Representing Science Representing Nature

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ABSTRACT

This paper examines the recursive and highly productive dialectic between the constitutive effects of science *as* a social praxis and as the *image* of a very unique kind of social praxis. I argue that dominant images of modern science engender a dangerous logic of reification though their appropriation of narratives of objectivity that claim a methodological path to unmediated or "natural" knowledge. Representations of science that fail to recognise their specificity as representations by abstracting human agency from the processes of representing science and scientifically representing nature, reify unexamined ideological presumptions (about human and nonhuman nature, and about science itself) within the kinds of scientific representations of nature that these representations of science engender.

Introduction

"If living history means we cannot help making marks on a fallen world, then the dilemma we face is to decide what kind of marks we wish to leave" (Cronon, 1996: 88).

"It could perhaps be said that the whole of philosophical conceptualization, which is systematic with the nature/culture opposition, is designed to leave in the domain of the unthinkable the very thing that makes this conceptualization possible" (Jacques Derrida in Rheinberger, 1997: 18).

Founding Questions

Returning by train to Toronto from a family visit to my hometown of Ottawa in May 2000, I casually flipped through my complimentary on-board copy of *VIA Magazine*. Normally filled with thinly disguised self-promoting articles calling the reader's attention to various tourist destinations serviced by VIA Rail, this particular issue featured seven prominent Canadians and their insights into what changes the new millennium might bring to Canadian society. The distinguished cast of soothsayers was drawn from a cross section of society appropriate to the categories considered uniquely important in the minds of many Canadians – namely, the economy, the family, culture, science and technology and, of course, hockey.[1]

It is perhaps an indication of the increasingly prominent and authoritative position that science holds in our collective imaginations that almost half of those represented in the article were scientists. It was their predictions, in particular, that captured my attention. From the anticipation of medical advances expected from the completion of the human genome project, through conjectures about the controlled chemical synthesis of life, to warnings about the need to maintain mastery over our own technologies (lest we become slaves to where "they" might take us), these scientists were at once affirming the efficacy of the objectivist ideology of modern science and simultaneously espousing the appropriateness of modern science as a profoundly productive cultural narrative.

While the subtle contradiction of this double move will form an important avenue for discussion in the pages that follow – raising critical questions about science as an epistemological practice and about the importance of how we understand and represent science to the production of specific understandings of knowledge, nature and human nature – my initial reaction to the *VIA Magazine* article resonates more intimately with what is missing from the images of science tacitly implied by these and other discussions of science and science practice in popular culture. Peculiarly absent from our representations of science, and from the representations science itself produces, are any and all of the actors – human or nonhuman – whose existence and meaning to us (who, in many instances, are "us") are deeply implicated in the fabrication and realisation of our collective existence. Amid the predictions of new discoveries, new technologies, new avenues for research and the promise of continued progress in the quest for certain

[1] Politics was notably absent.

knowledge, these scientists tell a story of a ceaselessly evolving science and an ever burgeoning society filled with potential and promise, (if only a few hazards). Yet, within the social narratives that inhere in these predictions, the "subjects" and "objects" – the actors whose co-presence is necessary to the conception and function of both science and society – remain fixed, constant, unique, and mostly invisible.[2] While we are continuously transformed by the use of new knowledge and technologies, we believe ourselves to be somehow absent from processes we've created produce (read "discover") them. We live in a world, it seems, in which knowledge evolves, technology flourishes, society develops, yet what it means to be human – the "essence" of being – remains, in some fundamental sense, unchanged.

Such ambivalence toward the powerfully abstracted authority of science to represent and shape the world we live seems dangerously naive at a moment in history when scientific and technological advances are increasingly inseparable from the larger contexts of local and global social challenges. Among these challenges I am inclined to include the degradation of the environment, the socio-scientific "management" of risks associated with emerging technologies of unprecedented complexity (such as genetic engineering), and the emergence and deployment of these technologies within the increasingly antidemocratic logic of a corporate driven social and economic paradigm. These challenges are vastly complex and intricately interrelated, but in ways that are not often recognised or acknowledged. How we choose to frame and respond to these challenges is profoundly linked not only to how we relate to each other and to the world in which we live but, more subtly, to how these relationships engender and are engendered by specific understandings of ourselves as actors or agents in an ambiguously social and natural world.

What assumptions about science, about nature, and (perhaps above all) about human nature are required to imagine our essential immutability in the face of profound socio-scientific uncertainties? What particular understanding of the human[3] and of what it means to "know" something is necessary to a view of reality in which one may act upon the world without oneself being acted upon? How is the absence of human and nonhuman agency from our representations of science and scientific knowledge a socially, politically and scientifically productive or determining move? How is this absence achieved? What happens in the space precisely delineated by the "determining absence"[4] of the actors in scientific accounts of knowledge and knowing? Most importantly, who, exactly, are the actors?

The full complexity of these questions will necessarily elude my attempt at answers. Yet, in the effort, I hope to demonstrate their importance, including their political importance, for human and nonhuman nature. More specifically, I wish to lay a foundation for asserting the significance of these questions for

[2] Except, of course, for the heroic scientific genius who, if not credited with the production or discovery of scientific knowledge, is nonetheless characterised as having a unique and even "natural" capacity to access "natural truths".
[3] This discussion will focus principally on subjectivities and how human agency is configured in relation to images of science as a dominant knowledge practice. It does not, for example, consider the "human" as explored in other related critical discourses like phenomenology.
[4] The notion of a "determining absence" is borrowed from Beer (1986). The concept, as it is used by Beer and taken up in this discussion, will be elaborated upon throughout the text.

environmentalism – a discourse which, in a variety of often conflicting manifestations, has set itself the task of drawing our attention to some of the actors displaced in our ways of knowing nature so that we might begin to build more responsible and liveable relationships within and among the "social" and "natural" worlds.

Theoretical Framework: The "Science Question" in Liberatory Politics

Recent science studies scholarship has variously argued that "scientific knowledge is not given by the natural world but is produced or constructed through social interactions between/among scientists and their instruments, and that these interactions are mediated by the conceptual apparatuses created in order to frame and interpret the results" (Ross, 1996: 12). Science studies scholars have accordingly challenged the notion of science as a universal or monolithic practice, suggesting instead that science is a heterogeneity of practices that manifest uniquely in relationship to varying disciplinary, historical, cultural, political and linguistic contexts and practices. These analyses stand in sharp contrast to widely held images of science as an objective, neutral or apolitical means of accessing fixed, universal (read "democratic") truths. Indeed, much of the more sophisticated science studies scholarship – most notably the recent work of feminist scholars – uproots the very notion of objective truth and, further, suggests that the tenacity of this concept in the imagination of the modern mind has engendered patently undemocratic and systemic relationships of domination.

These assertions have emerged as an integration of the ongoing work of philosophers and historians of science with more recent and more politicised perspectives from the social sciences. The synthesis of insights from these varying positions has enriched understandings of both how knowledge is produced and, perhaps more importantly, about how the assumptions that inhere in any given system of knowledge production – and especially in science – can play hidden but potent roles in the construction and organisation of social relationships and practices. At stake in these analyses are the images of science as a universal and unifying practice through which we have imagined the possibility of unmediated access to the "natural" truths of a coherent material world in which there is ostensibly nothing to distinguish between reality and our representations of reality. These images, as I will argue throughout this paper, are not only naïve about the actual practices of science, but their implicit assumptions about nature, and about the processes of producing knowledge of nature, have engendered a "systemic ignorance" about the kinds of knowledge necessary for advancing and sustaining human life in healthy environments under democratic conditions (Harding, 1996).

For the politically minded, the project of critiquing modern representations of science is thus as much about demystifying popular understandings of science (and scientists' mythic representations of science) as it is about asserting the importance of these understandings to the material, institutional, and symbolic relationships that shape public culture. When we suppose science as a mirror of nature rather than as an expression of dynamic interactions between social and material contingencies and constraints, we displace the relational aspects of scientific enactment in ways that reify its unexamined ideological presuppositions

within an abstracted vision of a fixed natural order. Images of science as the perfect representative of a "permanently and constitutively speechless objective world" (Haraway, 1992a: 312) engender processes of appropriation that align along particular axes of instrumental power; universalism is universalising, an ideological epistemology that "produces, appropriates, and orders all difference" through an "artefactual-social rhetoric of crafting the world into effective objects" (1991: 193, 185). Indeed, science is not only the embodiment of specific values and beliefs *about* nature, it is an *enactment* of those values and beliefs *in* nature; "what we know or claim to know about the natural world comes to us in our own constructions" (Keller, 1992: 3). That is, nature is not an external referent against which to measure the certainty of knowledge. Nature is a representation made meaningful through its articulation[5] within the processes of representation itself – processes that are inevitably shaped by the limitations of our cultural and linguistic frames and values on the one hand and by the constraints of a prelinguistic nonhuman world on the other. Traditional understandings of science in this way challenge the discovery of new spaces of understanding more responsive to the need for open, liberatory, heterogeneous, and creative ways of knowing.

The assertion that scientific knowledge (and thus also "nature") is somehow socially contingent or constructed – derived as much from social, ideological and linguistic conventions as from an objectively constitutive material world – is no doubt contentious and apt to be dismissed, or worse, misunderstood by those who see realism and relativism as two poles with no inhabitable space in between. In one sense, this is among the most meaningful projects of recent science studies: to map the space between the naiveté of a "copy theory" of representation (or an objectivist epistemology) and the relativism of an epistemology that sees all representations as equal. Recognition of this space is necessary to any critical and emancipatory project for it demands the rejection of reductionism and universality (the enforcement of one standard language through which all translations of the Real must be spoken) while holding an appreciation for our accountability in the fabrication of the meanings and representations that order our relations to each other and to nonhuman nature.

This paper endeavours to synthesise some of these arguments in a manner that demonstrates the relevance and unique contribution of critical science studies scholarship to larger emancipatory struggles and their attempts to find spaces in which to imagine responsible knowledge practices – practices founded not on notions of unmarked immutable truths, but on a radical awareness of the cultural, historical, political and linguistic contingencies of all knowledge claims. If it can be demonstrated that science is a cultural practice whose particularities emerge in relationship to a complex network of social and material "realities" and whose processes and products engender specific social relationships and practices, then the question is no longer about how to gain unmediated access to nature, but how to advance critical knowledge practices faithfully committed to both the contingency of all knowledge claims and to a diversity of just, sustainable and

[5] Articulation takes on a special meaning as this discussion proceeds. Following Haraway (1991) articulation will be used to emphasise the agential relationality of representation and to inform the desire for an openly discursive politics.

responsive – that is, politicised – representations of nature. This process begins, I argue, by coming to understand science *as* a representation and by recognising the material significance of how dominant images of science can deny their own representational character through the ostensibly objective representations of nonhuman nature they engender.

The importance of this critical positioning has been most eloquently articulated by feminist science studies scholars. Their sophisticated critiques of objectivity have argued, for example, that the ideological commitments that inhere in science practice have profoundly shaped and policed the social representation of women as well as symbolic and bodily manifestations of women's identity (particularly in relation to nature).[6] Indeed, the exigency with which feminist and other science studies scholars argue the ways in which culture, language, politics and other forms of social praxis shape the production of scientific knowledge stems from an appreciation of science's social efficiency in the (re)production and naturalisation of complicity about nature, identity and the categorical importance of these concepts to cultural/political/economic cum "natural" relations of domination. Science is itself a complicit actor in what "post-Marxist" political philosopher Chantal Mouffe (1993) calls a "hegemony of oppressive values"; the failure of science as an enterprise and social category to acknowledge challenges to its epistemological foundations or to accept certain responsibilities for its position in historically specific matrices of power (say, capitalism) through appeals to disinterestedly objective subject positions speaks to this complicity. Ruth Hubbard, a pioneering feminist scientist, seizes this notion and its importance to the feminist movement rather eloquently when she writes: "Women cannot expect to attain equality until we understand clearly how *scientific* descriptions of ourselves as biological and social organisms are generated and used in order to maintain sexual *in*equality. Though women have not had a significant part in the making of science, it has had a significant part in the making of women" (1980: xix original emphasis).[7]

This paper is not an extensive analysis of the feminist commitment in science studies. It is, however, with the significant help of a rich feminist perspective that I attempt to highlight how evolving technologies of representation, including "technologies of the observer",[8] have played into matrices of social power to powerfully shape constructions of social subjects. How, for example, has the abstraction of the scientific observer from the local and diffuse specificities of his/her observational context developed in relation to the values of liberal subjectivity upon which many of our political and economic institutions are founded?

[6] The association of women with nature engenders a (albeit historically specific) network of metaphoric associations of particular interest to feminist scholars who maintain that the hegemonic domination of women and nature are parallel forms of exploitation.
[7] While there are no doubt many more women scientists today than in 1980 when Hubbard made this assertion, understanding the material, institutional and symbolic productivity of science and scientific representations remains crucial to movements that aim to challenge dominant matrices of power.
[8] Jonathan Crary (1996) uses this term to characterise how the scientific subject is empowered to "objectively" scrutinise the subjective position of the observer through mechanical innovations (such as the camera obscura) that dramatically shape (and are shaped) by discourses of social power. He argues that visual technologies like the camera obscura allowed a quantification and homogenisation of vision/perception and created new objects of vision (e.g. commodities, photographs, even the act of perception itself) that could be "abstracted from the observer's position within a cognitively unified field" (1996: 19). Crary's argument is discussed in more detail below.

Consideration of the dialectic between constructions of an objectified or "scientised" nature and constructions of "totalised" social subjects is necessary to bridge the conceptual gap between naiveté about how science works and the struggles of emancipatory projects to find political space within the power fields of modernisation. Through feminist analysis of the constitutive role of language in genetic research and technology I ask what is the role of science in the construction of different social identities? To what extent do technologies of representation, including specific configurations of the "observer as human subject", shape not only our knowledge of nature but also the construction of social locations and identities? These questions are important because their pursuit not only enriches our understandings of knowledge production, but also because they point to modern configurations of these dichotomies as subjugating power moves, "specific human self-production and self-possession" (Haraway, 1992b: 81). These are configurations in which difference is policed, denied or erased according to the reifying movements of appropriation engendered by the ostensibly unmarked position of the scientific knower.

These explorations of subjectivity also raise challenges for critiques of science, which must be careful to acknowledge the contingencies of their own critical positioning. On the one hand science studies argues that to sequester questions in and of science from other interrogative contexts – the social, the political, the economic – is already to "falsify all the parts" and (in the case of questions of culture and justice) to "mystify oppression in the form of science" (Young in Haraway, 1992b: 78). But, as Bruno Latour warns, to privilege the social categories is one and the same move, one that always already denies that *all* representations (including representations advanced from positions of critique) emerge from networks of meaning and signification that are "*simultaneously real, like nature, narrated, like discourse, and collective, like society*" (1993: 6 original emphasis).

This tension underscores the need for and importance of the principal argument of this paper, which begins by exploring science as both a system of representation (through which nonhuman nature is made meaningful to us) as well as a representation in and of itself. There is an important and highly productive dialectic between the constitutive effects of science *as* a social praxis and as the *image* of a very unique kind of social praxis. Our understandings of the processes of representation in science are projected *in* representations of science as well as in the representations produced *by* science. As it is in both of these senses that science has come into question in recent science studies work, critiques of science must find analytical tools that effectively challenge modern images of science and science practice while nevertheless exemplifying the commitment to non-foundational politics underlying their projects. That is, in advancing alternative representations of science, science studies scholars must be careful not to ignore the contingencies of representation more broadly by failing to locate the representational organisation of their own critical positions.

By drawing attention to the relational dynamics implicit to the production of scientific meanings, and to the production of systemic knowledge more broadly, *Representing Science Representing Nature* contests

assumptions about nature as the fixed and external anchoring point of scientific representation. It thus challenges us to rethink the role of nature, or the Real, in the formation and articulation of representations and representational locations, and invites us to ask, what might alternative images of science look like? What does critical analysis of science teach us about the making of meanings and bodies both within and without the particularities of scientific practices?

Haraway articulates the underlying political commitment beautifully and precisely: "For political people, social constructivism cannot be allowed to decay into the radiant emanations of cynicism …We need the power of modern critical theories of how meanings and bodies get made, not in order to deny meanings and bodies, but in order to live in meanings and bodies that have a chance for a future" (1991: 184, 187). How might we learn from critiques of science how to fabricate better accounts of knowledge without forgetting our location within any and all knowledge claims? What do they teach us about representation in a broad sense, about nature and identity and their place in politics? How might nature, through critiques of science, be articulated as a political (rather than just an epistemological) problem?

Images of Objectivity: Representing Representation

"[T]he desire to discover certain and absolute knowledge of nature hinges upon a particular understanding of the human, as well as on a particular understanding of what it means to know something" (Evernden, 1992, 40).

"The effort to make the subject into an object leads us directly to the paradox of scientific 'objectivity'. An 'objective' observation is one that does not make a value judgement, and yet we judge it to be valuable precisely because it does not assign value" (Hankins and Silverman, 1996: 230).

A dominant (though by no means exclusive) narrative of evolving conceptions of science since the nineteenth century tells a story of the progressive elimination of human agency from its practices of observing, recording and speaking nature. Rather than mediate experiences of nature, science is understood as a means of "letting nature speak itself" through mechanical, methodological and conceptual techniques that ensure the insulation of scientific knowledge from the "extrascientific" considerations of a changing landscape of social, political, and moral practices. This supposed characteristic of modern science is what, in general terms, is meant by those who claim that science is an *objective* knowledge practice. Indeed, objectivity (and by extension science) has become the overwhelmingly accepted standard of reliability and truth-value, measured as an absence of the imperfect and polluting biases of human emotion and interpretation and supported by the remarkable efficiency of science in producing knowledge of nature that "works".

But while the term objectivity has evolved to become virtually synonymous with contemporary images of science, the meaning and practice of the term is far from distinct. Modern notions of objectivity are a conceptually layered network of associative significations with a complicated history. This layering, as Daston and Galison note, is what accounts for the "hopelessly but interestingly confused present usage of the term". From judgements of empirical reliability and procedural correctness to values of emotional detachment, political neutrality, and universality, objectivity in the modern mind is a conglomeration (rather than an integration) of historically and conceptually distinct forms (1992: 82). Yet, as Daston and Galison go on to argue, each of these distinct forms shares something in common: their expression as a negative value of opposition and absence. In each of its forms, objectivity is principally defined by the absence of some uniquely human quality or qualities – interpretation, perspective, value, emotion, for example – and in opposition to distinct forms of subjectivity in which those particular human qualities are conjectured to adulterate objective reasoning and observation. That is, each form of objectivity "opposes a distinct form of subjectivity" which is defined by "censuring [from scientific observation] some (by no means all) aspects of the personal" (1992: 82).

The history of the various forms of objectivity (and of science in general) might, in this sense, be told as "how, why, and when various forms of subjectivity came to be seen as *dangerously* subjective" (Daston

and Galison, 1992: 82 original emphasis). Such a history also suggests that the objective and subjective might be conceived as symbolic nodes (or a series of nodes) through which the changing expectations and conventions of scientific and "extrascientific" contexts have been shaped and translated.[9] This presents a number of challenges as well as salient points of departure for this discussion, which aims to characterise and problematise how modern images of science engender and are engendered by shifting understandings of ourselves and of the world we live in. What do modern forms of objectivity and subjectivity reveal of the values and assumptions that inhere in modern science and in modern understandings of how science works? What can we learn about the relationship between conceptualisations of the objective and subjective and their constitutive role in shaping our understanding of the practices of producing scientific knowledge of nature?

Historicising scientific expressions of objectivity and subjectivity points to their conceptualisation and practice as contingent and malleable constructs whose interpretations are socially charged, aggregated, and sometimes contradictory. "Objectivity is a multifarious, mutable thing, capable of new meanings and new symbols" (Daston and Galison, 1992: 123) and thus open to new interpretations potentially more responsive to changing social needs. This observation will become more important as this discussion proceeds. To begin with, however, historicising objectivity invites an important critical turn, shifting the emphasis of inquiry from questions about scientific efficacy (i.e. how can we account for science's efficiency in producing knowledge that works?) to questions about what scientific knowledge works so well *at* (Keller, 1992). How is scientific practice (which is largely understood to be monolithic and universal) engendered by changing social and scientific expectations and conventions? Indeed, the more interesting question is not "Is science objective?" (though understanding what is meant by objectivity is no doubt necessary to answering this question) but "What constitutive assumptions about nature and about human nature are being made in representations of science as an objective practice?"

In exploring these questions, I have found it necessary to divide this discussion into two distinct, but intimately related arguments. The first – "Locating Representation in Representations of Science" – deals with representation as a concept. More particularly, it asks how modern representations of science as "an inert mirroring of a timeless, objective reality" (Hayles, 1993: 32) reify unexamined and socially problematic ideological presumptions – about nature and about science itself – within the kinds of scientific representations of nature that these representations of science engender. With the help of insights from science studies, I assert that modern science, as it is widely understood in the western mind, is a simulacrum – a practice of representation engendered by the social saliency of its self-image as an objective means to

[9] Daston and Galison argue, for example, that the dynamic history of configurations of objectivity and subjectivity in science betray a paradoxical scientific morality – a morality that demands the absence of morality from the practices of observing, recording and representing nature. The dynamic mosaic of opposing configurations of objectivity and subjectivity in science tells a story of an evolving ethos of methodological and personal restraint and prohibition "against projection and anthropomorphism, against the insertion of hopes and fears into images of and facts about nature" (1992: 122). The paradox is, of course, that the desire for and pursuit of unadulterated knowledge of nature is itself a projection of unique hopes and fears.

the ostensibly immutable truths of nature. As a simulacrum, the dominant image of modern science engenders a dangerous logic of reification through its appropriation of narratives of objectivity that claim a methodological path to unmediated or "natural" knowledge. Science, represented thus, behaves as a powerful "hegemonic epistemological filter" (Sandilands, 1999: 77) whose ability to naturalise social significations and meanings makes it a deeply constitutive social praxis in the production and organisation of social relationships and practices.

The second argument – developed in "Writing (Human) Nature as a 'Text' or 'Code'" and "It's the Writing that Writes: Science, Nature and the Implosion of the Subject" – builds on the first by examining more closely the constitutive effects of modern representations of science in naturalising or reifying hegemonic matrices of social power through its representations of nature and its related constructions of social subjects. How has the ostensibly unmarked position of the scientific observer – conceived through various technologies of representation – reified social locations and identities developed in relation to specific social valuations of, say, the liberal human subject or the commodifying logic of neo-liberal capitalism? I draw on feminist critiques of scientific representations of the gene to demonstrate the configurations of nature and the subject that emerge from modern representations of science as subjugating power moves. These configurations police, deny or erase difference by abstracting human agency from the social processes of imagining, creating and representing social locations, identities and natures.

The critiques highlighted throughout this paper are meant not only to demonstrate the dangers of the related specificities of particular representations of science, nature and the subject, but also to argue the possibilities of writing differently. Indeed, by drawing attention to the powerfully productive dialectic been our representations of science and scientific representations of nature, this paper suggests that alternative representations of science are not only possible, they are necessary if we are to develop better accounts of how knowledge is made and of how we, as ambiguously "social" and "natural" subjects, emerge from the discursive practices of "representing science representing nature".

Locating Representation in Representations of Science

Importantly, representation in science refers to two different but ultimately inseparable problems in science studies. Science is both a *system* of representation (through which nature is made meaningful and useful to us) and *a representation in and of itself*. There is an important and highly productive dialectic between the constitutive effects of science *as* a social praxis and as the *image* of a very unique kind of social praxis. Our understandings of the processes of representation in science are projected in representations *of* science as well as in the representations produced *by* science. This dialectic often makes it difficult – indeed, unwise – to separate these two problems of representation in science studies work. Understanding the constitutive dangers of modern representations of science thus hinges to a great extent on an appreciation of the mutually engendering dialectic of presumptions moving between images of science and scientific images

of nature. These dangers emerge, in particular, from the ways that both sides of this science/nature image equation can interact to the effect of denying that they are representations at all.

In advancing and sustaining expectations of objective and reliable knowledge, modern representations of science make rather specific ontological claims: principally that the reality of nature is fixed, coherent, independent, and thus universal (i.e. there is only "one true nature"). These underlying assumptions, while difficult to refute or confirm in and of themselves, inform the guiding epistemological and representational principles of scientific inquiry: that nature is a matter of discovery; that knowledge cannot ultimately be imposed on reality (rather, knowledge is given *by* nature), and (most importantly); that "pure" or "true" (i.e. scientific) knowledge of nature is not *relational* (Franklin, 1996). To imagine the possibility of non-relational knowledge (i.e. knowledge that exists outside the geography of social praxis) it is also necessary to make related and oppositional claims about the epistemological process of science itself: that science is a "reality driven enterprise"; [10] that its methods and technological apparatuses "position knowers as less powerful than the reality they describe" (Franklin, 1996: 156), and; that those methods and apparatuses simultaneously abstract the scientific knower from the processes of producing scientific knowledge – and from reality itself – even as they offer her/him privileged access to the "truths of nature". The modern scientific subject as an observer and mediator of nature exists, ostensibly, in perfect opposition to the objectivity of the world s/he describes. The objective epistemological stance of the scientist is, in other words, represented as a non-position, an unmarked but privileged standpoint. This purported representational neutrality is what drives modern images of the scientific process, masking its status as a specific representation of knowledge and knowledge production. It is also what drives much critical science studies discourse, which argues that the unacknowledged contingency of science *as* a representation and as a system of representation is at the heart of a highly productive and problematic dialectic.

Historians, sociologists, and philosophers of science have argued that this standard image of modern science is not only an inaccurate representation of how science actually works, but a dangerous denial of the representational character of all knowledge – a denial, that is, that all knowers and thus all knowledge are positioned within the various contingencies of history and culture, and especially within the matrices of social power shaping the saliency of particular forms of representation and meaning.[11] For science studies scholars, wholly explicit knowledge is not only unthinkable, it is also a dangerous illusion that fabricates, and is itself fabricated, in an ideological framework of possession and reification. Feminist scholars have been particularly insistent, for example, that modern images of objectivity as a "view from nowhere" are a kind of "god-trick" through which the contingent socio-historical biases and valuations of the scientific knower, and of the

[10] This is the very description of science offered by the likes of Gross and Levitt in their vehement opposition to science studies critiques of modern images of science (Franklin, 1996).
[11] Scientific expressions of the objective and subjective play an important role in the production and reproduction of various forms of social power through their purchase on symbolic and material constructions of the "natural" social subject. This effect is discussed in more detail in the subsequent section.

scientific process itself, are abstracted from scientific practices and re-expressed through the ostensibly transcendent or non-relational "facts of nature" (see in particular Haraway, 1991). Modern understandings of science and nature are, according to this view, engaged in a reflexive dialectic that dangerously denies its own reflexivity, creating illusions of an objective natural order at the expense of the diversity and accountability engendered by an appreciation that all knowledge is partial. Understood thus, the "science question" is as much a problem of specific assumptions about nature and the nature of representation as it is a problem of the discursive authority of science to represent nature and to represent itself.

In articulating their various historical, social and political critiques of modern science, science studies scholars from a wide variety of perspectives have thus re-framed widely held representations of modern science as a uniquely objective epistemological praxis by illustrating them as just that – representations. This has been achieved, in part, by highlighting some of the contingencies specific to modern images of science and nature, and to science's rendering of itself as a unique authority in producing objective knowledge of a distinctly nonhuman world. Locating these contingencies has opened opportunities for problematising how modern images of science engender and are engendered by shifting understandings of ourselves and of the world in which we live. The ultimate strength and reconstructive potential of science studies critiques, however, is achieved through re-appropriations (from science) of the concept of representation itself, grasping its processes not as a stable mirroring of reality, but as a contingent, partial and always contestable heterogeneity of practices. To reclaim representation as an open, dynamic and relational endeavour is to simultaneously critique the dogmatism of an unaccountable objectivist epistemological stance and to reveal the possibility (and the need) for crafting more responsive and responsible representations of representation.

While the specificities of these reconstructive efforts are discussed more explicitly elsewhere (see for example Barad (1996), Haraway (1992a&b), Hayles (1993), Latour (1993)) representation as concept captures the spirit of this discussion and anticipates many of its arguments. It thus deserves brief elaboration.

In its most basic configuration, representation is the activity of making meanings. Through representation we are able to secure and mobilise simplified meanings from an often complicated and diffuse network of social and material expectations and practices, including but not limited to those brought about by personal and collective experience, culture, values, and language. As all forms of representation are necessarily guided by these expectations and conventions, they are also necessarily contingent and contestable, always shifting in association with the relational and dynamic character of the evolving social, disciplinary, technological and discursive forces that shape the representational landscape and that bring different representational landscapes into relation with each other. Though representations temporarily "fix" or stabilise specific relationships, significations and meanings, their stability is temporary and ultimately illusory. Representation is a praxis that does not "follow an entropic track toward stable equilibrium" but "obeys the rules of a never ending ramification" (Rheinberger, 1997: 15) moving always towards destabilisation and change. Understood thus, representations can be open, imaginative, responsive, and excessive, surpassing

or transforming their local context to become sites of novelty and meaning in sometimes surprising and unpredictable ways.

Nevertheless, representations are constructions made and made meaningful by and for humans and are thus subject at some level to the limitations of human imagination and cognitive capacity, as well as to the limitations that inhere in specific knowledge practices. This is an important assertion, perhaps especially in science studies, for it alleges that "we are always in the theatre of representation"; at the most basic level our biological and conceptual apparatuses permeate all of our observations and all of our attempts to make meanings, even as those meanings must nonetheless be consistent with the reality they describe (Hayles, 1993). Representations are thus relational, expressions of specific dialectics between uniquely human questions, methods of inquiry and articulation, and a distinctly nonhuman materiality. They are also important sites for critical analysis; their interrogation can reveal much about the assumptions, expectations and practices of their construction.[12] Indeed, this more critical view of representation challenges traditional representations of science (and traditionally understandings of the representations produced by science) by destabilising the assumed boundaries between subject and object, and by drawing the tools and practices of representation (which are purported to objectively and invisibly cross the divide between these two poles) into a constitutive relationship with the meaning-making process.

In much science studies scholarship this representational dialectic or, rather, its implicit denial within modern representations of science and scientific representations of nature, is at the heart of the "science question". While in science, as in other representational practices, "representations arise in response to such historically specific factors as prevailing disciplinary paradigms and cultural assumptions, as well as such species specific factors as the human sensorium and neurophysiology" (Hayles, 1993: 35),[13] modern representations of science deny the existence and/or the meaningfulness of these contingencies to the processes and productivity of scientific knowing. The conceptual dynamic between oppositional configurations of the placeless scientific observer and the immutability of nature in these representations constructs a "frozen logocentric" epistemological structure (Kay, 1995) that masks how meanings in and of science are fixed and stabilised not by some constitutive natural order, but by the selective pressures exerted by scientific and "extrascientific" spaces of representation. As Kay remarks, it is precisely the "movement of differences – as we continuously define entities and properties in terms of other entities and properties – that generates novelties and meanings" (1995: 614), defining the frameworks through which understandings of science, nature and ultimately human nature are brought into relation to each other.

[12] Representations can, for example, be deployed as forms of critical praxis, which like the "multistable image", inherently call the position of the originator and beholder into question and destabilise the fantasy of observational detachment in favour of relationality of observer to the observed (see Mitchell (1994)).

[13] To cite a simplistic example, the enormous investment in imaging technologies in the sciences is not only a manifestation of cultural, discursive, and epistemological assumptions about the neutrality or passivity of vision (thus making it an appropriate tool of an objective science) but an expression of the importance and dominance of vision in human experience. This is not to suggest an essential dominance of vision in human experience; the prioritisation of vision is as much historical and cultural (i.e. reinforced by dominant cultural assumptions and practices) as it is biological (see Haraway (1991, 1992a), Crary (1996), Mitchell (1994)).

Indeed, it is the relationality of representation, and of knowledge more generally, that is ultimately at stake in modern representations of science. The potency of science studies arguments comes not from a simple critique of science's internal representational structure, but from how that structure is brought into reciprocal relationship of representational exchange with other social meanings, ideologies, and agendas, including those that define modern understandings of science itself. Hayles and others have argued – contrary to what earlier sociologists and philosophers of science might have believed – that the production of meanings and significations in scientific practice is not ultimately isolated within the operational distinctness of science (or a given scientific discipline) as a unique cognitive activity. Rather, scientific representations function "as both the site and means for exchanges among … theories, frameworks, and most significantly, discourses" (James Bono in Hayles, 1993: 40). Science constructs and is itself constructed not only in relation to a nonhuman material reality but also in relation to the material, cognitive and paradigmatic contingencies and constraints imposed by a diffuse network of meanings, significations and conventions engendered by language, politics, technology and other forms of social praxis.

For critical discourses of science, this notion of representational exchange is of incisive importance to the task of revealing science as a representation, and to drawing attention to the implicit contingencies of scientific knowledge. The notion of representational exchange in science draws attention to how the intra- and extrascientific productivity of experimental systems hinges on complexes of meaning and signification created both within and beyond the initial space of representation (i.e. the laboratory or theoretical model). Exchange is what makes science "excessive", productive of surplus meanings and significations that "outgo" their local context and spill over into other spaces of representation. As Rheinberger reasons, "[w]e would not have the incommensurable plurality of the sciences as we experience – and fear – them today if their movement were not excessive, if they were not continuously producing a surplus that is beyond what we may have wanted, beyond what we might have been able to imagine" (1997: 22, 23). Yet it is precisely these excesses that dominant images of science deny in the service of maintaining the illusion of the scientist's privileged access to an immutable and material reality.

This does not mean, however, that the "excessiveness" of scientific representation (and of all forms of representation) is an epistemological problem to be overcome in search of the kind of objectivity postulated in and through modern science. Indeed, excess and surplus are an important source of novelty and innovation in science since they can result in new significations and new ways of seeing and relating previously anticipated or desired.[14] The danger of representational surplus (within science and elsewhere) is a function of the extent to which the excesses of exchange – the "movement of differences ... that generates

[14] The notion of excessiveness also invites alternative configurations of science and nature by challenging the notion of the stability of objective or natural meaning. "Representation *is* 'eventuation' (it is about intervention, invention, and the creation of events). Yet the ruse of this dialectic of fact and artifact consists precisely in that it functions by permanently de-constructing its constructivist aspect: the New does not enter through the obvious door but through some fissure in the walls" (Rheinberger, 1997: 108).

novelties and meanings" (Kay, 1995: 614) – are denied, unacknowledged or remain hidden. Through such processes of erasure or denial, scientific objects and subjects "assume a mystified and abstract identity" estranged from any relation to their position within the specific dynamics of a "unified cognitive field" (Crary, 1996: 19) and especially, as will be discussed below, from matrices of social power shaping the production, reproduction, and circulation of significations and meanings. Indeed, it is in the largely hidden excesses of scientific representation and representations of science that modern practices of objectivity have produced what some science studies scholars have argued, for example, is a masculine orientation in science that constructs the world as an object to be dominated and controlled (see Keller, 1992, 1995).

Unfortunately, modern representations of science rest on notions of universalism engendered by specific understandings and valuations of objectivity and subjectivity that deny the excessive activity of their representational structure in bringing into being specific relationships to nonhuman nature on the one hand and to social significations and values on the other. Representational exchange of meanings and significations within scientific practice is not forbidden as such, but within the limitations of a representational framework that assumes a "frozen logocentric" epistemological structure, the activity of exchange becomes a conceptual misnomer – its form hides the kind of movement that produces differences (Kay, 1995). Instead, we are left with the impression that our images (and the differences they represent) are not images at all – i.e. not the products of contingent and temporary relationships between systems of representation and other represented meanings – but fixed expressions of an inherent material world of objects. Equally dangerous, we are left with the impression that our images of science as a system of representation are not images either, but logical and descriptive accounts of a neutral (i.e. non-interactive) means through which objects express their inherent meanings.

In a world of fixed, independent, speechless and knowable objects, perfect communication of meaning becomes possible in relation to the perceived ability of a representational system to bracket out the "movement of differences" brought about by the system itself. In dominant configurations modern science this is understood as the prescribed functional outcome of the scientific method, the cleansing of fixed objects of their non-objective (i.e. non-natural) meanings and significations so that they appear unmarked or natural. Through images of science as the perfect representative of a voiceless objective reality, scientific representations are always – that is, *as a matter of practice* – understood as expressions of natural truths, of meanings that inhere in nature rather than within the collateral contingencies engendered by material and representational constraints. In modern images of science, scientific representations are, purportedly, not representations at all but transcendent facts, "facts that have been fabricated by man yet are no one's handiwork, facts that have no causality yet can be explained" (Latour, 1993: 22). Science is represented, and thus empowered, as the dominant and authentic voice of a nature it claims speaks for itself.

For many of the more politicised science studies scholars, this is the most pernicious aspect of the dominant representation of modern science: its implicit denial of itself as a representation (Hayles, 1993) and,

more particularly, as a practice of representing itself dialectically through representations of nature. These denials empower science as a powerfully hegemonic practice, an "epistemological filter" with the ostensibly "natural" authority to "include the world in the sovereignty of a discourse that has the power to represent its representations" (Foucault in Mitchell, 1994: 58). Science, represented thus, is a simulacrum – a practice engendered by an image of itself as a perfect voice of a reality which has itself been "scientised" – configured to fit seamlessly into the cognitive framework of the scientific method. As a simulacrum, science fixes networks of dynamic meaning and signification in images of nature by *appropriating* and defining narratives of objectivity that claim a methodological path to "natural" truth.

Importantly, "appropriation" takes on a double meaning in this context. It is the twinned process of incorporation and normalisation or, alternatively, a process of colonisation, an act taking possession of the partial while simultaneously claiming to define the whole.[15] As a system of appropriation of nature, we understand science as the voice of meanings that inhere in nature but speak themselves and so empower science to place boundaries around objects and subjects that appear natural. Modern science is empowered to appropriate through images of science that reflexively deny the constitutive significance of science's representational contingencies, including the contingencies engendered by disciplinary paradigms, cognitive frameworks and (most emphatically) by the meanings and significations encoded in ostensibly "extrascientific" social practices and discourses. The symbolic and material meaning effects of these contingencies are thus deployed and naturalised through specific representations of nature and, by extension, through the specific representations of science that produce those representations of nature. That is, the representational tenets of standard images of science reify the presumptions of their own configurations within the images of nature that those configurations help to create.

As Keller explains, the net effect of failing to recognise the constitutive structure of language in science, for example, is "to exclude from the domain of theory those … phenomena that do not fit (or worse, threaten to undermine) the ideological commitments that are unspoken yet *in* language – built into science by language we use both in constructing and applying our theories" (1992: 143 original emphasis). Even the simple use of non-technical language already constructs a framework loaded with meaning, conceptual associations and limitations. The metaphor of "laws of nature", for example, "carries into scientific practice the presupposition of an ontological hierarchy, ordering not only mind and matter, but theory and practice, and, of course, the normal and the aberrant. Even in the loosest (most purely descriptive) sense of the term *law*, the kinds of order in nature that laws can accommodate are restricted to those that can be expressed by the language in which laws of nature are codified" (1992: 30).[16]

[15] The notion of appropriation in science is used (by Haraway (1992a) for example) both for its double meaning as an act of incorporation and normalisation but also as a political concept that points to the radical potential of "inappropriate/d others" – positions of identity and expression that challenge the limited possibilities of dominant social narratives.

[16] Among the more tangible examples of this representational dynamic one might include the naturalisation of patriarchy and the un-naturalisation of homosexuality (see for example Sandilands (1999) and Haraway, (1989)).

Our images of nature and of science can thus obscure the contingencies and ambiguities that inhere in any system of representation by postulating unmediated access to a seamlessly coherent and independently rational universe. Representations deployed in the production of the social meanings of science and in the production of scientific meanings are ostensibly stripped of their contingency and of their relationality, ultimately fixed and stabilised by the selective pressures they themselves engender within and/or beyond their local scientific contexts. These representations can then take on impossibly permanent meanings by becoming reified within images of nature as a fixed external referent.

The dangers of displacing this dialectic of appropriation emerge somewhat more clearly in relation to Ian Hacking's observation that "science represents to intervene and we intervene in light of our representations" (in Keller, 1995: 4).[17] Science is not only the embodiment of specific values and beliefs about nature, it is an *enactment* of those values and beliefs; "what we know or claim to know about the natural world comes to us in our own constructions" (Keller, 1992: 3). Modern images of science in this way engender its practice as a structure of reification whose representation of itself decontextualises meanings and significations from their local and diffuse specificities through processes of dislocation and purification that *perform* their inherence in nature. Contingencies (loaded with meanings, associations and limitations) can be carried into scientific practices and their effects reproduced in concordant images of nature. The reflexive processes of representation and their denial within modern representations of scientific knowledge mean that appeals to scientific representation risk always the reification and naturalisation of the meanings and significations (including ideologies and agendas) that define the discourses guiding our relationships and interactions with each other and nonhuman nature.[18]

Writing (Human) Nature as a "text" or "code"

"Nature is a mode of concealment, a cloak of abstractions that obscures the discomforting wildness that defies our paranoid urge to delineate the boundaries of Being" (Evernden, 1992: 132).

An important example of these processes at work in science can be found in the proliferation of scriptural metaphors in the life sciences. Thinking through the scriptural metaphors of genetics – DNA as a code, text or "natural language" – for example, has manifested very particular experimental and technological systems that presuppose (i.e. are designed to find) a decipherable linguistic structure in human and nonhuman nature. Indeed, molecular biology is replete with scriptural metaphors that have dramatically

[17] While Hacking uses the term representation in the traditional philosophical sense (i.e. as concepts referring to real entities) his point nonetheless applies to the more complex use of representation argued here. Intervention is necessary to the production of systemic knowledge by science because it establishes a level of reliability (not just the socio-economic applicability that Hacking is arguing) upon which representations can be further developed and linked to other representations.

[18] Wilderness, for example, is a complex mix of scientific projections and romantic ideals, which have been embraced by mainstream environmental discourse. The appeal to science, and ecology in particular, to establish a scientific basis for defining primal nature (the benchmark against which to measure environmental degradation) has, some argue, led to the physical embodiment of "a nature that never existed but that now defines the essence of nature to which all other natures are compared (and found wanting)" (Sandilands, 1999b).

determined the kinds of questions asked as well as *how* they are asked – through the kinds of experimental systems enabled by representing nature as a text or a code – both within the field of genetics and in the other life sciences (see for example Kay (1995), Keller (1992, 1995), Haraway (1991, 1992b)). These metaphors – the "Book of Life", the genetic "code", the "natural language" of DNA – are not essential or benign descriptors but historically contingent significations that have arisen from complex networks of intra- and extrascientific exchange. Writes Kay:

> The informational representations of heredity and life were not an outcome of the internal cognitive momentum of molecular biology; they were not a logical necessity of the unravelling of the base pairing of the DNA double-helix. They were transported into molecular biology still within the protein paradigm of the gene in the 1940s and permeated nearly every discipline in the life and social sciences. These information-based models, metaphors, linguistic, and semiotic tools which were central to the formulation of the genetic code were transported into molecular biology from cybernetics, information theory, electronic computing, and control and communication systems – technosciences that were deeply embedded with the military experiences of World War II and the Cold War (1995: 609).

Kay's socio-historic analysis of the emergence of an information paradigm of gene action challenges understandings of DNA – the purportedly natural language or universal code allegedly "hidden" in a four letter alphabet of nucleic acids – by demonstrating the ways it might be read as a "text" that was not so much "discovered" and "deciphered", but "written" by scientists working under historically and culturally specific conditions. The importation of specific representational and linguistic conventions into the "pure" or "hard" science of molecular genetics reified the effects of a particular technoscientific context by inscribing those conventions in nature. Importantly, what is being reified in this exchange is not simply a way of talking about nature, but a means of intervening in nature based on the ideological commitments that are unspoken yet implicit *in* the language of a militarised political context. More importantly for Kay, representing nature as a text reflects a metaphysics devoid of consciousness, one in which the agency of nature, and ultimately our own agency, is lost to the perceived reductive and essential materiality (or "textuality") of nature. For Kay, the transportation of information theory into genetics through scriptural metaphors of nature engenders a dangerous irony; nature is "written" by scientists as a text, without reference to human subjectivity and purportedly without consciousness, "leav[ing] us with the inescapable conclusion that it is the writing that writes" (1995: 615). Writes Kay:

> Based on this linguistic imagery and representation of life as text, the genome can be read and edited unambiguously by those who know. With this writing technology believers have thus laid claim to new levels of control over life (1995: 610).

As Haraway emphasises, these claims to technological dominance over nature – through which the scientist has gained privileged access to, indeed mastery over, the "book of life" or the master text of nature, including the text that defines human nature – emerge (naturalised) as nodes of extrascientific exchange in the

gendered, militarist, reductive and commodifying power fields of global capitalism. Indeed, Haraway has offered some of the most valuable and striking illustrations of the significance of the socio-historical specificity the information paradigm as a network of "masculinist" and militarist metaphors emphasizing production, commodification, and the reduction of the world to a "problem of coding". These metaphors have secured a certain cultural legitimacy through their naturalisation and reproduction within the authority of scientific representations. Haraway's critical characterisation of the recent proliferation of genome projects, for example, links World War II and Cold War military research in the area of "command and control" communication theory and technology to the reductive productionism of late capitalism, and suggests a reading of genome projects as the appropriation of DNA sequences in a "particular historical form – one amenable to property and commodity relations" (1992b: 80). This retooling of human and nonhuman animals to a productionist agenda is accomplished, to a significant degree, through dominant narratives about genome initiatives in which humans are themselves understood as the reading technologies of their genes (1992b: 88). The individual in these narratives is (quite literally) *written* as the "word" or "code", but in a script emptied of soul, life, value, embodiment and choice through which humans initially distinguished themselves from their machines (Kay, 1995) and through which the politicisation of identities (of nature and other agencies) becomes both possible and meaningful.

Kay's and Haraway's emphasis on the co-relationship of narratives of the gene and narratives of human agency and identity draws attention to an important facet of the political project underlying critical science studies work. The standard representational practices of science are processes of objectification and subjugation, expressed not merely as inscriptions[19] of and through "nature" but also as inscriptions of and through social subjects; the ostensibly unmarked natural object is engendered by and engenders "different metaphors of mind, nature, and the relation between them, [that] reflect different psychological stances of observer to observed [and], in turn, give rise to different cognitive perspectives – to different aims, questions, and even different methodological and explanatory preferences" (Keller, 1992: 31). These metaphors, through the reifying effects of modern images of science and nature, thus also delimit possibilities for expressing meanings (of and through subjects) as well as *how* those meanings can be legitimately (or at least saliently) represented through naturalised configurations of human subject identities and locations.

As Haraway explains, the representation of science as an unmarked standpoint empowers science as a kind modern master metaphor, a dominating ideological position that "produces, appropriates, and orders all difference" (1991: 193) through processes of normalisation and incorporation that perform the inherence of certain kinds of difference (including but not limited to differences of race, gender, and class) in

[19] The term inscription is used here, and elsewhere in this discussion, to convey two somewhat conflicting meanings simultaneously. Inscription implies the act of writing or marking something as well as the constitution or delimitation of boundaries. Representations of science find expression in the representations that science produces, by both defining and constituting the articulation of objects and circumscribing their ostensibly natural meaning. The concept of inscription can also be used in a positive or deconstructive sense to help explain that despite the ways our representations mark the world, we cannot ultimately control these constructions because nature eludes and subverts the meanings we try to impose on it.

nature. These images of science engender a dangerous and dogmatic dialectic of reification, in part because they operate in ways that obscure the possibility – indeed, the very notion – of answerability to the kinds of difference they teach us to see. By resting on notions of universalism, realism, and perfect communication – i.e. a "copy theory" of representation – modern representations of science can project specific configurations and valuations of objectivity and subjectivity that inherently deny their constitutive effects in bringing into being the specific material and symbolic relationships (to nonhuman nature and social significations and values) that trace the limitations of their social articulation. Modern representations of the gene as a "master molecule", for example, profoundly shape our understandings of ourselves, as well as our place in the social and natural world, by naturalising an image of the gene as the "master" concept of the life sciences, the "master" of the living body (including to a lesser extent the mind), and as the essence of a textual nature that can be (or has been) "mastered" technologically (see Keller, 1993, 1995).

Through particular representations of science and its concordant representations of nature, "nature" and the human subject assume simultaneously objectified and subjugated boundaries that define and order our existence in ways that appear natural. It is in these senses that feminist and other science studies scholars argue that the methods and procedures of modern science "not only foster inexperience about social divisions of [say] race and gender but actively perpetuate such divisions" (Ross, 1996: 13) by displacing the context of their meanings with the content of a reified natural order.

Keller offers a politically appropriate example by tracing the complexity of the networks coursing through representations of the gene, linking interactions between alternate spaces of representation in science (evolutionary biology and modern genetics) and a uniquely liberal humanist configuration of the individual. In the tacit linguistic conventions of Darwinian evolutionary theory, Keller finds that a uniquely modern ideological autonomy of the individual is privileged "at the expense of biologically constitutive interactions" and in ways that obscure "the logical distinction between autonomy and opposition" (1992: 116). She writes:

> [M]uch of contemporary evolutionary theory relies on a representation of the 'individual' – be it the organism or the gene – that is cast in the particular image of man we might call the 'Hobbesian man': simultaneously autonomous and oppositional, connected to the world in which it finds itself not by the promise of life and growth, but primarily by the threat of death and loss – its first and foremost need being the defense of its boundaries. In psychological terms, we might say that such an individual betrays an idealised conception of autonomy, one that presupposes a radical conception of self, and that simultaneously attributes to the relation between self and other an automatic negative valence – a relation, finally, not so much of independence as of dynamic opposition (1992: 116).

As with Haraway's configuration of the narratives of human identity emerging in relation to human genome projects, the conflation of autonomy and opposition through a naturalised social subject resonates not only from within the competitive interaction models of evolution that permeate the life sciences, but also from

within the political and socio-economic structures of neo-liberal capitalism that incorporate and inscribe competitive interaction as the "natural" basis for organising human relations. Both these processes – incorporation and inscription – work together in the creation of this cultural construct (Hayles, 1999) as well as in its naturalisation through particular cultural constructs of science.

Implicit in these insights, as Keller (1992) notes, is the need to shift from thinking about science as representing in a descriptive sense to thinking about representations themselves as tools for intervening, as inscriptive technologies capable of embodying and reproducing their meanings through both symbolic and material relationships. The socio-scientific alignment of processes appropriation (incorporation, naturalisation, reproduction) is an epistemologically *and* ontologically (or onto/epistemologically) constitutive dialectic; at stake is not simply the production of knowledge of reality, but the production of (what is for us) reality itself. Indeed, scientific representations of nature have not only helped to create specific representations of nature, through the appropriation and normalisation of specific cultural values and ideals they have participated in the larger social processes of constructing physical embodiments of nature and human/nature relationships. [20]

This observation applies equally to scientific representations of human nature. The incorporation, naturalisation and reproduction of specific values and assumptions about race, gender, or other representations of difference manifest dialectically and diffusely through representational as well as *bodily* conventions, relationships and practices. Gender, for example, "is produced and maintained not only by gendered languages but also by gendered body practices that serve to discipline and incorporate bodies into the complex significations and performances that constitute gender within a given culture" (Hayles, 1999: 200).[21] The simultaneous processes of organising knowledge and concordant social practices that find a certain cultural legitimacy through science can modify "in myriad ways the productive, cognitive, and desiring capacities of the human subject" (Crary: 1996: 3). The resulting network of equivalences – constructed through the dialectics of incorporation, inscription, reproduction and exchange – though engendered to a significant extent by modern representations of science, thus must also be understood in terms of the role of technologies of representation (including the "observer as human subject") in shaping concrete and historical frameworks and technologies of power and social discipline (Foucault, 1978).

It's the Writing that Writes: Science, Nature and the Implosion of the Subject

"Objectivity is associated with a view from everywhere, and hence from nowhere – a view with no limitations and hence no connections to humans located at specific places and times. That it is a power trip is undeniable. That this power has frequently been misused is also undeniable" (Hayles, 1993: 41).

[20] Wilderness reserves and eco-tourism, the commodification of the gene and the related privatisation of food crops, are two of the more obvious examples (on wilderness see Cronon (1996), Sandilands (1999b), Birch (1995)).
[21] Recall, for example, the naturalisation of patriarchal relationships or discourses of homosexuality, both of which exemplify the importance of nature in establishing body practices and social relationships. See Haraway (1989) for an excellent discussion of the naturalisation of a naturalised patriarchal hierarchy in Carl Akeley's African Hall and its representations of the "natural body of man".

As Jonathan Crary suggests in his engaging work *Techniques of the Observer*, modern images of science as a uniquely objective practice present not merely a problem of representational practice but a problem of social power, "a power founded on the capacity to produce equivalences" (1996: 12) and engendered by specific and historical constructions and technologies of the "observer as human subject". Though Crary's specific interest is the historical construction of vision in the nineteenth century, woven through his analysis is a provocative discussion of power and representation in which the "abstraction of vision from any founding site or location and a proliferation of exchangeable, ephemeral and mobile signs" (what Haraway refers to as the "god trick") is caught up within the larger power fields of modernisation.[22] He argues "not only did the empirical isolation of vision allow its quantification and homogenisation but it also enabled the new objects of vision (whether commodities, photographs, or the act of perception itself) to assume a mystified and abstract identity, sundered from any relation to the observer's position within a cognitively unified field" (1996: 19). Ironically, and paradoxically, the subject becomes visible and thus manageable through these representations even as the *scientific* subject remains *in*visible as an agent of this "technique of overlapping subjection and objectification" (Foucault in Crary, 1996: 15).[23] Moreover, these representations are not merely expressed as and through representation in science, but come to form the basis of our understandings of science itself, by drawing its practices of knowledge and knowledge production into the framework of its own assumptions.

In the specific historical context of "modernisation" and its continued manifestation in the proliferation of capitalist economies, this representational dynamic is the root of the onto/epistemological potency of modern images of science; representational denial engenders images of science that establish its role as a vector of subjection and objectification through which objects and subjects, knowledge and knowledge production (including science), and thus also power, can be representationally abstracted from their local and diffuse specificities – from their humanness/humanity – and reproduced as singular, fixed, mobile, and hence quantifiable and commodifiable conceptions. Writes Foucault:

> The moment that saw the transition from historico-ritual mechanisms for the formation of individuality to the scientifico-disciplinary mechanisms ... thus substituting for the individuality of the memorable man that of the calculable man, that moment when the sciences of man became possible is the moment when a new technology of power and a new political anatomy of the body were implemented (in Crary, 1996: 17).

[22] "Modernization is a process by which capitalism uproots and makes mobile that which is grounded, clears away or obliterates that which impedes circulation, and makes exchangeable what is singular. This applies as much to bodies, signs, images, languages, kinship relations, religious practices, and nationalities as it does commodities, wealth, and labor power. Modernization becomes a ceaseless and self-perpetuating creation of new needs, new consumption, and new production. Far from being exterior to this process, the observer as human subject is completely immanent to it" (Crary, 1996: 10).

[23] This is of course a complex historical arrangement (which is Crary's principal point) determined "not by some deep structure, economic base, or world view, but rather the functioning of a collective assemblage of disparate parts on a single social surface" (Crary, 1996: 6). Subjection and objectification through science is only made possible by the existence of an already subjugated and objectified scientific observer; the human subject, like nature, "can be subjected to experimentation only insofar as it is already [a] representation" (Rheinberger, 1997: 112).

Through increasing scientific knowledge of the body – technologies of individualisation or "bio-power" – representations of the human subject, and their expression through a concordant organisation of social practices, are made "compatible with new arrangements of power: the body as worker, student, soldier, consumer, patient, criminal – a means of rendering a perceiver manageable, predictable, productive, and above all consonant with other areas of rationalisation" (Crary, 1996: 147). The ultimate threat of these arrangements, however, is not found solely in their specificities but also in their determinate universalities, made possible by paradoxical notions of subjectivity which objectify and subjugate (objects, subjects, and even science itself) without reference to the social and cognitive positioning of the "observer as human subject" working within historically unique networks of knowledge, meaning, and social practice. Meanings, including meanings of science, collapse into the very framework of assumptions through which those meanings are produced.

It is useful to recall the earlier discussion of scientific representations of nature through scriptural metaphors of the gene. The insistence on both the existence and knowability of a universal code or language of biological meaning, for example, (the ultimate end of reductionist images of science) has the final(ising) effect of negating the possibility of not only acknowledging the contingency of scientised knowledge, but of our subjective and constitutive power to imagine something different. As the metaphors we use to inscribe nature and ultimately our own nature are reified through the representational processes of appropriation taking shape in relation to technologies of objectification and subjugation, they can collapse as determinate forms of representation; we are left, in other words, with the inescapable conclusion that it is not we who write human relationships to the world but rather it is the writing that writes itself (Kay, 1995: 615). Hayles states this problematic more clearly within the context of cybernetics and its attempts to capture the essence of life in the coding systems of computers: "What is often erased [in cybernetics] is that the equations we draw between organism and machine work because it is seen from a position formulated precisely so that it will work" (Hayles: 1999: 94).

A language without origin, a creation without a creator, science as the perfect representative of nature – within the powerfully abstracted meanings and significations circulating via these modern metaphors, images of science and their representations of nature, including human nature, are reduced to the empty (re)productions of science's own instrumental objectifications (Haraway, 1992b: 82). The "frozen logocentric" form engendered by representations of science (and scientific knowledge) that reduce the universe to a system of distinct, oppositional, yet unequally valued, dualisms (i.e. nature/culture, human/other, subject/object, male/female etc.) self-destruct into a universalising monism; the subject itself inevitably becomes an object of its own scientific inquiry, an arbitrary sign that "instead of linking two persons in an unbreakable reciprocity", always refers back to the "disenchanted universe of the signified, common denominator of the real world toward which no one has any obligation" (Baudrillard, 1983: 84-85). The

knowing subject produced within these images science, "the very source of both the concept of nature and its investigation", ultimately discovers him/herself as "one statistical object among the many to be explored … a mere epiphenomenon" (Evernden, 1992: 92). We are, within these images and their networks of meaning, subsumed by our own technologies – by the metaphors that made them possible and by the metaphors that they allow. Evernden writes: "We have, in effect, been consumed by our own creation, absorbed into our contrasting category. We created an abstraction so powerful that it could even contain – or deny – ourselves" (1992: 92). Or, in the rather more dramatic words of Haraway: "Context is content with a vengeance. Nature is the programme; we replicated it; we own it; we are it. Nature and culture implode into each other and disappear into the resulting black hole. Man makes himself, indeed, in a cosmic onanism" (1992b: 82).

The "totalised" subject thus (dis)appears twice within the circularity of modern images of scientific knowledge production: first in imagining and sanctioning the allusion of a fixed, transparent and knowable world of objects which can be objectively known (since the equally transparent boundaries of knowing subjects enable their subtraction – or "purification"[24] – from scientific representations of ostensibly natural objects), and; second, as knowable objects in and of themselves whose very knowability symbolically closes the loop of representation around an emptiness precisely delineated by the ultimate denial of the very categories upon which scientific inquiry depends – subjects and objects. The productive power of a scientific logic thus turns in on itself in a kind of self-negating, self-appropriating move in which everything, including science itself, is recast in its own image. "This full objectification of 'nature' could only be complete with the full 'autonomization' of the human subject. Fully objectified, we are at last finished subjects – or finished *as* subjects. The world of 'autonomous' subjects is the world of objects, and this world works by the law of annihilation of defended selves imploding with their deadly projections" (Haraway, 1992b: 88 original emphasis).

[24] The term is borrowed from Latour (1993) who argues that the oppositional polarities of modern thought exist and function as symmetries of contradiction. These symmetries are mediated by representational practices – "translation" and "purification" – that together form the basis of a uniquely yet impossibly modern constitutive representational framework. On the one hand, translation hybridizes constructed categories of meaning by continuously creating new "mixtures" or relationships between their previously delineated significations; hybrids emerge from the interplay between categories otherwise understood as distinct in modern thought (such as "nature" and "culture"). On the other hand, purification simultaneously denies the heterogeneity created in our translations by fabricating two distinct "ontological zones" – the human and nonhuman – in which the condition of "hybridity" is necessarily precluded; purification actively restores the appearance of a "modern" order to an otherwise heterogeneous and unpredictable system. Though these practices are themselves co-constituted by the movement of their interaction (without translation, purification would be without purpose; without purification there would be, finally, no "pure" categories to hybridize), their co-existence is obscured or denied in the modern world in the service of maintaining the illusion of ostensibly transparent and hierarchical meaning.

Conclusion: The Politicization of Nature

"No longer able to sustain the fictions of being either subjects or objects, all the partners in the potent conversations that constitute nature must find a new ground for making meanings together" (Haraway, 1992b: 65).

The question at the heart of this dialectic of representation, in which the misleading subject/object dichotomy driving modern representations of the production of scientific knowledge is reconfigured as a system of networks of mutual articulation, is one of agency. What is the role of objects in the construction of different social identities? To what extent does the subject (as a concept and as an agential being) participate not only in the construction of objects but also in the fabrication of identity (as a concept and as a specific or multifarious social/objective position)? These questions are important because they, in effect, define the perceived limitations of human agency and imagination in the construction of social and material realities. They also delineate the possibility and perception of our collective responsibility for the specificities of nature and human nature at play in our representations.

These questions of agency and identity also suggest a profound political problematic. If nature and human nature are bound to each other in an intimate dialectic of social and scientific practices, we will need not only a better understanding of science, but also a critical praxis capable of articulating alternative configurations of subjects and objects. If these configurations are to be non-oppressive, they must admit to the essential ambiguity of boundaries, identity, and representation more broadly (including their representations of themselves as a more critical praxis) without conceding the necessity and potency of these categories to the political processes that shape our collective existence.

The significance of "science question" thus goes beyond the contingency or partiality of scientific knowledge to include the need to demonstrate how modern representations of science both produce and reproduce what is in some ways a disingenuous innocence about how knowledge is made and about the systemic dangers and injustices engendered by marking the world from a purportedly unmarked standpoint of possession and reification. The pervasiveness and tenacity of these images of science and nature arise from the elusiveness of abstracted onto/epistemological presumptions, which simultaneously define the boundaries of valid/valued knowledge and hence constitute what is for us human and nonhuman nature. The elusiveness of these presumptions results precisely from the filtering of the instrumentality of language, and other cognitive, discursive and material technologies from the representations which emerge, finally, naturalised from science. Univeralism, realism, and perfect communication are not essential and immutable truisms of scientific practice, but the misguided impressions of a totalising logic, artefacts of a dialectic between specific representations of science and scientific representations of nature. These assumptions are coded into dominant images of science and naturalised through the concordant specificity of the images of the world that they (and their invisibility as assumptions) help to create. The arrangements of nature, realism,

objectivity, and subjectivity at play in modern presumptions about science – and thus also within the knowledge that emerges from modern science – are not ontological inevitabilities but the precise consequences of the representational practices they themselves engender. That is, these arrangements are constitutive. They are also historical, discursive, and flexible in the face of changing social and scientific expectations and practices.

It is in the spirit of these assertions that Hayles characterises attempts to refigure modern understandings of science and science praxis as "acts of recovery, [attempts to] excavate from an abstracted shorthand the complexities that unite subject and object in a dynamic, interactive, ongoing process of perception and social construction" (1993: 32). Building on their intricate excavations of the ways in which "culture, language, and politics shape the production of scientific knowledge by mediating our representations of nature and discourses of life" (Kay, 1995: 612), the most progressive science studies scholars have aimed not simply to politicise science, but *all* knowledge claims, as well as the objects and subjects that attempts at specific knowledge necessarily engender. Karen Barad, a physicist and feminist science studies scholar, captures the guiding essence of this project when she remarks "boundaries are interested instances of power, specific constructions, with real material consequences. There are not only different stakes in drawing different distinctions, *there are different ontological implications*" (1996: 183 original emphasis). Systems of representation, including science, are onto/epistemologies, simultaneous practices of constructing (what is for us) reality and what constitutes valid knowledge of that reality. As such, the boundaries we draw to distinguish between what is natural (or Real) and what is social (or "constructed") are not fixed and inevitable; they are power moves in which much is determined, including – as Neil Evernden (1993) reminds us – the "nature" of nature and of the subject.

This commitment resonates not only with the need for more critical discourses of science, it also speaks to a broader recognition of the challenges of overcoming the reified power frameworks of an objectivist logic. As Catriona Sandilands explains, tracing the necessary relationality of knowledge (i.e. the simultaneous construction of nature and the social subject within discourses and practices of science, language and politics) points to the need for a discursive politics whose liberatory potential emerges not simply from the promises of alternative positions of representation, but from their sustained "interruption of the fantasy of totality and substantial identity" (1999: 188). This is especially significant for emancipatory movements whose attempts at more critical discourses of nature risk embracing the displacements of objectivism by unwittingly sanctioning its uniquely modern configurations of nature and the social subject.

To translate the insights that such a view affords in the service of liberatory desires, it is therefore necessary to appreciate the ways that nature emerges as an effect of discursive and ultimately political processes, and not from privileged positions of detachment and neutrality. This paper has explored the social and scientific productivity of these later expectations as they have been projected in images of science and in the concordantly naturalised representations produced *by* science. Through systemic "observational

restrictions on what can count as a knowledge claim and the [ambiguously passive] policing of a strict 'hard'-'soft' subject-object boundary" (Plumwood, 1993: 121), dominant representations of science have appropriated narratives of objectivity that mask the reflexive processes through which certain social significations and meanings are filtered by and/or folded into parallel projections of purportedly unmediated and fixed truths. Cloaked in modern images of science, the saliency of nature as a political trope has thus been hidden, but all the more potent for the in/appropriate(d)[25] meanings, identities and locations it has helped to engender. Nature, as Evernden remarks, "justifies nothing, or anything" (1992: 15) alerting us to the need to move beyond historicising particular representations of nature (and concordant meanings and practices) into a space where nature is itself politicised as a constitutive partner in the creation and practices of meaning.

This critical project is in this sense as limiting as it is emancipatory and as necessary as it is dangerous. It is limiting because it continually raises serious doubts about the morality of our modes of being – the meanings we ascribe to the world and their reproduction in the symbols, institutions, and practices by which we define ourselves. It is emancipatory since it is only through such doubts that we are liberated to create alternatives. It is necessary if we truly wish to overcome obstacles of self-deception and self-consciously construct a society based on liberty, equality, and the creative celebration of difference. And it is dangerous, for we risk always the reification of certain critical stances (each with their own exclusions and inequalities) or, alternatively, lapsing into a sense of depthlessness[26] with the realisation that instability is a permanent feature and there is no constitutive outside.

[25] A loaded term introduced by Haraway (1992a) to signal the exclusion or oppression of certain identities through their appropriation into networks representation and meaning that preclude their articulation as legitimate social locations or identities. In a more critical orientation, in/appropriate(d) positions may be deployed to disrupt or challenge the limitations of dominant social narratives.

[26] Used here to signify the absence of the possibility of shared meaning, a reduction of human and nonhuman nature to a meaningless materiality.

References

Barad, Karen. 1996. "Meeting the Universe Halfway: Realism and Social Constructivism without Contradiction," in L.H. Nelson and J. Nelson (eds.) *Feminism, Science and the Philosophy of Science*. Boston: Kluwer Academic Publishers.

Baudrillard, J. 1983. *Simulations*. Translated by P. Faus and P. Beitchman. New York: Semiotext(e).

Beer, G. 1986. "The Face of Nature: Anthropomorphic Elements in the Language of *The Origin of Species*," in L. Jordanova (ed.) *Languages of Nature: Critical Essays on Science and Literature*. London: Free Association Books.

Birch, Thomas H. 1995. "The Incarceration of Wilderness: Wilderness as Prisons," in Max Oelshlaeger (ed.) *Postmodern Environmental Ethics*. Albanie: SUNY Press.

Crary, Jonathan. 1996. *Techniques of the Observer: On Vision and Modernity in the Nineteenth Century*. Cambridge: MIT Press.

Cronon, William. 1996. "The Trouble with Wilderness; or, Getting Back to the Wrong Nature," in William Cronon (ed.) *Uncommon Ground: Rethinking the Human Place in Nature*. New York: W.W. Norton & Company.

Daston, L. and P. Galison. 1992. "Images of Objectivity." *Representations* 40: 80-128.

Evernden, Neil. 1992. *The Social Creation of Nature*. London: The Johns Hopkins Unive rsity Press.

_____. 1985, 1993. *The Natural Alien*. Toronto: The University of Toronto Press.

Foucault, Michel. 1978. *The History of Sexuality: Volume I - An Introduction*. Translated by Robert Hurley. New York: Vintage Books.

Franklin, Sarah. 1996. "Making Transparencies: Seeing Through the Science Wars," in Andrew Ross (ed.) *Science Wars*. London: Duke University Press

Hankins, T.L and R.J. Silverman. 1996. "Science Since Bable: Graphs, Automatic recording Devices, and the Universal language of Images" in *Instruments and the Imagination*. Princeton: Princeton University Press.

Haraway, Donna J. 1992a. "The Promises of Monsters: A Regenerative Politics for Inappropriate/d Others," in Grossberg et al., *Cultural Studies*. New York: Routledge.

_____. 1992b. "Otherworldly Conversations; Terran Topics; Local Terms," *Science* as *Culture*. Vol. 3 (part 1), No. 14: 64-98.

_____. 1991. *Simians, Cyborgs, and Women*. London: Free Association Books.

_____. 1989. "Teddy Bear Patriarchy: Taxidermy in the Garden of Eden, New York City, 1908-1936," in *Primate Visions: Gender, Race and Nature in the World of Modern Science*. New York: Routledge.

Harding, Sandra. 1996. "Science is 'Good to Think With'," in Andrew Ross (ed.) *Science Wars*. London: Duke University Press.

Hayles, Katherine N 1999. *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*. Chicago: Chicago University Press.

_____. 1993. “Constrained Constructivism: Locating Scientific Inquiry in the Theatre of Representation,” in G. Levine (ed.) *Realism and Representation: Essays on the Problem of realism in Relation to Science, Literature, and Culture*. Madison: University of Wisconsin Press.

Hubbard, Ruth. 1980. “Introduction,” in Hilary Rose & Steven Rose (eds.) *Ideology of/in the Natural Sciences.* Cambridge, Mass.: Schenkman Publishing.

Kay, Lily E. 1995. “Who Wrote the Book of Life?: Information and the Transformation of Molecular Biology, 1945-55.” *Science in Context* 8 (4): 609-634).

Keller, Evelyn Fox 1995. *Refiguring Life: Metaphors of Twentieth Century Biology*. New York: Columbia University Press.

_____. 1992. *Secrets of Life/Secrets of Death: Essays on Language, Gender and Science*. New York: Routledge.

Latour, Bruno. 1993. *We Have Never Been Modern!* Translated by Catherine Porter. Cambridge, Mass.: Harvard University Press.

Mitchell, W.J.T. 1994. *Picture Theory: Essays on Verbal and Visual Representation*. Chicago: The University of Chicago Press.

Mouffe, Chantal. 1993. *The Return of the Political*. New York: Verso.

Plumwood, Val. 1993. *Feminism and the Mastery of Nature.* New York: Routledge.

Rheinberger, Hans-Jörg. 1997. *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. California: Stanford University Press.

Ross, Andrew. 1996. “Introduction” in Andrew Ross (ed.) *Science Wars*. London: Duke University Press.

Sandilands, Catriona. 1999. *The Good-Natured Feminist: Ecofeminism and the Quest for Democracy.* Minnesota: University of Minnesota Press.

_____. 1999b. "Between the Local and the Global: Clayoquot Sound and Simulacral Politics" In Warren Magnusson and Karena Shaw (ed.) *Rainforest Crunch,* Minneapolis: University of Minnesota Press.