one another in a teleological model of assortative mating in which genetic control of behavior leads people to seek those with genetic characteristics that are biologically complementary to their own, to combine these qualities in their offspring, avoid in-breeding, and increase genetic diversity in populations and genetic exchange between populations -- such a theory would have only very much smaller discursive gaps to bridge to be taken seriously and plausibly, and not at all metaphorically, in our society. The matters are close enough in the specification hierarchy that our usual discourse practices can and do bridge their domains.

It is also important to point out that scientific objects constructed in the outer rings seem to have a unique property NOT shared by those inwards of them. This, however, is because of a philosophical ideology which defines what is, in terms of the specification hierarchy, a negative property as a positive one. Electrons are defined in physics in such a way that they have a finite number of physical properties, or in philosophical and logical terms, they can be exhaustively defined by a finite set of necessary and sufficient category-membership conditions. They are objects with no accidental properties, no inherent and dynamically irrelevant variation, no semiotically non-distinctive features. So called "ideal" physical systems are all defined in this way, though only those in the outermost ring are strictly so. Logicist ideologies want the whole universe to be so describable, but science has long established that useful descriptions of all the inward rings are not.

It is not possible, in principle, to define a scientific object like "a language" (or "a human" or "a community") in such a way that intensional (categorical) definitions will ever be sufficient to resolve the problems of what does or does qualify as such an object (extensional definition). This is because these objects are differently discursively constructed than formal objects (as in mathematics) or objects of the outermost ring (physical objects that are exhaustively described by formal properties). Inwards objects do not have definite "dynamics"; they are not only temporally extended objects, but they are not invariant in potentially dynamically relevant details across time. This is linked to their individuality and historicity as we have seen. Consider an object such as "the English language". If we seek to assign all human utterances as being either part of or not part of this object, or if we define sets of such utterances by the kinds of criteria used to construct objects in the inward rings (all utterances by a particular individual, all in a given community) we will find that there are no individually necessary and jointly sufficient conditions for doing so. The notion of "the English language" dissolves first into its community dialects, and these into individual idiolects, and the idiolects and dialects are not only uniquely individual in ways which may prove relevant for any proposed formal criteria of classification, they are also changing in time with the developmental history of the individuals and communities. It cannot in principle be possible to say when the first English sentence was uttered, or whether a given speaker is a speaker of English, or whether a given utterance is in English or not across all cases. The science of language stays as far from the inevitably fuzzy edges of its object as it can. It pretends that its object is just like an electron or an integer most of the time, but with fuzzy edges, whereas it would be more useful to recognize that it is dealing with an object of a wholly different sort, not even an "object" in a definite sense, but, at least, an epigenetic system.

What is said of matters biological and cultural is not only more directly linked for these reasons and in these ways to matters human than the discourses of the outer rings, but also depends more sensitively and more critically on the viewpoint from which they are discursively constructed as scientific objects, since all scientific objects, but especially those nearest the center of the specification hierarchy, are essentially constructed by principles of similarity and difference with respect to whatever, or whoever, sits dead center and makes these constructions.

Historically, and still today, the viewpoint at the center has predominantly been that described, rather exhaustively above: the modern European middle-class, middle-aged, having-married, having-fathered, having-been-trained-in-science, masculine, male point-of-view. In terms of specification order, we can put this roughly as: culture, class-age-gender, scientificity. Our concern is that the last, specialized training in the practices (including the ideological self-construals) of science as a subcommunity, inherits properties (dispositions, biases, perspectives) not simply from the general culture, but from the particular class, age, and gender specificities of those who have historically been members of this subcommunity.

Few men of this community would imagine that, if there were a scientific discipline which had been founded by women and which throughout its long history had been almost exclusively pursued and developed only by women, that this discipline would show no discernable traces of this fact, or would imagine at least that, as a man, they could potentially bring a new and possibly fruitful perspective or point of view to such a discipline. Fewer still middle-class men would imagine that they could not find ways to improve on some system of social practices that had heretofore been the exclusive province of working-class women (or men). Few adult males would doubt their ability to best children at any task; few in European culture would doubt that they could excel at whatever belonged solely to the province of the elderly. Few masculinized, heterosexual males would doubt their ability to best "nerds" or "queers" at any task worthy of a real man. And how many of our culture have, and still do, set out to set straight those of all the non-European cultures ("lesser breeds without the Law" we sang in school) about every matter of every sort, from religion, to business, to law, to politics, to science.

The time is not long past when it was explicitly proclaimed by those at the center of the Europatriarchal hierarchy that children could not, women could not, Africans and Asians could not, and all those who were not truly manly could not as a general rule make valuable contributions to science, to technology, to philosophy, to religion, to business and political affairs -- to all they regarded as truly important and arrogated to their particular province in social life.

Why are some of these truths no longer so loudly proclaimed? What, in fact, determines which social practices are appropriated to the provinces of various ages, classes, and gender-categories within a culture, or at least within modern Europatriarchal culture? And how do these factors in turn influence the character and practices of, for instance, a science? We arrive here at the border of the second critique.

The Masculinist Critique

The Specificationist critique develops from the simple observation that some scientific discourses and systems of practices do not seem as relevant to, or as sensitive to, matters of cultural and subcultural perspectives as do others. The specification hierarchy for the scientifically constructed objects of the natural world seems to suggest both that those sharing the fewest culturally privileged properties with humans and human social relations and processes are the less (though still) perspective bound, and that all scientific objects (and particularly those sharing the most culturally privileged properties with the human sphere) are constructed from a specifically human, and an even more specifically culturally positioned perspective.

The Masculinist critique develops from the observation that doing nuclear physics, civil engineering, or petroleum geology is not widely considered by men in our culture to be a "sissy" occupation in the way that being an interior decorator, hairstylist, or fashion designer is. While it would be hard to come by believable figures for the proportions of gay men in those sciences, it is not hard to believe that they would be as underrepresented there as women are, or that they are clearly present in more than representative numbers in the other three occupations. These sciences, and many others, have strongly masculinized self-constructions. Entering and working in these occupations plays a role in the social construction of masculinity for individual men and as part of the operation of the much larger system of gender-defining practices in our culture.

Ought we not then to suppose that the role of these sciences in the gender system has influenced in some way the nature of their social practices as communities? that what they are, as systems of social practices, as sciences, is in part shaped by their functioning in the social construction of gender relations?

The issues raised by this example go far beyond science alone or gender alone. We need to examine the gender system itself in its broadest and most comprehensive sense, and the system of occupations and daily life practices in the culture, and then we can look intelligently at how they might articulate with and depend upon one another.

The gender system

Both sex and gender are notions well in toward the center of the specification hierarchy. They are also both also deeply implicated in core ideologies of our own culture. It is therefore necessary to treat received notions about them with extreme skepticism and to attempt to examine exactly how they are socially constructed and reconstructed, case by case. They are not logical categories and have no useful analysis in these terms. They are effects or products of meaning-making practices that are always different on each occasion of their deployment. The unities and invariances of their

ideologically constituted stable forms are as much illusions as their historical, cultural, or biological necessity, universality, or permanence.

In a social semiotic, or ecosocial dynamic, analysis (Lemke 1984, 1988b, 1990a, 1994, Forthcoming) what we must examine are the doings by which sex and gender categories, or more properly assignments, are made. The gender system is not a system of terms or objective social or biological relations. It is a system of social practices which produce these as their effects, and it is a system by both material criteria (material interaction and interdependence of the practices as material processes) and semiotic criteria (constructed relations of meaning among the practices and their effects/products). What do people DO that constructs the notions of sex and gender, the discourse about them, and the construals of phenomena in terms of them? What do people DO that shapes the material development of bodies and the embodied dispositions to semiotic practices along paths of difference that are then construed in terms of sex and gender?

This is a very large area of inquiry, and I plan to just sketch a very few bits of it, mainly those needed to get a comprehensive enough picture to ground the masculinist cultural critique of natural science.

The notion of "two sexes" is itself a product of the gender system, in interaction with many other systems of social practices, including discursive practices. The dominant gender ideology of our cultural tradition attempts to construct two mutually exclusive and jointly exhaustive gender categories, male and female, and to conflate or identify these with two categories in the discourse of biological sexual reproduction (centrally of humans), male and female. We can tell immediately from their positions in the specification hierarchy that NO categorial approach is feasible in either of these two domains. Such an approach serves predominantly ideological purposes.

In humans, there is no biologically valid definition of "two sexes" that fits the categorial model, as there could not be in the nature of biological scientific objects. The chromosomal criterion fails because it produces more than two: XX, XY, XXY, XYY, etc. Cellular, developmental, evolutionary, organismic, etc. criteria all generally produce more than two sex types, do not always agree with one another, and are not necessarily invariant either from species to species phylogenetically or from one developmental stage to another ontogenetically. As with language, the ideological solution is to simply rule out all the cases that do not fit the "two sexes" model. Hermaphrodites, transsexuals and intersexuals of various sorts, to speak only of the organism phenotype level, are erased from the cultural view of reality, by silence, by relegation to obscurity, by medical intervention to impose the "two sexes" cultural model on a recalcitrant biology, and even by denial of first the occurrence of, and then the "normality" of these phenomena.

The gender system seeks to naturalize its "two genders" model with the "two sexes" charade. When we come to ask how many GENDERS are actually constructed in our community, we find a vast system of diversity, as we would expect. Again, it is not the genders themselves which are fundamental, but the practices that construct and construe them. The analysis of the gender system, can, however, begin from an exuberant typology, and then begin to collect and interrelate the practices constitutive of these sociotypes.

So vast and complex is this system that I can only barely sketch its broadest outlines here. Let us begin, cautiously, from the canonical model, the ideologically dominant discourse construction. According to the "two genders" model there are two genders/sexes, "male" and "female" with cultural attributes (neglecting biology for the moment) of "masculinity" and "femininity". Here is the first clue, for the cultural attributes are clearly non-categorial; there are degrees of masculinity and femininity, and there are multiple criteria and dimensions for each. Moreover, just as not all human organisms are canonically biologically male or female, so not all human social persons are culturally either masculine or feminine. There are two neuter categories, defined as "exceptional" or "abnormal" (note that the entire gender system is constructed from the center of the specification hierarchy as defined above, so from at least a canonical male viewpoint): "nerd" and "androgyne"; and there are the "invert" categories: "effeminate" or "sissy" (of those typed as biological males) and "masculine" or "butch" (of those typed as biological females).

The exceptions begin to show us that we are dealing with a number of independent dimensions of social construction of gender, which in principle cross-multiply each other, but which are ideologically mapped onto one another in such a way as to make the system appear one-dimensional (male/masculine vs female/feminine) when in fact all the possible combinations also appear (male/feminine, female/masculine). We can now escape somewhat from the canonical perspective by considering how the gender system looks from the "excluded" perspectives. The canonical ideology also maps sexual orientation onto a single dimension; there are only two orientations "heterosexual" and "homosexual"

defined in terms of the "two sexes/genders" model. One is again excluded as "abnormal" and mapped onto the other excluded cases, so that male homosexuals are stereotyped as effeminate, female homosexuals as masculine.

There are, fortunately, well-developed gay and lesbian communities and subcultures to which we can turn for a different view of the gender system. I take up only the male gay culture here. Within this culture there is a debated (because it partly reproduces the canonical ideology), but still recognized polarization into more masculinized and more feminized gay sociotypes, and there is a sort of heterosexuality among gay men in that couples tend to be of polar unlike types. But it is very clear that the social construction of the gay genders in gay culture is not identical with that in "straight" culture, and that the two approximate gay genders are not identical at all with the canonical masculine and feminine types. Delving a little deeper one sees that there are a number of sociotypes in gay culture, and because this culture is intensively focussed on sexuality and on gender images, these sociotypes are all also subgenders. Sexual attraction among gay men is often subgender specific. An analysis of these sociotypes immediately shows a social class effect which is very revealing about the gender system as a whole: some of these sociotypes are clearly products of working-class gender images (the "leatherman", the "clone") and others of middle-class norms (the "all-american boy"). There are more than two male-gay gender poles, and social class is an element of this system.

We can now return to "straight" culture and also see that there are different norms of ideal masculinity and ideal femininity between middle and working class subcultures. There is also the interesting phenomenon, I believe, that the dominant model for masculinity is the working-class one, and for femininity is the middle-class one, which raises many fruitful questions about the larger nature and functions of the system as a whole in relation to social class conflicts.

I will not pursue more details here (see Lemke, GS), but only say that my current working model, itself necessarily still a gross approximation, of the gender system considers social practices that construct different gender models by social class, age, and sexual orientation. The model is recursive, so that the number of categories in it is unstably large, as is appropriate for a system of this sort, but it is still useful to begin from a notion that there are usually at least three basic gender types in each subcultural system (a masculinized pole, a feminized pole, and a neuter), and that there are distinct subcultural systems by social class (at least 2 classes), by age (at least 4 age classes), and by sexual orientation (at least 3, but really far more), for a minimum of 72 culturally defined gender types.

This of course ignores the multiplication of biological sexes, of which we must suppose there are at least a half dozen. It is not clear however that the minority sexes have formed communities and cultures and so subcultural gender systems of their own. It is also not clear if there exist, say, culturally articulated sexual preferences for or sexual orientations toward members of these other sexes. It also not clear if, say, autosexuality and bisexuality count as additional sexual orientations (probably yes), and whether they generate subcultural models of gender (probably no).

The full recursive complexity of the system is illustrated by considering, say, a transexual, who might have one chromosomal sex (XY), a mixed anatomical-physiological sex (F/M) and a gender self-identity (one of the many subcultural Fs, or a mixture) -- which may be variable over the course of the life-history -- and a sexual orientation or preference for a similarly complex type. If a woman in a man's body is attracted to women, is she a lesbian or is he heterosexual? The meaninglessness of such a question illustrates the inadequacy of the canonical model for serious inquiry, and points to its probable ideological functions.

We now have the beginnings of a view of the gender system within which we can pursue the masculinist critique.

Occupational masculinism

The initial principle of the masculinist critique is that the sciences, as relatively masculinized occupations, participate in the social construction of masculinity for their members, and the maintenance of the canonical (middle-class, middle-aged, heterosexual) model of the gender system in society as a whole.

To pursue this further we need to consider how not just people, but occupations are gendered, and how the gendering of each interacts with the gendering of the other. The gender model we will be using in this analysis will mainly be the dominant one, but will have to take into account at least the differences between the middle- and working-class subcultural models. These are the models which, by and large, the gendering of occupations works to reproduce.

MASCULINIST OCCUPATIONAL CONSTRUCTIONS:

POWER, over people, esp. central (male, middle-class, middle-aged, etc., diminishing to peripherals (females, children, workers) with respect to Beliefs, Behavior/labor
RESOURCES, under control, esp. financial, material, energy
CONTROL, scale of (numbers of people, geographical area)
IMPORTANCE, Social
TECHNICAL COMPETENCE, specialized training
SELF-CONTROL, emotional

AGGRESSIVITY, expected, required, exercised
DANGER, degree of (high is favored); cf. Courage
VIOLENCE, potential to exercise
ADVENTURE, EXCITEMENT
SKILLED LABOR
FEATS OF STRENGTH

not GENTLE
not CARING FOR OTHERS
not ESTHETIC, INTELLECTUAL SENSITIVITY

Roughly speaking the first group are the middle-class criteria, the second group the working-class ones, and the last are the inversions from the feminized and gay male occupations.

Passing now beyond workday occupations to other activities, among the most masculinized are:

Amateur sports participation (sport divided by class)
Individual exercise activity (weight-training ... jogging)
Professional sport pseudo-participation (divided by class)
Technical/skilled amateur labor: Electrical, plumbing, carpentry, construction; diminishing to housepainting, yardwork (cross-class basis)

and the least (high incidence of gay male or female participation):

Amateur arts, music participation/performance/activity
Professional arts/music pseudo-participation (concerts, galleries)
Similar intellectual: foreign films, lectures, art novels, serious reading;[all from middle-class cultural sources]

Note that within these categories there are masculinization clines, so that there are more masculinized sports (football) and less (tennis, golf) often associated with class, age, and gender differentials in participation. Of particular relevance to our inquiry into SCIENCE is the relative masculinization of the professions as middle-class activities:

Lawyers:
Criminal prosecutors, defense lawyers; Litigators ... tax lawyers

Physicians:
Surgeons (brain/heart ... cosmetic) ... pathologist, pediatrician

Scientists:
Physicist, Engineering, Geologist ... Botanist

Academics:
Scientists, Economists ... Literature, Fine Arts

In each case the cline is listed from most to least masculinized.

The table of masculinist occupational constructions identifies some of the mediating strategies for the construction and differentiation of occupations and activities as more and less masculine. How do the sciences as occupations, activities, and communities, as systems of social practices participate in the masculinizing practices of the dominant gender system?

Science, Gender, and Power

Science has not always been as high in the scale of masculinity as it stands today. The applied sciences, especially engineering, and to a lesser degree medicine, have long participated to some degree in the prestige of being "manly" occupations. This coincided largely with the extent to which they had acquired coercive social power or were instrumental in supporting the power of others. The theoretical and research sciences were long considered the province of country clergymen, potty amateurs, and more recently, science "eggheads" and "nerds". There is still a complex struggle going on over the relative masculinization of the middle-class occupations, part of the general social revolution from owner-capitalism to managerial technocracy (cf. Lemke 1990b).

Science has masculinized itself largely by association with military occupations (chemistry and munitions, physics and nuclear weapons) and to the degree that it has become Big Science, i.e. big business, with a managerial elite (lab directors). The most masculinized roles in science, and among the sciences, are those associated with the greatest degree of power and control over other people (especially those who are themselves masculinized and closest to the center of the specification hierarchy) and over resources. The social importance of the occupation or the science depends in many respects on its alliances with the military and industrial centers of social power and prestige.

These are largely the constructions that define the middle-class model model of masculinization. But there is a profound ambivalence in the dominant culture between the middle-class and working-class models of masculinity. For reasons that are only partly clear at this point, the gender system's role in helping to maintain the dominance of the middle-class over the working-class, requires the higher degree of masculinity to be assigned to the latter. I believe this is closely associated with the ways in which the relatively most dangerous social fraction, the younger working-class male population, is subjected to normative control through its self-identity. The extreme masculinization of this identity produces occupational dispositions which are not competitive with middle-class males (whose occupations are seen as less manly) and behavioral dispositions which are easily manipulated by such strategies as extreme homophobia or gender insecurity (the ideal role is very difficult for many to play) toward embracing extremely dangerous or physically exhausting and debilitating roles (soldier, policeman, stevedore, foundryman, etc.) which contribute more to middle-class interests than to their own. One need only question their masculinity, or suggest that they are "sissy" or maybe even a closet "faggot" to get them to assert a hyper-masculinized identity which works against their interests.

On the other side of the class divide, however, this arrangement also makes middle-class males somewhat envious of the greater masculinity assigned to working-class men, and they too compensate for this by dispositions toward moderated forms of the working-class masculine constructions (aggressivity, risk-taking, tours de force of skill, showing-off) which are still compatible with their own occupations.

Which brings us to the academic occupations in general, and the sciences in particular. Academics in general are rather low even in the middle-class rankings of masculinity; they are "wimps" (a working class term). Male academics seem to constantly struggle towards a higher degree of masculinization, and many features of academic politics and academic argumentation, debate, competitiveness and enmity can be better understood in these terms.

Across the various academic disciplines there are different reigning traditions of the models of masculinity. The humanities have a generally more aristocratic model (a residue, and a romantic reconstruction, not I think a historical survival, at least in the US, though possibly in some other cultures), and this highly feminized, or effete, even by middle-class standards. This also, of course, makes the humanities much less closed to the dispositions of women and gay men. At the other extreme are the natural sciences, where there is a relatively greater play given to the working-class model of masculinity, which may actually work to make the sciences more accessible to working class males than are the humanities, while at the same time more strongly excluding women and gay men.

Within the sciences, there is a clear polarization between biological and physical sciences, and within biological sciences between the more masculinized subdisciplines of biochemistry and molecular genetics, and the less masculinized ones such as ecology, organismic developmental biology, botany. Once we come to the details of

particular scientific subcommunities, matters are, as they should be, complex and individual, dependent on historical trajectories, epigenesis, and emerging self-organization. In a subcommunity such as American primatology (cf. Haraway 1989, 1991), it would seem that there has been a struggle going on, the more intense and obvious because of the high stakes of a discourse whose objects are relatively close to the center of the specification hierarchy, between a more masculinized disposition and a genuinely female one (not at all the same as "feminized", which is still a construction from the masculinized male point of view).

The "hard sciences" are hard-nosed about hard data; priding themselves on how hard they are, they hardly ask why hard should be considered more intelligent or more reliable than soft. Hard, cold logic can only make sense semantically in contrast to soft, warm logic, unless these terms stand for cultural norms of masculinity and nothing else. The exploration of the metaphors of science, not simply those it uses to characterize its own activities, but those it relies on to think about matters for which it has little or no ready-made conceptual framework, should produce endless examples of masculinist dispositions. The discursive construction of scientific objects, of the existence of phenomena looked-for or capable of being culturally recognized, of the canons of observational reliability, evidentiality, argumentation, resolution of dispute, etc. -- all must reflect the pervasive masculinized dispositions of the sciences. The details in particular cases are well worth examining.

The specification hierarchy suggests that in some places where natural science is most masculinized (the physics of simple and ideal systems), its masculinizing dispositions may make little difference to what it ultimately says, but considerable difference to how it says it, by what path it comes to say it, what alternatives it never considered, and, particularly, whom it encourages to speak with its voice and whom not. On the other hand, much of natural science deals with matters closer to home, for which it matters quite critically with what gender dispositions we shape our theoretical objects and scientific practices. Here masculinism is not simply a social gatekeeper protecting the privilege of a tiny fraction of humanity, it is also a systematic bias reaching into every aspect of the scientific enterprise with significant effects.

Generally speaking, those scientific disciplines are most masculinized which are most closely linked to the social bases of coercive power; their masculinization helps to keep that power within the circle of those who have predominantly held it in our culture in modern times. On the other hand, those scientific disciplines are most profoundly biased, limited, and distorted by masculinism, not simply in their operations, but in their discourses about the natural world, which construct their objects nearest to the center of a specification hierarchy that has human systems in general, and the viewpoint towards them and towards all things of middle-class, middle-aged, heterosexual males at its prime focus.

The masculinization of the sciences, the masculinist focus of the specification hierarchy, and masculinism in general is today being challenged by the growing social power of women and gay men. The larger cultural system of which masculinism is a critical element, which I have called simply Europatriarchal culture, is further being challenged by the growing power of non-European cultures and communities outside it and within it. It is in crisis, it is changing. Its violence, to the extent that it still has the will to sustain itself on this ground of its original construction, will have to be met by violence. Violence against women, against gay men, against the poor, against children and the aged, against non-Europeans is the foundation of Europatriarchal culture. Our own largely middle-class dispositions do not wish to think about or focus on violence against bodies as the foundation of our social order.

Violence is the inflicting of pain on bodies. The central core of masculinism is the disposition to inflict pain on the bodies of others to control them. To the extent that masculinism pervades the sciences, we must be able to identify, so that we may expose and counter, its overt and covert violence, its cruelties, the pain of all kinds it inflicts or threatens, however implicitly, to inflict on us to enforce control. Every established institutional social system in our culture is grounded in coercive power. Every ideologically functioning social practice ultimately acts to conceal this grounding. If we want to pursue an analysis of science, masculinism, and the gender system to the ultimate material basis of cultural forms, we must carry it this far.

Coercive power is not the only possible ground of a social order, for the power to control others is not the only modality of power. Power means, ultimately, being able to do; control of others is a masculinist, and perhaps an especially Europatriarchal disposition. There is also the power to support others, to work with and empower them, to enter into mutually supportive relationships, to concede and yield, to harmonize. Perhaps it is my own partially masculinist disposition which makes me doubt that any social order can be grounded entirely without recourse to coercive power, but I equally believe that our other human social powers will need to play the principal roles in an ultimately just social order. Other gender dispositions, arising out of other epigenetic trajectories of actively lived

experience, provide the human reservoir in our culture, and in other cultures, of the diversity of powers and models for social relations on which we must draw to create not just a better science, but a better ecosocial balance.

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