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EDITORIAL

Introducing Women in Science

BRIAN MARTIN and EVELLEEN RICHARDS

Through all of its history, what is called 'science' has been dominated by men. Almost all of the most famous, powerful and well-paid scientists have been men. Most women in the area have been in junior, supporting positions. Nevertheless, a number of women have forged careers as scientists, often in the face of enormous difficulties.

The male face of science was treated as unremarkable until the 1970s in Western countries. Since then, an increasing number of critics and challengers have been examining education, employment and ideology in science and demanding changes. Three major factors have contributed to this challenge.

To begin with, the second wave of the feminist movement, which developed in the 1960s, eventually got around to looking at science. The initial concerns of the movement were with issues such as rape, abortion, direct discrimination and the gender division of labour. Science was first introduced into the discussion via the role that some scientists took in justifying sexual inequality, such as through alleged differences in intelligence. Science as an occupation was criticised because of the very low representation of women, especially in prestige fields such as physics and molecular biology.

This criticism of the 'abuses' of scientific knowledge and of discrimination in career structures helped focus attention on science as a social institution. Some critics began examining 'science' itself, namely the body of scientific knowledge and the human and material practices which go on to produce and validate that knowledge. Beyond the abuse and discrimination, they began to suggest, perhaps science as a social institution is inherently masculine. This led to early attempts to develop a feminist epistemology of science.

The second factor in the equation was the complementary effect of the radical science movement. In the late 1960s and early 1970s, groups of scientists and students, outraged by the use of the science and technology in the Vietnam War and aware of the role of science in producing military weapons and environmental problems, began what was called the 'social responsibility in science' movement. Initially involving many mainstream scientists, the movements in several countries quickly moved in a radical

direction, developing critiques of the use of science and technology for profit and social control.

The radical science movement has played only a marginal role in relation to mainstream science. It continues to attract people on the fringe of science, especially students, though there are a number of prominent scientists who take an active role. But whatever its institutional weaknesses, the radical science movement has provided a fairly sympathetic arena for feminist critiques of science, especially those critiques which challenge the nature of scientific knowledge and practice rather than just the participation of women in science.

A third factor in the rise of concern about male domination in science has been the grassroots social movements, including the environmental movement, the peace movement, the animal liberation movement and the people's health movement. In these and other movements, challenges to the status quo are commonly countered by appeal to the scientific experts. This has necessitated a concerted attack on particular experts and often on the ideology of expertise.

A good example here is the movement against nuclear power. The proponents of nuclear power included governments, corporations, and nuclear scientists and engineers. All of them vouched for the safety, cheapness and necessity of nuclear power. In opposing nuclear power, the statements of the establishment nuclear experts had to be attacked. This was done both by bringing forth counter-experts—a minority of scientists and engineers who were willing to voice criticism of the nuclear industry—and by questioning the validity of 'nuclear expertise' itself. The critics argued that decisions about nuclear power were not only technical but involved social, political and ethical dimensions. The establishment nuclear experts were submerging these dimensions behind a facade of objectivity ; what was needed was popular involvement in decision-making.

Within the women's movement, birth control and abortion were early key concerns, and feminists focussed on women's health issues. On the practical side, the early 1960s and 1970s saw the flourishing of many women's health groups, and much experimentation with self-help and alternative medicine This brought feminism into conflict with medical expertise and led to efforts to record the experiences of women as recipients of such 'male' expertise and question its efficacy, status, and gender neutrality. The women's health movement thus generated the earliest attempts by feminists to develop a gender analysis and politics around a body of scientific knowledge. It produced a number of popular books and pamphlets which directly confronted medical expertise and promoted the view that not only the practice but also the theory—the knowledge—of modern scientific medicine was gender-laden. At the same time, these early activists asserted the value of women's own experiences of childbirth, sexuality and those areas of medical knowledge peculiar to or having a particular relevance to women, and demanded their involvement in decision-making in such areas. The popular

scepticism of medical expertise engendered by the women's health movement spilled over into other publicly contested areas of scientific and technical expertise and probably did more to undermine the belief in the neutrality and objectivity of science than the more theoretically focussed efforts from the radical science movement and feminist epistemology.

Since the 1970s, a rich and diverse literature embodying analyses of women and science has emerged from the development and interweaving of these three streams. This ranges across the whole spectrum of feminist concerns, and includes the original and still important concern with gender-linked achievement in science, the ways in which science functions to legitimate the social inequality of the sexes, the use of science for profit and social control (such as military research or the proliferation of questionable drugs and medical technologies), and more radical calls for a transformation of the very foundations of scientific knowledge. The solutions offered are as diverse as the analyses. One prevalent response, which merges nicely with existing programmes for equal employment opportunity and affirmative action in many western countries, has been to push to get more girls into science. This approach offers valuable support to women in or planning to enter scientific careers, but it does not tackle the problem of the unattractiveness to most girls and women of becoming a scientist. Conceptions of science start early; educationists have turned their attention on science education in schools, where girls begin to drop away and boys persist even though there are no particular differences in ability.

The trouble with such approaches is that they assume the problem is one of women adapting themselves to get into science ; science itself is left unexamined. If organisational structures, research programmes and assumptions about knowledge in science embody masculine values in some way, getting women into science is a flawed approach. What will happen is that some women will be alienated by the masculine dynamics of scientific research and the scientific community and will leave, while others will adapt to the masculine scientific culture and become no different from male scientists. One analogy here is to the military : is it really useful to get more women into the army, or is it more important to challenge the nature of organised warfare ?

'Feminist science' has been posed as an alternative to conventional science incorporating masculine values. The idea of feminist science opens many possibilities. It might mean scientific knowledge developed without assumptions about male superiority, as in the biological sciences. It might mean knowledge built on assumptions about the unity and interconnectivity of nature, rather than domination of nature. It might mean scientific research organised in an egalitarian fashion rather than through the usual hierarchies which are linked to male domination. What feminist science means or will mean remains hazy so far, because formulations of the theory and practice of such a science have been unclear and inconsistent. It is even possible to argue that feminist science is a contradiction in terms, and that

what is required is 'feminist anti-science'.

In terms of political practice, it is important that initiatives continue in a range of areas. Getting more women into science may not, in principle, challenge the nature of science, but in many areas the struggle itself can upset male preconceptions and masculine routines more effectively than can a separatist effort to do feminist science. Nevertheless, it is important to continue the deeper critiques of the masculine nature of scientific knowledge and practice so that successful women scientists, and men too, do not settle into complacency about the validity of their activities. Finally, it is essential for connections to be maintained between scientists and members of social movements, in order to counter the routine connections between scientific elites and dominant social groups.

In this issue of *Philosophy and Social Action*, each contribution can be interpreted as showing some aspect of the challenge to science by women. Susan Niven's cooly sarcastic account of her experiences as a mathematician shows how incredibly threatening a single woman researcher can be to many male scientists. Thomas Simon argues that the political theory of participatory democracy is an effective way to confront male-centred science and help move towards feminist science.

Jacqueline Feldman aims to develop a feminist critique of science which goes beyond a patriarchal analysis and beyond the reassertion of traditional feminine values, to a degendered analysis which takes account of the essential marginality of women. Ann Dugdale's paper offers a critique of the writings of Evelyn Fox Keller (particularly Keller's attempt to frame the epistemological assumptions or preconditions of a feminist science) which have become very influential in the literature on women and science.

Merrelyn Emery tells about a workshop which provided stimulus for specific actions towards the goal of feminist science and outlines a framework for such a science. Together, these papers illustrate some of the variety of approaches to feminist analysis of science.

We also wanted to have a Third World contribution (as well as a Second World contribution) to the women in science issue, but perhaps it has not worked out because the issue of women in science has, so far, mainly been raised in the countries of First World. It has, however, been decided to bring out a separate special issue of PHILOSOPHY & SOCIAL ACTION on "Women in Third World'. □

चन्द कोयले ही अगर जल उठें,
तो बाकी गीले कोयले भी
आग पकड़ लेते हैं।

—सर्वेश्वर दयाल सक्सेना

WHEN A FEW IGNITE
EVEN WET-COAL CATCHES FIRE.

—SARVESHVAR DAYAL SAXENA

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On What is Known : a Personal Viewpoint

B. S. NIVEN

When I was a little girl and went with my father on a walk to the bank I was always left in the street outside while he conducted his business, since it was known that the spiritual nature of Woman, although making her the superior of Man, unfitted her for financial matters.[1] Later, at High School, it was known that girls did not study the physical sciences, since they had better things to do in life, so I was gently steered towards the study of 'Domestic Science' (which was neither scientific nor domesticating). I was also keen to study Latin and German at school; however it was well-known (and explained to me very carefully) that girls did not have the intellectual capacity to study Latin. German was not available at the school I attended (in South Africa) so I was compelled to study 'Afrikaans' a language which has never at any time been of any use whatsoever to me. The adults who surrounded me when I was a girl all without exception knew that it was obligatory on a woman to get married, have children and spend her life doing the dirty work for other people. This, of course, should be done without pay, since her superior spiritual nature was enhanced by noble self-sacrifice; it was known that paying a woman to do housework or any other kind of work was degrading. It was greatly regretted that in the small co-educational school I attended a low level course in mathematics was compulsory for all children, even the girls. However the mathematics master was on the whole able to cope with that one. One of my fellow students was reduced to tears at every mathematics lesson until her parents, who knew that mathematics was unnecessary for a girl anyway, took her away and sent her to the local convent to be educated, where they did not teach the girls wicked things like mathematics or science. As for myself, the poor man was unable to find a mathematics problem which I could not solve. This upset him greatly. However, he knew that I had no chance of being accepted into University mathematics courses, since I lacked the higher stream school mathematics. This was a great comfort to him since he knew that the study of higher mathematics would warp irrevocably my sweet womanly nature.

I entered University a few days after my seventeenth birthday, after a spot of family blackmail on my part and the interference of the Professor

of Mathematics and Dean of Science at Natal University College, Professor J. McKinnell, who overruled the entrance regulations and accepted me as a student of pure mathematics and physics. Here at University I found people who did not seem to know that it was incorrect for women to study mathematics and science. Neither McKinnell nor my mentor in physics J.R.H. Coutts seemed to have the right ideas. Indeed Coutts (an internationally respected soil physicist) not only did not know everything including the place of women in society but openly admitted this, often directing me to the scientific journals when I asked him a question. Coutts used to pause at my bench when he did the rounds in the physics laboratory; as he wandered off to the next student I would often hear him mutter "Yes, the best student I ever had was a woman." When I completed my BSc at the age of nineteen both gentlemen advised me to proceed to a higher degree (in mathematics and physics respectively); unfortunately it was known that women don't do research so there were no grants available for me. I graduated in physics with a group of twelve men. I think I was the best student; why else did the others copy my tutorials? I remember one of them being very downcast when Coutts gave him only half marks for an answer for which I was awarded 100%. Nevertheless two of the twelve obtained scholarships to proceed to a PhD degree. The others all obtained jobs within a few weeks of graduating. When I applied for jobs however I found that it was known that women are totally unemployable in the scientific world. Not only were they known to be intellectually inferior to men but they were also known to be unreliable since they would leave the job at a moment's notice in order to marry and have babies. The idea that a married woman could have a paid job was known to be immoral and was therefore unacceptable to all right-minded people.

After three years of taking odd jobs in factories and so forth, I was fortunate enough to obtain a post as temporary filing and registry clerk with the Council for Scientific and Industrial Research (CSIR), Johannesburg. I was put in charge of a group of women who worked on calculating machines in the mathematical statistics section. I worked under the direction of men who had the same qualification as myself. I thought that on the whole these men weren't as good in science and mathematics as myself, but because they were men it was known that they should be in charge. I moved from CSIR to a business consulting firm where my work was mainly in operations research and then to the Chamber of Mines where I worked as a statistical consultant. The consultant mining engineers with whom I worked had a hard job adjusting to a woman mathematician, but on the whole they managed well and I even gave a talk to the South African Mining and Ventilation Society, to the consternation of many of the members.

The Professor of Mining Engineering at Witwatersrand University (in Johannesburg), R.A.L. Black was yet another eccentric professor who did not seem to know the correct place of women in society. He required his students to be taught some mathematical statistics and didn't seem to realise

that this should not be done by a woman. Accordingly I found myself teaching in the mathematics department at Witwatersrand University, my main duty being to lecture to mining engineering students. Just as I was settling down happily to an academic career under the benign guidance of J.M. Hyslop and F. Young (Professors of Pure Mathematics) and J. E. Kerrich (Statistics), events outside University circles caught up with me.

> At this time it was known in South Africa that Black people were markedly inferior to White people and that they would not, therefore, benefit from having a University education. Black students were therefore excluded from Witwatersrand University by government decree (in 1959). It was also widely known that Black people were unable to govern themselves since they did not have the intellectual capacity. Thus they had been excluded from the voter's rolls by the 1910 Union of South Africa Constitution which was drawn up in Westminster. It was greatly to be regretted that certain misguided Black people objected to this treatment, thought they were entitled to vote, and had organized themselves for this goal by 1912. Wicked Black people continued to agitate, albeit peacefully, until 1960 when groups of them converged on police stations round South Africa and attempted to hand in their 'passes' in a peaceful but of course totally depraved way. Many of these sinful Blacks were actually laughing as they ran away from the police at Sharpeville, seventy miles from Johannesburg and the police, quite correctly, shot them in the back for their disgraceful behaviour.

I decided that South Africa was unsuitable for a research scholar so I left and went first to Britain and then to a post as a lecturer in the mathematics department of the University of Western Australia. Here I found that the two Professors knew that the duty of a woman mathematics lecturer was to take an increased teaching load so that the men were able to spend more time on their important research. Since 'Bobbie', a charming woman tutor in the department, was known to be totally happy teaching full-time it was a source of great mystification to both mathematics Professors that I was not willing to give up my research in order to be a happy and well-adjusted woman lecturer. I was at this time very busy with some early systems ecology to do with *Tribolium* beetle populations[2,3] with splendid co-operation from colleagues in Chicago who were working on the beetle.

I decided that the University of Western Australia was unsuitable for a research scholar so I left and took a Senior Lectureship at Adelaide University. At the interview for the post which was in the Waite Agricultural Research Institute I pointed out to the Director J. Meville that I was deeply involved in research work and would be unavailable for routine statistical consulting; he reassured me on this point: a Senior Lecturer was expected to teach undergraduates and do research and special statistical consultants were hired by the Waite Institute to attend to routine consulting.

Once again I proceeded to settle down happily to an academic career. The group of distinguished and brilliant animal ecologists in the University led by H.G. Andrewartha and T.O. Browning clearly did not know that it was incorrect and immoral for a woman to do research. My Tribolium work prospered and I earned a nice fat National Science Foundation grant which took me to the United States (in 1973). However events in the University outside ecological circles were catching up with me.

A new Director at the Waite Institute knew that a woman would never have been appointed to a Senior Lectureship (a senior post in Australian Universities) except on the understanding that her 'research' activities would consist of doing statistical consulting full-time in order to assist her male colleagues with their important research. Most of the aforesaid male colleagues knew perfectly well that this was the case and had been so on my appointment. A desperate last ditch attempt by H. G. Andrewartha who came back out of retirement (in 1978) to talk to the Director was partially successful ; the constant harassment ceased completely for four months; during this time I was able to complete some of the initial work on my new research on formalized theory of ecology[4]. However the pressure built up again to the extent of several visits per week from a colleague who knew he was my senior in the heirarchy.

I decided that the Australian University system was unsuitable for a research scholar so I left and looked round a suitable spot in which to carry on with the new research which, to my slow-witted feminine brain, seemed to be doing quite well. I discovered that the ecologist at Griffith University (in Brisbane), R. L. Kitching, also did not seem to know that it was indecent for a woman to do research, so with a good deal of help from him I moved to Brisbane, attached myself to Griffith University in an honorary capacity (in 1980) and settled down happily to the life of a research scholar[5]. Because I was not teaching and thus not in receipt of a salary I invested my savings and superannuation for my previous post as carefully as I could. This was difficult for me since, as is well-known, women are grossly unfitted for financial management At the same time I applied for a grant in lieu of salary from the Australian Research Grants Scheme. Unfortunately I now came up against another area of knowledge which has, to date (April 1987) militated against my obtaining a grant.

My new research followed the lines of the distinguished biologist and logician J. H. Woodger who described a formalization, as opposed to mathematical modelling, in the following words[6] : "In considering the relation of mathematics to biology we must distinguish between the process of applying existing mathematics to biology and the less familiar process of letting biological statements suggest new mathematical ones". However it is widely known among both mathematicians and biologists that Woodger's work was a failure in that it contributed neither to mathematics nor biology ; it is known, therefore, that all scientific work using the same approach must necessarily be unsuccessful. Thus when I had the audacity to apply to the

Australian Research Grants Scheme my work was quite correctly assessed as being "arid, sterile and useless". This worried me very much, since I was obviously grossly deceiving my ecologist colleagues and I wrote urgently to the ecologists H. G Andrewartha and L. C. Birch (in 1984) explaining this to them and suggesting they withdraw their new ecology book[7] since not only was their analysis of environment based on work which was arid, sterile and useless but they had included an Appendix written by myself in which I gave my formalization of the notion of an animal's environment, It is greatly to be regretted that these two authors have refused to withdraw this corrupt and evil work, in which the underlying mathematics is known to have followed totally useless lines and furthermore to have been constructed by an immoral and misguided woman (who ought to be having babies). The particular Committee of the Australian Research Grants Scheme which handles my applications is the Committee dealing with all pure mathematics and physics grants : as is entirely proper only men are members of this Committee (during the years 1981 to 1987) since it is well-known that women not only lack the capacity for such disciplines but also are unfitted for handling financial matters including grants.

It is known that the delicate nervous system of the female mathematician is often soothed by the contemplation of non-overlapping sets. In particular, therefore, I have been greatly comforted by the following naive but very neat classification of people :

I. People who know that little girls should not be corrupted at school by lessons in science and mathematics and that women have better things to do than scientific research. This set of people is well represented in the science departments of Australian Universities by the distinguished gentlemen who sit on appointments committees. The major criterion for a senior appointment is the number of publications ; since the gentlemen who already have tenured appointments are in a position to turn out many articles, with the help of their research assistants and Ph.D. students, the status quo is being manfully maintained. Women who for special seasons are prevented from doing research when young are not in the race and the number of women Professors in science is well under the 50% which a naive mathematical statistician would expect. These learned and distinguished gentlemen are greatly aided by highminded colleagues who carefully advise women University students not to proceed to higher degrees, and schoolteachers and parents who explain to their charges that science and mathematics are too big a strain on the frail intellect of the human female. There is a large overlap between this set of people and people who know that Blacks are inferior but I have not yet been able to determine whether the two sets are identical.

II. People typified by the soil physicist J. R. H. Coutts who seem quite unable to acquire this knowledge. They have even been known to encourage a little girl to study interesting subjects and to support a woman colleague in the Australian Universities. Fortunately such wrong-headed,

ignorant and misguided people are very rare.

III. The singleton (Myself). I knew when I was a little girl that I liked mathematics and was better at it than the other children, both boys and girls. I knew as an undergraduate that my fellow students in the physics course copied my tutorial exercises because they were incapable of solving the problems themselves. I now know that I should have started my research career at the age of nineteen, as my original mentors in mathematics and physics advised. I know that having now achieved my research career, even if unpaid and largely outside the University system, that I am doing the thing which best suits my intelligence and personality, however delicate and womanly. I know that the main reason why the Australian Research Grants Committee won't support me is be-because their assessors cannot abide a mere woman succeeding where they failed ; they are viewing my growing publication list[8] with horror and my rapidly increasing international scientific status with dismay. I am not sorry for them ; I also know, as a statistician, that I have a good chance of outliving them.

The neat classification of people pleases me greatly since I myself belong to what set of people who never know that they are talking about, nor whether what they are saying is true[9].

Acknowledgement

I have pleasure in recording my thanks to R. J, Henry, an element of set II, for his critical reading of an early draft of this paper. □

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Feminist Science and Participatory Democracy

THOMAS W. SIMON

Introduction

A male philosophy colleague of mine portrays the history of philosophy as the history of epistemology and regards political philosophy as peripheral. Disguised androcentrism? Another colleague admonishes me for not sticking to purely epistemological issues in a philosophy of science course and for straying out of the legitimate philosphical domains into the politics of science. Disguised political bias? An administrator rejects a course proposal on utopian thinking because it does not have sufficient intellectual content. Disguised anti-radical?

Are these isolated views related to feminism? Are androcentricism, epistemological hegemony in political theory, and anti-utopianism related? In this paper I examine the interface between these views by analyzing the attempt by some feminists to envision a feminist science by constructing a feminist epistemology. After evaluating the problems with this project (for example, that a focus on epistemology can place feminists in an androcentric trap), an alternative vision of a participatory politics and epistemology is outlined. This intelecually respectable utopian version of a feminist standpoint challenges androcentrism in science by placing political theory and politics at the center of philosophical concerns, contrary to my colleagues' wishes.

A Future Feminist Science

What would a feminist science look like? Would it look very similar to what scientists do now except for having more females involved in the enterprise? Would a feminist science examine a different set of problems than those currently in vogue? Would a feminist science radically transform the way scientists explain, predict, and experiment?

> Elizabeth Fee rejects the feasibility of imagining a feminist science. We can expect a sexist society to develop a sexist science, equally we can expect a feminist society to develop a feminist science. For us to imagine a feminist science in a sexist society is rather like asking a medieval peasant to imagine the theory of genetics or the

> production of a space capsule; our images are, at best, likely to be sketchy and unsubstantial (Fee, 1981, p. 22).

Contrary to Fee's example, the stakes for a feminist science do not include the skill of predicting a specific theory or forecasting the development of a technology. At stake are the broad outlines of how science should be epistemologically and politically structured. Nor does the utopian project necessitate as wide a time gap as between the medieval period and today. The future is much closer at hand.

Certainly, imagining a future feminist science is no easy task. Nevertheless, the enormity of the project should not deter the imaginative faculties. The imaginative project provides a long-needed perspective for evaluating our current scientific state of affairs. This critical perspective is not the only one, nor does it have to be a static and unchanging one. Imagining where we are going helps us judge where we are. Since future-thinking occupies no prominent political place in our culture, our images are woefully inadequate. Developing more substantial images constitutes the challenge. Utopian thinking can have a liberating effect (see Goodwin and Taylor, 1984 for an excellent defense of this).

Also, contrary to Fee, the actual or imaginative construction of a feminist society is not a pre-condition for imagining a feminist science. Science and society are much more intricately related. Imagining a feminist science is not divorced from societal concerns. By imagining a feminist science we are imagining aspects of a feminist society. There is no single one-way connection going from society to science. Science does not neatly follow on the coattails of society. Scientific developments can reflect, mystify, hide, and foretell social changes. Given the dominance of science in our culture the utopian[1] science project is an integral part of the struggle for a feminist society. So, need to collectively map out what a feminist science would look like.

Standpoint Epistemologies

From what standpoint can we envision a feminist science? For many feminists, epistemology provides the framework for constructing a feminist science (Harding, 1986), even though some (Flax 1986 as noted in Harding 1986) contend that there is no one feminist epistemology. This (these) standpoint epistemology (epistemologies) is (are) completely different from the empiricist-based epistemology supporting current gender-biased science.

Hilary Rose portrays one of these standpoint epistemologies.

> A feminist epistemology derived from women's labour in the world must represent a more complete materialism, a truer knowledge. It transcends dichotomies, insists on the scientific validity of the subjective, on the need to unite cognitive and affective domains; it emphasises holism, harmony, and complexity rather than reductionism, domination, and linearity (Rose, 1986, p. 72).

Constructing an epistemology along these lines is a challenging and noble task. But it just may be the wrong, or at least, a misleading, task. Epistemology, as I will try to show, is the wrong standpoint to emphasize for it devalues the political dimension.

Treating epistemology as the fulcrum point is a well-executed political ploy in both philosophy and science (see Gunnell, 1986). Almost every history of modern philosophy takes epistemological questions as primary and political ones as peripheral. Although the epistemological turn is evident in modern philosophy, this history is distorting. For example, Wittgenstein's *Tractatus* is only misleadingly interpreted from an epistemological framework which ignores the cultural, political, and ethical context out of which the work grew and through which we can provide a more plausible reading (Janik and Toulmin, 1973).

Likewise most philosophers view science primarily in epistemological terms. Science only secondarily has a politics or even a history. One way this epistemological hegemony serves as a political ploy is that it diverts attention away from other, particularly political, questions. If science as a means of attaining knowledge is kept in the foreground, then science as a means of organizing power for men remains hidden in the background A preoccupation with epistemological questions does not prevent political questions from being asked, but it makes asking them less likely. Within the epistemological domain political questions are taken less seriously than others. Even "admitting to political interests makes the arguments less objective, and thus less valid" (Birke, 1986, p. 158) when viewed through epistemological eyes.

Before considering an alternative political standpoint it is important to note what I am not saying I am not saying that epistemology is irrelevant. To the contrary, as I will try to show in the next section, political standpoints are entangled with epistemological ones. What I am arguing against is the primacy of any epistemological standpoint. Nor am I saying that feminist standpoint epistemologies are not political (Harding 1986, p. 194). My worry is that they are not political enough. Indeed, Enlightenment epistemological, as Harding 1986) calls them, underpinnings of science are a problem but not simply because of their specific epistemological claims, however objectionable they are. It is also because our Enlightenment legacy takes the primacy of the epistemological framework as sacrosanct.

To engage in epistemological combat by arguing, as Rose does, for the validity of the subject, for the inclusion of the affective, etc., is to fight androcentrism on male turf, the epistemology battleground. As Ruth (1981, p. 49) notes epistemology is legitimating god of philosophy.

Standpoint Politics

Instead of carrying out the debate primarily in epistemological terms I propose replacing the epistemological dimension. Within the political arena participatory democratic theory serves as a natural ally for feminism.

Both oppose domination and advocate empowerment.

Feminists have designed noble and, at times, frustrating experiments in participatory democracy, but these experiments have not been only a product of contemporary feminists' efforts. Throughout women's her-story participatory forms have been employed. Other standpoint politics for feminism are very important, but participatory politics, even though often ignored by others, occupies a special place.

Yet, participatory theorists ignore their common ground with feminists. Ignoring experiments in participation by women is no easy feat for participatory theorists. Somehow they manage to do just that. Even Carole Pateman (1983) laments the omisssion in an earlier work, which has become a classic in participatory theory (1970). Two of the most recent works on participatory theory (Barber 1984, Green 1985) hardly even mention fefinism to say nothing of participation by women.

Assuming a reconciliation between participating theory and feminism, what does this have to do with feminist science? The question is difficult to answer if science is primarily viewed in an epistemological and only secondarily in a political framework. Raising any political questions seems inappropriate with epistemology at the helm. However, if science is primarily seen as a means of organizing power, then the project of democratizing science is more appropriately targeted.

The most obviously political feature of science is its institutional structure. The way science has historically developed as an institution is one way power has been organized in science. With a relatively small percentage of GNP expenditure on science prior to World War II there was little governmental interference in scienee. Now the influence of science, radically changing the power dynamics of science, is enormous (Dickson, 1984). For example, scientists now directly influence governmental policy decisions in their roles as consultants.

The clash between this elite institutional structure and participatory democracy could not be more dramatic. Rose and Rose (1976, p. 33) estimate that "some 200-300 key decision-makers—primarily scientists—consritute the inner elite out of a total scientific work force of some two million". Even if that figure is exaggerated, participatory theorists would flip that power dynamic on its head so that the 1,999,700 or so workforce controlled more of the power-base. The challenge to participatory theory is not only to find means of control for the workfore but also for society. Decisions about science are now largely made by the scientists themselves with little outside policing. Only a few controversies pass before the public eye The only controversy ever brought to the public by the scientists themselves was recombinant DNA and that was done very reluctantly and in a very orchestrated manner. Hinding from public scrutiny is completely contrary to participatory theory. The task awaiting participatory theorists is how to bring science into the open.

Defenders of the scientific status quo have two inconsistent ways of

retreating away from a political clash with participatory theory. First of all, they can argue that regardless of the non-democratic institutional character of science, it yields remarkable results. In fact, given the high degree of specialization needed to do science, it is because of its non-democratic structure that science is so successful.

The response is two-pronged. The remarkable success attributed to science is certainly debatable. For example, much of the success attributed to medicine is more justly laid at the feet of the changing sanitation or other environmental as well as social conditions (Inglis, 1981). Medicine's assault, past and current, on women is well-documented (Ehrenreich and English 1979; Lewin and Olesen, 1985). Seeondlv, even if we applaud science for its advances, it is difficult to see how those advances are primarily due to the non-democratic character of science. Let us even grant that. A perfectly justifiable project for participatory theorists, then, is to envision ways in which those same advances could have been democratically obtained.

Instead of relying on the importance of the institutional structure defenders of science can reverse themselves and claim that the institutional structure is not essential for doing science. So, the second move is to sever the tie between the institutional framework of science and the particular epistemology upon which science relies. Whenever problems are detected in the institutional framework, science retreats to the safe ground of epistemology and methodology. From this vantage point. scientific methodology is portrayed as the unique (and relatively exclusive) way of advancing knowledge.

Responding to this we see that the attempt to isolate scientific methodlogy has been a failure (Feyerabend, 1975). It is not even clear what has been isolated. For there is no one accepted description of scientific methodology. Even if the methodological canons of science were isolatable, they would still show the taint of institutional structure. For example, science is thought to differ from other epistemologies because of its use of controlled experimentation. Yet, the preponderance of controlled over clinical studies in science is due, in part, to the funding structure and not to some epistemological dictates. The accounting methods for funding require easily quantifiable results readily attained through controlled experimentation.

The inability to sever the tie between the institutional structure and the epistemology of science opens doors for the standpoint politics of democratizing. Showing the effects of democratizing science's institutional framework on its methodology now becomes an easier task. This task is taken up in the next section.

Feminist Science From A Participatory Standpoint

Imagininig a feminist science is not as difficult as it might seem. The difficulty comes in mapping out the means for bringing about tha future. The standpoint politics of participatory democracy and feminism provides

the lens for focusing on the future.

Through this lens we can imagine all aspects and all levels of scientific decision-making bearing the stamp of feminist participatory practice. Meetings, whether at the laboratory or at the professional organizational level, are facilitated and not led in an authoritarian manner. The goal of meetings is not to inform others of the direction decided by a few but rather to work towards consensus in determining that direction. These and other devices of, what I call, the procedural sense of participatory political theory impact on scientific epistemology. In each of the social sciences a number of research strategies vie for hegemony. Some of the research strategies offer sharply contrasting epistemologies. A raging battle in the social sciences constantly brews over the ligitimacy of quantitative statistical studies against more qualitative interpretative ones using participant observers. Participatory theory provides one framework for trying to resolve these conflicts. I would argue, for example, that in linguistics a research strategy emphasizing the centrality of sociolinguistic investigations into sexist langu age more fully meets the demands of participatory theory to overcome domination than does a research strategy which gives central place to syntactical concerns.

It is not difficult to predict a flurry of objections cast against this proposal to democratize science. Basically, there are two sets of objectives : those at least answerable in the framework of participatory procedures and those challenging that framework. In the first set, we find challenges to the practicality and to the political nature of the proposal.

Every version of participatory theory confronts the charge of impracticality. The objection relies on various factors : (1) not enough time for participatory decision-making; (2) too many people included in the decision process; and (3) too many complex issues addressed. None of these present insuperable obstacles. The time spent in bureaucracy could be better spent in democracy. Another catchy way of putting that is that time could be found if the will to find it was there. Next, decentralizing the institutional structure of science would partially remedy the too-many-people problem. Furthermore, participatory practice does not involve all people making each and every petty decision (See Jones, 1957, for a discussion of this practice in ancient Athenian democracy). The choice of a research strategy is a major policy decision that could be practically made by all those involved. Finally, the complexity claim is diversionary. The degree of expertise needed to make an institutional decision is far less than that needed to make specific claims. I do not need to be an authority on lasers in order to make an informed judgment about the wisdom of science pursuing Star Wars research.

A less prominent but more sophisticated objection attacks standpoint politics. Accordingly, standpoint epistemologies, with their attempts to portray one standpoint as the best justified, are problematic enough (see Harding 1986 for an excellent summary of this). A standpoint politics is

even worse since it pretends to have the political truth. Epistemological absolutism is troublesome; political absolutism is disastrous.

The objection is well-taken, but it misses the mark when aimed at participatory democracy. Because of its non-authoritarian foundation participatory democracy is one of the few political theories which is not vulnerable to objections cast against authoritarianism: Secondly, the objection assumes that science is not already politicized and that certain decisions are made, without recourse to politics, on purely epistemological grounds. A more plausible description is that political factors are constantly impinging on epistemological decisions A research strategy is not adopted solely on the grounds of the strength of the epistemological arguments. Power-plays among academics play more of a role than most of us are willing to admit.

Also, adopting participatory procedures does not mean casting aside epistemological standards or concerns. These practices simply broaden the base for considering epistemological and other concerns. Later I shall try to demonstrate the political and epistemological interactions. In the meantime, even if the epistemological assumptions of participatory theory remain hidden I prefer a standpoint politics with a tacit epistemology to a standpoint epistemology with a tacit politics. The reason is that the politics of the latter are much more difficult to combat because of their hidden nature.

The other set of objections is more formidable because the replies are more radical and therefore less readily accepted. Two of the objections within this set are :

(1) What if researchers decide participatorily upon a sexist (or some other loathesome) research strategy?

(2) Feminist challenges to scientific epistemology are much more fundamental than choosing between already competing research strategies.

To answer the first we need to make a major change in the procedural version of participatory democracy. Participatory democracy is not simply formal and procedural. The substantive goals of overcoming domination and developing empowerment lie at the very heart of the participatory program, So, the question, who participates?, is not merely a procedural one. It is not only the scientific workforce which should participate in decision-making. Those who are dominated and oppressed in the society ought to have a primary voice, especially in research which involves them, Armed with this normative substantive principle any research strategy promoting domination is unacceptable. I would then agree with the authors of *Not in Our Genes* (1985) that biological determinism constitutes an objectionable approach.

Expanding the domain of participants also helps us address the second objection by linking participatory politics to feminist epistemologies, Smith (1979) proposes a standpoint epistemology whereby "The authority of the inquirer [is put] on the same epistemological plane as the authority of the

subjects of inquiry" (Harding, 1986, p. 157). In studying midwives, the midwife's interpretation of her experience should be given some weight relative to the researcher's interpretation. It is esay to see how giving the subject of an inquiry participatory status facilitates this epistemological move. If the midwife participates in decisions over research strategy and design, then her interpretative experiences gain even more credence.

Another illustration is more indirect but shows the direction this analysis takes. As noted before the most important ones who need to participate in the scientific decision-making are those most affected by the proposed research. In many cases these are beings "without voice" : the young, some differently abled, future generations, and non-human animals. Minimally, tnose without voice should participate through representatives among those with voice. For example, those who speak solely for animals should have a controlling voice on animal experimentation review committees.

Birke sees this political-epistemological connection arising out of the animal experimentation issue :

> ...feminist science has to avoid methods that continue such forms of oppression in other spheres—which, at least to some contemporary feminist authors, must include the ways in which animals are presently exploited in laboratories (and elsewhere). A feminist science, then, would have to look for more cooperative, and generally non-invasive, ways of understanding nature (Birke 1986, p. 150).

Thus, we see that the politics of animal experimentation is tied to epistemological concerns. Non-invasive ways of working with animals in science generally would mean more field and clinical as opposed to controlled experimental studies. Although the connection is not automatic, these, in turn, are more conducive to adopting non-reductionistic, holistic, etc. approaches to science which are exactly the types of characteristics listed by Rose (1986) as components of a feminist epistemology.

Unlike implementing the more reform-oriented participatory procedures, the more substantive version of participatory theory needs a feminist society in order to be put into practice, for the latter version directly challenges the power base of science. To that extent Fee is correct : a future feminist science goes hand-in-hand with a future feminist society. However, imagining a feminist participatory science does not require a full-fledged feminist society in place. The challenge is to find the means to both those ends.

Showing these political-epistemological connections should allay the fears of Keller (1982), and Brike (1986) that a political standpoint politics is liable to fall prey to a danger. Keller describes this danger as residing

> ...in viewing science as a social product; science then dissolves into ideology and objectivity loses all intrinsic meaning. In the resulting cultural relativism, any emancipatory function of modern science is negated, and the arbitration of truth recedes into the political domain. Against this background, the temptation arises for

> feminists to abandon their claim for representation in scientific culture and in its place, to invite a return to purely "female" subjectivity, leaving rationality and objectivity in the male domain, dismissed as products of a purely male consciousness. (Keller, 1982, p. 593).

Participatory political theory carries with it an epistemology that does not completely abandon science and objectivity. However, there is another side to this claim which has been one of the themes of this paper. Over-emphasizing epistemology to the detriment of politics can trap feminists in a male political domain, disguised as an epistemological one. The issue is not simply the epistemological aspects of non-reductionism and holism but rather the political components of those epistemologies as well. Reductionism is not simply a successful epistemological means for providing explanations and predictions. Rather it is also a way of structuring science into highly specialized political units which are very readily dominated by males who have the political advantage in the society at large. A holism that fails to integrate a political critique of reductionism is doomed. Participatory theory challenges both the politics and the epistemology of androcentric science.

Conclusion

Three standpoints have been examined ; (1) utopian, (2) epistemological, (3) political. As an evaluative standpoint utopian thinking is not only defensible, it is very necessary. If we do not envision any aspect of a better society, then we are in deep trouble. Developing this vision largely within an epistemological context, however, distorts past, present, and future. Arguing on an epistemological plane lends feminism a certain form of legitimacy, but it is a form that is politically molded by a current power structure. Questions of knowledge are inextricably intertwined with questions of power. The epistemology of science is part of the politics of science, contrary to the wishes of my colleagues. Whatever shape the feminist vision of science takes. it must be, first and foremost, a political vision. Participatory theory provides a means of directly confronting the politics and epistemology of androcentric science. Participatory theory will not cure all sexist ills, but at least it asks some of the right questions. □

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1. Even using the word 'utopia' reflects a political bias. Utopia means "no place." I prefer the less derogatory 'eutopia', meaning "best place." (See Simon 1986).

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A Feminized Science : From Theory to Practice

MERRELYN EMERY

There are many feminisms but a feminist science should question all forms of domination (Fee, 1986, 54). This paper argues that only through a deeper conceptual and practical understanding of the 'feminine principle' (a path for renewal Harding, 1971, 240) will we achieve a feminized science (Femsci) viable because it is a humanized non-dominant science.

Historically there has been a 'feminism' which is holistic, humanistic and ecological. 'Feminism' as a 'movement' has fragmented in recent years and defferences have often been used to further the interests of cliques or women at the expense of men, rather than care for humanity and the planet. This paper uses 'feminism' as a coherent value system as above.

There is certainly no shortage of insight into the failures of patriarchal or masculine science (Msci) but despite a decade of feminist critiques, "no feminist science has evolved" (Rosser, 1986, p 168). This failure is not confined to feminist prespective. More generally, alternative visions of science and society show high degree of commonality (Emery M. 1982, 78—88; see the SHE Future, (Robertson, 1978), Eco-Philosophy (Skolimowski, 1978), Convivial Equiry (Henry & Thompson, 1980) and there is an unresolved question as to whether a feminist science differs significantly from a humanized science. But none have made significant dints on the major institutions, particularly organized science. 'Science' is, therefore, almost by the definition of invulnerability, one of the most entrenched manifestations of the constellation of ideas and values incorporated into the world view of mechanism (Pepper, 1966).

As theoretical alternatives are in place, all that is lacking is the reality. To become a vital force for change in science and, therefore, society, the gap between vision and reality must be bridged ; the feminist principle must be translated into an alternative way which performs the functions of science but holistically, with respect for life in all her forms. At least four interrelated elements appear to be necessary and of these, methods to transform dreams into action are critical and available.

The Search Conference "Can we build a feminist science?"

WISENET, the women in science enquiry network, was established in 1984 with a broad set of objectives to change access to and the nature of science. A small group of members of both sexes in Canberra at the Australian National University had been meeting periodically, exploring various ways of coming to grips with the notion of a feminist science and as one of these ways, a Search Conference was organized and advertised. Canberra is rich in educational and research resources and a broad sample of scientific people turned up on the 6-7 February, 1987.

A Search Conference is a carefully designed method for participative planning (discussed in more detail below) and this one followed a fairly classical pattern (Emery M. 1982). It began with a briefing on the method, a history of the project, personal introductions and expectations. Utilizing direct perception and validating personal experience, the conference compiled a database of significant changes taking place in our shared 'extended social field'. Over 160 recent changes were quickly recorded in all areas of our lives. Small groups then synthesized this data into desirable and probable futures at the global level and reported. Through ensuing discussion and negotiation, the following statements were agreed to be those of the conference as a whole, (The one significant conflict is discussed below.)

A DESIRABLE FUTURE

(i) Women can define independent positive identities and express them

Women are visible everywhere doing a wide range of jobs including those involving strength, intellectual ability and nurturing. Mothers would be honoured, have excellent resources and there would be freedom (not licence) to explore and seek pleasure in all ways. Children would be valued as people, not being moulded into stereotypes.

(ii) Greater identification with the natural world

Small groups of people have land to be self-sufficient; as *caretakers*, not owners. Spaces in cities and backyards grow food on recycling principles, replacing large monocultures. Large tracts of wilderness are protected (no rights to mine) and Aboriginal land rights are extended with whites learning from Aborigines how to live with the land. Australia is 'greened' with protection for and vast replanting of trees. High-rise accommodation is replaced and everyone has access to open space.

(iii) Knowledge and learning is holistic and interactive, not based on desire for control and destruction

More choices are available in healthcare, homebirthing etc. and all people have access to education facilities throughout life, eg. libraries, universities, trade workshops. Networking and community based learning

centres replace institutionalized education with their goals developed within the community.

(iv) More equal distribution of wealth and resources among people with an awareness of the need to limit exploitation of resources

Production relates to community need rather than monopoly profits and large-scale production exists only where this is the most economic or practical use of resources. The unit of production is the small self-managing group. We have alternative power (solar, wind etc. no nuclear) and new biodegradeable packaging. Waste is out ! Mining, forestry and all natural resource use is planned and controlled nationally on the basis of community need. New technology is also subject to community decision and control. There is a question about the future of farming.

(v) People are able to express their own spirituality

People are spiritually aware within small community-based rather than large institutionalised religions. Creativity expands.

(vi) Life within communities

Social structures consist of self-managing groups without hierarchies based on race, sex, occupation, sexuality or lifestyle. Participatory democracy operates without abdication of power or responsibility to representatives and there are no armies, police, courts or law system as we know them. Ideas for change proliferate.

(vii) Men accept their interdependence with others and with nature

They are learning not to obstruct women defining themselves as people and share equally the responsibilities and joys of being a parent.

(viii) *Communications* (this point was *not* unanimously agreed). There is more emphasis on face-to-face communication with sharing between and within communities with increased use of post, telephone and radio rather than centralised computer systems.

(i) *There is a collapse of economies* based on expansion because of the crises in the monetary system and capitalism.

(ii) *Increasing* rich/poor *polarisation* with privatisation of education and a public education crisis. Polarisation is both national and international.

(iii) *Increasing distance* between authorities and counter-culture with a growth of resistance, eg. 'greenies' and increasing media control over public opinion.

(iv) *Increasing degradation* of the natural environment with consequent illnesses (eg. cancer, respiratory diseases) pollution (lack of pure water, food, air) and depletion of natural resources (forests, fossil fuels).

(v) *Increasing degradation* of the social environment and violence between nations, governments and people with both repression and resultant self-abuse (addictions, suicide etc.) and social stress and mental illness.

(vi) *Growth* in the use of *computers* and technology application with resulting changes in work practices and perceptions of what is valid knowledge (eg. research that is represented by computers). Bureaucratic control and automation in production are increased and world views are changing.

Groups then worked towards a 'desirable science' and its contribution to narrowing the gap between desirable and probable futures.

(i) *Humble Science* which recognises its own limits, values and other forms of knowing. It is non-elitist (cf. Bleier, 1986, p 16).

(ii) *Which is in the hands of all people.* There is open debate of ethics, politics and awareness of social responsibility/accountability. The community is involved in control and funding.

(iii) *With a shift in emphasis towards human welfare and ecology.* All socially responsible enquiry is valid.

(iv) *Adopting an interdisciplinary approach* with a proliferation of specialisations but with increased collaboration between them.

(v) *With collaborative, cooperative methodology and non-hierarchical, non-sexist, power structures.* Divergent and holistic approaches are encouraged.

(vi) *Which communicate and educate* to demystify through honest, realistic reporting of interrelationships (dynamic) as well as facts (static) in order to realize full human potential and fun.

A DESIRABLE SCIENCE WILL CONTRIBUTE BY

(i) *Meeting Community Needs*—It will :

Develop smaller community-based (alternative) technology directed to community needs (not profits) and empower community networks : Use Nobel dollars more usefully, break the military connection or turn the University into a home for the homeless.

(ii) **Democratizing**

Scientific workplaces, breaking down dominance, the patronage system and degree structure. Use interdisciplinary work teams, empower individuals, support people within institutions who have these views and goals, network amongst women working in science and fund non-traditional areas such as women's centres. Decrease the elitism in schools by changing the balance of teaching to learning and thereby demystifying scientific knowledge and production. Value all levels of education, rewarding equally. Perhaps make community teaching part of the work of all research scientists.

(iii) **For Oneness, Wholeness**

Science must spring from the values of a desirable future for all, an ecological stance which expands spirituality and science as a way of life (not life in an institution). It must make possible a more holistic view of people, destroying the myth of rationality and objectivity. Science is intrinsically interesting and debate about it must widen to include educational, social issues and ethics.

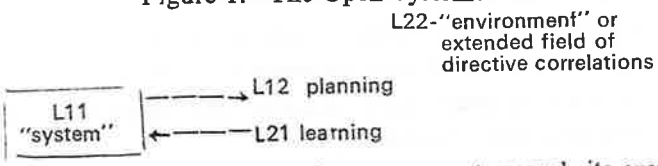
It had become obvious that implicit conflicts were running through the Search which needed to be rationalized. Common ground eventually emerged as : "Science is discursively and culturally produced and at any given time it is what is recognized as 'science" (cf. Bleier, 1986, 2). It is not absolute and it does use intuition and revelation but at the moment, 'science' is not done by house-wives at home. The Search then embarked on its final stages which were plans for action. Of seventeen possible project to operationalize Femsci, three were selected for preliminary work. Plans for 'street theatre' at an upcoming science conference using music, dance and mythos to illustrate the return to 'learning by indirection', synchronizing participative learning (Hall, 1976 ; Havelock, 1963, 1978). Science shops address contributions (i) to (iii) while childhood science learning will hopefully and respectfully build upon children's world views and creativity. Work continues on these fronts and the Science Shop will be fully fledged by the beginning of 1988.

This Search Conference illustrates the other elements necessary for the development of a Femsci.

1. A New Paradigm : Open Systems Thinking (OST)

Feminism finds its reasoning at odds with the linear logic of Msci (Rose, 1986, p. 58) and is critical of Msci's fragmentation of reality which, of course, is much too diverse and complex to be analysed by scientists (Namenwirth, 1986, 31). The world's complex problems demand a methodology for thinking that transforms a singular view into an integrated, collective process of thought *and* action with continuous communication and adaptive change at all levels (Stulman, 1967, 25). Working with the 'behaviour of whole systems unpredicted by the separately observed behaviours of any of .. the parts" (Buckminster Fuller, 1970, 64) is now known as Open Systems Thinking (Emery F, 1981).

Figure 1. The Open Systems Model



The basic set of four relations between a system and its environment are lawful (L), governed by dynamics which are able to be known. Both system and environment are dynamic entities (L 11) and L 22) which transact through the function of perceiving and learning (L 21) and planning (L 12). Directively correlated (Sommerhoff, 1969) means mutually determined. At the simplest level, system and environment act together to produce a new outcome (Ackoff and Emery, 1972).

Open systems thinking is an *ecological* rather than disciplinary paradigm, opposed to linear causal thinking (Emery F, 1981, I, 10). It is a-disciplinary, concerned with *wholes* as is feminism (Namenwirth, 1986, 32). It addresses social concerns or problems which require collaboration between specializations, comprehensiveness, a future orientation and heuristic strategy (Emery & Trist, 1972, 91-92.

Because it concerns wholes, OST includes human values and ideals as they are as much basic data as are economics or material properties (Emery M, 1982, 139; Harding S, in Fee, 1986, 50). This is sufficient to cast it as heresy in the eyes of those who mind the ruling disciplinary 'objective consciousness myth' (Roszak, 1968).

2. The New (Old) Set of Ideals.

The ideals below are derived from the OST framework (Emery F, 1977) but are the essence of the historical "feminine" (Neumann, 1954, 1955) and, therefore, very old. Msci has adhered to a set of ideals and practices with relatively recent origins in early Greek culture. Ideals and epistemology are inextricably interrelated (Table 1 and see below).

Table 1. **Ideals and Operational Modes for Msci and Femsci**

MSCI		FEMSCI	
Ideals	*Operation*	*Ideals*	*Operation*
The Good	Literacy	Homonomy	Conversation
Truth	Teaching abstractions	Nurturance	Learning through
Plenty	Materialism	Humanity	perception
Order	Hierarchical	Beauty	Spirituality
	domination		Participative
	(patriarchal bureaucracy)		Democracy

(Adapted from Emery M, 1982, 194, with original sources)

Homonomy (Angyal, 1941)—interdependence with others. relating parts to each other and the whole for mutual benefit ; the opposite of selfishness.

Nurturance—cultivating those means which contribute to the growth of the whole and its parts ; the opposite of exploitation.

Humanity—putting the well-being (spiritual as well as physical) of people above the needs of institutions ; opposed to inhumanity.

Beauty—that which is aesthetically ordered and intrinsically attractive in all spheres ; the antithesis of ugliness.

In the ancient matriarchal cultures (Reed, 1954 : Gould Davis, 1971 ; Herbert, 1975 ; Shaw, 1981) the supreme deity was The Great Goddess or *The Great Mother* (Neumann, 1955) ; the unity of Life and Earth. Her ideals derived from the functions of physical woman (Bachofen, 1967) such as gestation and lactation. The objectification and damaging of people and environment by a dehumanized Msci (Arditti, 1980, 364) and bureaucracies (Pietila, 1987) alienates many women as "world-loathing .... is woman loathing" (Lederer, 1968, 168). Nurturance, the ideal most visibly and traditionally associated with motherhood, is now a key to women's efforts to create a more sane future for all (Pietila, 1987). The peace and environmental movements are essentially concerned with preserving and nurturing the earth and all her creatures.

Within the complex Great Mother, feminine wisdom is personified by Sophia who is most active in times of change or spiritual transformation, providing cultural therapy (Neumann, 1955, xiii). Her wisdom "is no *abstract disinterested knowledge* but a wisdom of loving participation" and "desires whole men knowing life in all its breadth" (Neumann, 1955, 331). Learning to act wisely is the process of pursuing the feminine ideals through participation in the creation of reality (Emery M, 1986).

3. A New Epistemology : Naive Realism or Ecological learning

Msci and our educational system are the consequences of an epistemology and the tragedy of their success was inherent in its basic premises (Schwartz, 1971, 10). These are a further product of the world hypothesis of mechanism (Pepper, 1966) which springs in part, at least, from Euclid's fifth proposition that parallel lines do not meet, thus guaranteeing a mechanical and stable universe (Emery F in Emery M, 1982, 18-19). Phenomena which could not be explained within a geometric, Euclidian and later 'Newtonian' universe came to be outside the realm of rational enquiry. In the same era, literacy was invented, transforming our appreciation of life through a shift from oral-aural and musical to visual; a rebalancing of the senses. While the origins of the relationship between a mechanical universe and literacy remain murky, there was a coincident reinforcement (Ong, 1967). A postulate which contradicted perceived reality opened the way for a form of knowledge which could not be learnt from experience. It led to an intellectual elite, the literate, who specialized in *abstract* knowledge. Ordinary experience was devalued as the abstractions could be conveyed only by reading and teaching. What is 'scientific' is incorporated into the academic culture of the ruling classes (Gorz, 1980, 268).

We are now a "rampantly visualist culture" (Ong, 1967, 10) as observation and literacy gained dominance in science. The universe became curiously silent (Ong, 1967, 63) but, of course, it is neither static nor silent. The implications of our failure to know holistic patterns were exposed as the *Silent Spring* (Carson, 1962). As only spoken language features vitality and change a predominantly literate culture becomes a victim of its own logic, its characteristic inertia. We all suffer from the "pathology of normalcy" (Fromm, 1963, 3) which is difficult to escape. Even idealistic radicals fall into closed system thinking (Goldsmith, 1981) and some academic feminists (eg. Ferguson, 1984) escape neither their discipline nor their national culture (Emery M, in press).

However, this epistemology may now be put to rest as an alternative exists which does not dismiss or trivialize experiential knowledge (Rose, 1986, p 70) but which emphasizes learning from direct perceptual experience through creative group work. Known as 'ecological learning' its concepts and practices are spreading rapidly. Once again the scientific basis of our beliefs has been shown to be less than 'scientific'. Not only have Bolyai and Lobachevski irrefutably established that a proof of Euclid's fifth postulate is

impossible (Pirsig, 1974, 260), Heider and Gibson have also shown that the environment is recognised as having an informational structure which is embodied in the invariances that exist in the relation between energy flows, despite fluctuations in the individual flows and regardless of whether they impinge on the sensors of an organism. The perceptual systems of living species have evolved so as to detect and extract this information from their environments despite a great deal of 'noise' at the sensory level (Emery F, 1981).

Every human is equipped at birth with a unified perceptual system uniquely adapted to directly extract meaning from the environment (Gibson, 1966; 1979; Starkey et al, 1983 ; Haith, 1980). We were never 'tabula rasas' or empty, mechanical people (Emery F, 1981). Theories of 'learning' based on these assumptions have had the disastrous consequence of dissociating us from our environment.

This applies equally to social affairs as human meaning and levels of conversation are as directly known and made conscious as is the physical environment (Bion, 1952; 1959 ; Emery M. 1982, 1986). The powers of spoken language are the preserve of the Muses (Sophia's sisters) whose role was to produce celebration and pleasure in the pursuit of knowledge, in the days before research became 'work'. Learning in oral cultures was to *know* reality not to '*see* the truth' (Caudwell, 1937). Conversation is "phatic communion" (Malinowski in Farb, 1973, 24), verbal togetherness or social cement", preparation for concerted group action (de Laguna, 1927, xi) and the old cultures spent "an amazing amount of time simply talking" (Farb, 1977, 104).

Feminism is well aware of the need to change from command to conversation (Fee, 1986, p 47) changing the narrative field "by telling another version of a crucial myth" to reconstruct new meanings (Bleier, 1986, 14) but appears not to have grasped that 'the medium is the message' (McLuhan, 1964). Contrary to Bleier, I argue that changing from asymmetric to symmetric relations (commands to conversation) is not a different process from changing paradigm but a part of it. Neighbourhood learning centres are returning to the *mythos*—the oral culture term for the story which instructs (Havelock, 1978, 46) as the way to change practice, consciousness, and paradigm (Slattery, 1979, Gloster, 1981).

A change to valuing direct perception, conversation and symmetric relations will inevitably cause problems for some feminist scientists and academics who, having fought for their status in the system, will be as loath as their colleagues to change it, But "the task of our generation . and the task of all education is metaphysical reconstruction...to understand the present world, the world in which we live and make our choices". "More education can help us only if it produces more wisdom" (Schumacher, 1973, 83 & 66). To reverse our flight into the sterile world uf Msci there is an urgent need to practice ways in which new learning and transformation may take place with as little pain as possible.

4. New Methods

So if we are to put a Femsci into practice we must introduce it through methods which demonstrate the new learnings required. These must be in all senses 'rituals' of the holistic new way, gcnerating the energy which accompanies excitemeut and joy (Emery M, 1986) in order to reverse the effects of Msci (Namenwirth, 1986, 25) and fuel continuing action. Rituals serve learning through participation in meaningful expressive action (Sennett, 1974, 266). These rituals must :

(a) elicit visions of basic human spirituality and ideals
(b) involve participatory democratic face-to-face modes such that
  (i) conversation replaces the broadcast (lecture) and written language;
  (ii) the impotence of oppression (Pietila, 1987) is replaced by a contribution
(c) focus upon important practical tasks within the sphere of control of participants using experience of reality not abstraction
(d) lead to eelebration of responsibility, accomplishment and effort.

Groups engaging upon such new learning towards a Femsci should evolve into networks of wider involvement. Two well-tested methods (rituals) may serve its introduction. The design and management of the Search Conference (Emery M, 1982; Crombie, 1985) and Participative Design Workshops (Emery & Emery, 1974, Crombie, 1978: Williams, 1982) flow explicitly from OST, feminine ideals and ecological learning.

Search Conferences are designed on thc basis of each of the elements of OST. The first phase (which desirably also contextualises a Participative Design (Workshop) specifically examines ihe environment (L 22) of the existing or potential system and then elicits ideals through a shared desirable future. This phase is also explicitly governed by the ground-rule that 'all perceptions are valid'. Later phases explore the system itself (Lll), its unique character, and the system-environment function of planning (L12). The method itself is a learningful one (L21) on many levels, not least because people have to talk and argue in leaderless groups to arrive at a colleetive plan.

Feminism recognizes power not as domination of others but as internal strength and shared control over direction, ensuring personal growth and political efficacy (Pateman. 1970: Pietila. 1987). Participative Design Workshops are specifically designed to fill this yawning gap between our ideals and the inability of our dominant hierarchies (bureaucracies) to support them, or meet the everyday needs of healthy people pursuing their purposes. They provide the concepts, practical tools and experiences that people need to participatively redcsign their organizations as democracies. Even very large organizations can opsrate as *non*-dominant hierarchies (Emery F, 1976). Any group using a Search to plan its future should at some stage consider a Participative Design Workshop as ultimately it will have to face the question of 'how do we organize ourselves to achieve this?' Unless the intuition of the group is very strong, it will be revert to an election of decision makers, or in

other words, a bureaucratic structure justified by 'representative democracy' 'Pietila, 1987, 46).

There are greater rewards for women than men in democratic structures where they can begin to realize their potential. Responsibility, multi-skilling and their effects on growth are often strongly transferred to the family, for example, where housemate and children discover that they are now living with a different person (Emero M, 1982. 105-6). Democratizing organizations shows that women do not need special education divorced from their normal life activities. Much of the learning which damages girls and women arises from the hidden curriculum, the structure of the school or university. Changing the ostensible curriculum leaves the dominant hierarchy untouched to continue to destroy confidence and motivation ro learn in its students, Bureaucracies by their very nature reinforce the myth of the inferior female. Until the organizational infrastructure of our culture is democratized improvement in the status of women will represent a marginal gain.

These two flexible methods can link feminist critiques of Msci to an emergent powerful Femsci.

DISCUSSION

The Femsci fulfilled its basic aims of generating action plans and the energy to see them through. Creative work is contagious. All four human ideals were explicated as is usual and flowed through to final plans Convergences often come as a surprise to participants. This is simply because their 'normal' environments do not provide the conditions for their emergence through 'learningful' commuication (Asch, 1952; Emery M, 1982). Methods and the environments they create are therefore critical in transforming theory into practice.

Recognition of the need for a new paradigm, epistemology and democratic power structures are present tnroughout the Femsci literature without seeming awareness of their interrelarions. Hopefully, this Search conveyed something of this through its experience but there will need to be explicit learning of both the concepts and managerial practices. Participative Design Workshops are more easily grasped as the structural concepts for changing from bureaucratic to democratic are self-contained. To introduce a comparable briefing at the beginning of a Search, however, would detract from one of its main purposes which is to provide an experience without the group assumption of dependency (Bion, 1952, 1959); that which dominates in teaching.

As a holistic oral ritual the ways in which decisions are reached during a Search Conference are always fascinating and this experience illustrated two important points. Firstly, most decisions were not 'taken' but appeared in the Aboriginal way (Emery M, 1982, 94 from many sources) albeit, more quickly. (Those which cannot be reached within the time constraints of a Search are best left as 'time and talking will tell'). Second, there was a conflict, distinct from the non-appearance of a decision, about the use of

nigh tech. This disturbed some participants with the intensity of its expression. We now have to face one of the most difficult consequences of the mechanical, literate world view; our cultural flight into dissociation (Emery F, 1977). This has totally reversed oral culture's appreciation of violence summed up by 'sticks and stones can break my bones, but names will never hurt me'. In these cultures verbal hostility was accepted as a function of interdependence and ritualized as a way of keeping the peace (Ong, 1967 ; Farb, 1977; Gardner & Heider, 1974). People in democratically structured organizations inevitably notice a shift from apathetic communications to deeply felt and intense ones. *Involvement creates meaning.* 'The family that yells together gets together' (?). Only further experience with non-dominant structures will overcome today's fears.

For the embryonic Femsci to become a force for change it must also consider carefully its long-term strategy. In a case such as this where heavy resistance can be expected, the appropriate strategy is that of 'the indirect approach' (Sun Tzu; Liddel-Hart, 1943, 1946). Based on Wei-ch'i, it works to diminish the ratio of resistance to innovation, putting effort into areas of heavy resistance. It is a jigsaw puzzle strategy requiring great adaptability, non-linear and discontinuous logic. Victory and defeat are relative phenomena over protracted periods (Boorman, 1971). It is a highly demanding strategy to Western eyes which expect to see quick results, but anything less cannot be expected to effect fundamental and enduring change.

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Feminist Critiques of Science

JACQUELINE FELDMAN

Introduction : on the singular and the plural

In dealing with questions about the masculine and the feminine, I want to start by noting the significance of the singular and the plural, as they appear in the title.

The singular tends to mythologise a complex reality, as is the case with 'science'. An essential part of modern society, science presents itself to us in various ways, which sometimes happen to be contradictory. It is a symptom of its diffuse and powerful presence that we speak about it using the singular. The word 'science' means many different things. Are we speaking about the scientific method, about the results which are brought about by it, or about the applications it produces ? Are the social sciences really sciences in the same sense as physics or biology ? Are we speaking of the institution which has been established as the keeper of a monopoly on legitimate knowledge, which suppresses all other types of knowledge as backward, obscurantist, irrational or, at best, marginal ?

Discussions about science very often suffer a confusion of these different aspects. The first aim of this article is to present an 'analysis' (in a quasi-chemical meaning of the term) of this omnipresent and complex phenomenon, in order that the various possible options might appear more clearly.

Another approach, which might look firmer would be to start from an analysis of patriarchy and to analyse science through it. Although this approach is seductive because of it seems to be radical, it runs the risk of becoming dogmatic. Patriarchy has existed for thousands of years, modern science only for three centuries. In the case of patriarchy, there has been a slow evolution. Unhappily, this evolution has taken us from 'hard' patriarchy, where gender roles were frozen (as was the case in the last century, provoking the feminist revolts of the turn of the century and the 1960s), to a softer one, such as the one we know today. It therefore seems to me premature to erect the anti-patriarchal position as the only efficient starting point. Consciousness of the patriarchal nature of society and of women's oppression has been an essential part of 1960s feminism. It now seems to me, in this less spectacular phase where we arx now, that what is needed is

to deepen, improve and refine the examination of reality, taking care to avoid any militant self-satisfaction.

'Patriarchy', an essential and useful notion, must now become itself a rigid, simplified, mystified, singular term. Let us recall that the women's movement has refused the mythic 'women', in order to revindicate the existence of plural, different women and also of many different feminisms. Therefore, the title uses the plural in referring to their critiques of science.

This article is aimed primarily at helping me clarify my position towards science, as a scientist and a feminist woman. This implies a refusal to choose between the so-called 'feminine' and 'masculine' worlds, and the recognition of a necessary androgyny. In order to better define my starting points, I mention my experience in passing from the exact sciences to the social sciences, an experience leading also to the impossibility of being satisfied with simple schemes about 'science'.[1]

1. Science in society today

I examine here some aspects of modern society where science is essential, through its evident power upon nature or, in a more diffuse way, through present knowledge of the human being. I then examine the corresponding place of women.

Military technology. One of the reasons governments support science is its efficiency for making weapons, even if many pure scientists have a pacifist sensibility. Women are traditionally absent from these virile confrontations and traditionally against war, but without real means to make themselves heard. Let me here give a tribute to the tenacity of British women standing up against nuclear missiles.

Space exploration. The anti-nuclear struggle is part of the ecological one, and women are present in it.[2] I have not heard of any real movement against space exploration. Even if it is not free from military connections, it is presented as one of the great human, that is universal, adventures. Quite symbolically, it has invited a few women, and a Muslim Arab, to 'fly' in outer space.

We are here confronted with the inescapable influence of a dominant culture on all of humanity, a fact acknowledged by Marxism. This leads to particular problems about what a female culture could be, a point which is discussed with subtlety by Rossana Rossanda.[3]

Civilian technology. This has been contributing to changing the place of women in society. In a traditional society, physical force might relegate women to second place. The place of technology, which should help women to be emancipated from their so-called 'nature', is surely at the heart of feminist revindications of women, as they discover new, subtle ways that they keep them in second place.

Medicine. Contraception and the reduction of birth and infant mortality have greatly helped women to become free from a tight biological definition. Furthermore, although women may be absent from the creation of

modern technology and be only consumers of civil technology. they traditionally are conspicuous in the medical professions. even if it is more often as nurses than as doctors.

Social and human sciences. These new sciences very directly touch women, as they allow a better understanding of the psycho-social construction of gender and gender relationships. It is therefore not surprising that feminist studies are centred here. Women are present here and their presence should be reinforced in coming years, even if the top figures are still men.

Psychoanalysis. This discipline has a rather ambiguous relationship with science, and some readers will be surprised by its mention here. I raise it because psychoanalysis has started within science and, at the same time, contributes to passing beyond it. Moreover, it is of special importance for women, as can be seen from the name of one of the branches of the French feminist movement, Psychoanalysis and politics'.

Indeed, while the first feminist wave of the century attacked legal barriers, the second wave in the 1960s and 1970s had to admit, after most of these barriers had been lifted, the enormous strength of psychological obstacles.

Moreover, women have traditionally been dedicated to emotional relationships between people. As we find many women involved in curing bodies, so we find many curing the psyche. The insistence in psychoanalysis on the importance of the very first years of the child gives a significant place to the mother. Centred, in its orthodox version, upon sexuality, it constantly questions sex differences, even if some of its answers might not seem satisfactory to many feminists. Finally, because the psychoanalytical project is a kind of work about one's identity, it is particularly important to modern women, torn between the old models of femininity and the new ones which remain to be defined.

Women's place in this domain is surely one of the best recognised: many choose a woman as an analyst. Even if theoretical leaders are, as usual, mainly men, women have more chances to be heard (for example, Anna Freud and Melanie Klein in the US, Maud Mannoni and Francoise Dolto in France).

2. The scientific institution: a predominantly masculine universe

As an illustration, I quote some 1972 data from France. In the Research Organisation CNRS, 30% of scientists were female. The most masculine science was nuclear physics (14% females), the least so were the life science (biology and psychology, 47% females). There were no women on the political committees. Females were scientific directors of 5% of laboratories and 10% of teams. Until 1977, only one woman had received the gold medal out of 25 awarded.

The main facts here are the classical hierarchy of recognition and power, and the different (traditional) interests of woman scientists, We find few of

them in the mathematical and natural sciences, and most of them in the human (including biological) sciences.

These figures have not drastically changed since 1972. One should also notice the relatively high participation of women in French science, especially in the mathematical and natural sciences, compared to other countries.

Speaking concisely, one might say that because science is so important in society today and because society is patriarchal, it is logical that there are few women in science. Reasoning the same way about advanced fronts in technology, about which most women are not even conscious and no statistics yet exist—artificial intelligence for example—we might expect women to be even less represented, in places where the real decisions about our world are made.

Because science appears to be a meritocratic game, with well-specified rules in order that the best can win, the disproportion between the genders is a real issue in a society which is supposed to aim at equality. A recent article by Londa Schiebinger offers a review of the different writings on this issue[4]; she proposes four different ways to look at it, on which I will comment here.

"Not so few: in search of lost women". Science produces remarkable results indeed, but one of its related activities consists in promoting these results and glorifying their discoverers who are called 'geniuses'. This very social activity can immediately be compared with the anonymity reserved for women in general because they are dedicated to the private life (even if some men are ready to pay tribute to the quality of some remarkable women, including their own mothers).

The image of the genius being essentially that of a man: women participants in science often appear transparent to their colleagues. Therefore it is necessary to point out that there also exist 'famous' women, a long historical stream from the literature,

In the supposedly meritocratic system of scientific reputation, the tendency to obliterate women has its counterpart in the presentation of a few women as 'exceptions', as has been the case for Marie Curie. This is dangerous, but not as much as total obliteration. In a sense, a real evaluation can only exist for equal people and, as women are still predominantly defined as women (rather than as universal human beings), any evaluation is likely to be under or over-estimation.

"Why so few? Identifying (structural) barriers. These barriers can either be of a manifest nature—scientific institutions have long been closed to women—or, more often today, they are due to a more or less conscious discrimination : the mathematician Emmy Noether is denied a university position, or the Nobel Prize winner Barbara McClintock has to wait a long time before gaining recognition.[5,6]

Most often, however, the young student is discouraged in a much more subtle and efficient way. A (female) science journalist tries to understand the failure of an ontherwise gifted girl at Harvard: the girl explains, "In the first

place, all the math teachers are men In the second place, when I met a boy I liked and told him I was taking chemistry, he immediately said, 'Oh, you're one of those science types'. In the third place, it's just a kind of social thing. The math clubs are full of boys and you don't feel comfortable joining." "In other words," concludes the journalist, "she was made to feel unnecessary, and out of place."[7]

The women's movement has stimulated the writing of many texts of this kind. They show, through their analysis of the subtle difficulties in fully participating in the scientific world, the kind of symbiosis which exists between it and the masculine universe.

On the contrary, one may notice that a positive emotional relationship with fathers may have played a determinant role in the professional choice of women scientists. This fruitful relationship is, however, not reproduced by society.

These first two approaches throw light on the psychosocial aspects of what might be called the dissuasion of women from a scientific career. The approaches assume that the two genders should be a priori equal and that society produces the existing barriers. The next two approaches directly confront sex differences.

"Naturally few? Biology as destiny." This third approach has a long history, from Aristotle who "argued that women did not have sufficient heat to boil the blood and purify the soul"[8] to the actual theory of the 'brain sex'. But it is also possible to reverse the issue and ask what scientific discourses on sex differences might teach us about science and society.[9]

"The impact of the few ? Gender distortions in science." This last approach starts from the actual masculinity of science and takes issue with it. What does this masculinity involve with respect to the supposed objectivity of science, when only one gender defines what science is ? At which level do masculine deviations appear ? Is it in the choice of subjects of research, in the manner of treating them, in the building of models describing reality or, at a deeper level, in the very ways of knowing ?

This approach brings out new and bold questions, and the rest of the article is intended as a dialogue with it. But, before proceeding, it is necessary to be precise about the different types of scientific knowledge with respect to the degree of certainty of their results, and to define my own position about the irritating and central question of sex differences.

3. On the different degrees of certainty in science

Science is the legitimate knowledge in our society. Scientists are paid in order to make facts as secure as possible. Scientific argumentation is the type which prevails in discussions. These are the reasons why the spirit of rigour, which was at the origin of science and through which lay people are entitled to trust the scientist, should be defended against the perversions that the growth of the institution inevitably brings.

If classical philosophy has always insisted on clearly separating certainty

from opinion, the development of science has involved covering more and more territories where certainty is far more difficult to reach than, for example, in mechanics (where it is not so easy either).

By speaking of and eventually criticising science, one should always keep in mind that its different domains entail different kinds of scientificity. Mathematics is built to avoid ambiguity. In physics, truth rests both on the mathematical expression of the theory and on experimental confirmation. Biology has only some really exact parts in a complex body of models and notions. Social sciences and psychoanalysis have their epistemological problems, which are far from resolved.

The fact that all this diversity is brought under *one* name, science, is often prejudicial, and prematurely brings philosophies, which swing from a dogmatic scientism to a nowadays fashionable scepticism, into the intellectual market place.

This danger of a confusion between different aspects of science is prejudicial to the acute and critical examination which is particularly necessary today. I wish here to defend, together with Henri Atlan,[10] the necessity to be aware of the specificity of different ways of knowing, so that the truth involved in each domain is dependent upon that domain, and so that limits to this truth can be made precise.

This is all the more true when discussions of sex differences are involved. A criticism of the multidisciplinary work *The Feminine Fact* [1] is that it often does not make clear the degree of validity that the layperson can expect in 'results' given by specialists.

4. The sex difference aporia

In logic, an aporia is some difficulty presenting itself in a rational discourse, which seems without solution. The word stems from the Greek *aporein*, to be in trouble,

The situation concerning sex brings our reasoning into trouble: the difference exists. It is first biological, but one has only to look around at children's education to see how much our society seems to need to reinforce these differences and, some sociologists would say, to create many of them.

Is it or will it ever be possible to sort out what stems from biology and what from external constraints? One could only answer if societies existed which brought up their offspring in exactly the same fashion, a utopia which does not seem likely to come about; nor, perhaps, is it desirable.

In order to go beyond discussions of hypothetical futures, I propose to admit that it is basically impossible to conclude the issue. Such an admission of the impossibility of a conclusion is just a case of the spirit of rigour advocated in the last section. Keeping this impossibility at the horizon does not prevent us from going on with this issue.[12] I shall quote here two positions.

The geneticist Albert Jacquart points out the difference between genetics, where there exist mechanisms (whose regular actions can be elucidated) and

statistics (where complex phenomena are only subject to a summary analysis).[13]

In the same line of thought, the biologist Andre Langaney proposes to distinguish between four sexes: the genetic sex of the chromosomes which is, apart from a few exceptions, unambiguous; the physiological sex of hormones, where an overlap is already present; social gender; and personal gender which everybody has to define for her/himself in the kind of open society to which we belong.[14]

It is precisely the new and great task of philosophy today to conduct a real reflection on gender, as proposed by Luce Irigaray.[15]

One should be aware of sex differences and of the necessity for any society and any person to be defined by them. One should refuse to decide a priori whether they stem from biology or society. One should however be aware that the biological argument, which relies upon mechanism and reduction, can be dangerous if taken outside of its own domain, while sociological argumentation tends to open possibilities.

5. Science: also a spiritual adventure

It might seem surprising to speak of spirituality in connection with science. This term is more usually associated with religion. Has not science developed in opposition to religion by refusing truth by revelation?

I have decided to use this term for two reasons. One concerns the state of science today and the other the fact that this article primarily addresses women.

In western countries, religious dogmatism is no longer the first danger. There exists the danger of Technics, which tends to reduce to mechanism the very way of obtaining knowledge and to flatten complex realities. The spiritual adventure of science tends to be relegated to bureaucratic career considerations. The nowadays fashionable sceptical philosophies contribute to dissolving the very strong relationship with Truth which existed in the beginnings of science. Just as the development of religious institutions threatens the very spirit of religion, so the development of science threatens its very spirit.

As already stated, the rhythm of historical development for women is not the same as the one for so-called universal history. The former has been, until now, slower than the latter, and it is necessary to go back very far into the past to understand it. From the point of view of women, the whole story of culture has to be recaptured. The western story of knowledge starts with religion, continues with philosophy and leads to science. Women have been excluded from each of these three major developments.

In this very long development there are different steps in the work of the mind which lead to today's scientific spirit.

Religious *abstraction* which goes with monotheism has very probably played a central role in the work of separation and specialisation. Recall here the Judaic interdiction against representing God or even naming it.

Already at that time, women were suspicious of religious people and kept apart from most of the spiritual work.

Philosophy may be defined as the effort towards *rationality*. Western civilisation has been training for it since ancient Greece. This thought instrument allows for both the coherence of discourse and a certain adequacy in fitting it to reality. Rationality needs abstraction, in order that discourse goes on independently of the immediate, sensitive reality. It demands very good self-control, a sharp critical sense. All this is responsible for western efficiency and prepared it for science, which adds objectivity.

Objectivity brings another separation from the external world, which is carefully investigated with an experimental method when that is possible. Objectivity implies that scientists agree with the definition of the object, and calls for separation between the scientist and his/her study object. That is why the external objects have been first the physical world and then, with more difficulties, the biological one. Here, the scientific way departs from other, more internal ways of knowing (mystical, religious, philosophical, psychoanalytical).

If we forget about all the social prohibitions which have existed against women's education and focus on this adventure of the mind, it is possible to understand better why science has become mainly a male world.

This spiritual, rational, objectivist, intellectual story is a long and difficult process for humanity, which involves a real self-discipline. It is as if humanity, in its path towards an objective knowledge of external reality, wanted at best to 'protect' or at worst to 'put aside' the second sex, as it has been 'protected' or 'put aside' from wars and political responsibility. Men have wanted 'natural' women, that is, spontaneous, sensual, emotional, affectionate women. So, one may indeed oppose the rationality of men to the intuition of women. The quest for objectivity, which goes together with control of the external world, is for the first sex, while the second sex is left with an uncultivated subjectivity. The rigour, systematisation and critical mind (intellectual weapons all) of men are opposed to the 'charming' emotionality of women, which, together with a real pragmatism, is not to be devalued.

These "feminine" qualities are encouraged in areas well controlled by men. In this difficult separation between intelligence and emotion, men needed (and, as we can still see around us, still need) to be able to fall back on the warm immediateness of their women, who again provide a place for warriors to rest.

One can see that this separation is much more likely to happen in young boys, who have to separate from their mother image, than in young girls, who may continue their whole life to stay in warm fusion with their mother.

It is only if one is clear about the extra difficulty of the scientific life, that one can understand why so few women are tempted by it, as they are more likely to be loved if they stay outside this world.

Before ending this section, let me recall the importance in science of

imagination. In order to discover, one has to imagine, but in accordance with given rules. As the physicist Richard Feynman puts it, "one has to imagine reality"[9]. This game aspect has been emphasised by many scientists, from Newton to Atlan. But the game implies that separation we have already met. It means escape from daily contingencies. The game is mostly something for men, whereas women concentrate on daily necessities. The necessity to be useful, devoted first to the family: that of course is contrary to freedom. Some wings have here again been cut.

6. The universality of science and its psycho-social supports

This title might seem provocative Either science is indeed universal and, as a consequence, independent of social context, or it does depend on a context and, as a consequence, is not universal. In this section I defend both theses : science is universal and context-dependent.

Science, emerging from the Enlightenment, pretends to be universal, as does Reason, the primary tool necessary to conduct humanity towards Truth. For the sake of that universality, Science forces back, puts aside or tries to eliminate other ways of knowing, defining them as 'pre-scientific' and 'obscurantist',

This once beautiful project has problems today. As noted earlier, science too often has become too efficient, with some rather irrational results, It has also remained a domain that only initiates can understand. While everybody is able to use electricity and microcomputers, only a minority of people have access to real understanding of the basic laws. Worse, it is not clear that the scientific spirit is more common today than three centuries ago.

The critical movements of recent years have pointed out that science is a feature of industrially advanced societies, that is mainly western society. So, how can something be all that universal if it is restricted to one sex and to a few human groups ?

Here again, it is necessary to distinguish between different aspects of sciencs. Science needs material and special cultural means, whence the existence of particularly active centres, which leave other teams in the periphery.[16] There cannot be any doubt about it: science is very unequally distributed.

But physical and biological laws are indeed universal. as they are verified in every country. The problem is more complex for the social and human sciences, where ideological presuppositions are still mixed up with knowledge. and where the research 'object' might evolve faster than the research programme.

What remains universal is the process which supports the efforts towards knowledge, and the objectivity which is sought in each case, with the inescapable difficulties in each spec ial domain.

In the last section I mentioned spiritual adventure. Any spiritual adventure pretends to universality, even when it explicitly defines itself as esoteric (which is not the case for science). What this means is that speculation is

taken upon what is common to the human mind, beyond the evident differences brought about by local customs and native inequalities. Every spirtitual adventure is transcendental to daily reality, even if it occurs in a well-specified historical and social context.

No universality can exist by itself, but only a faith about a certain kind of potentiality going beyond the socio-cultural context. This is the case for science, taken as a declaration that any human being who is appropriately educated can aspire towards a knowledge of reality which is as objective as possible.

This declaration goes along with those other ones which were proclaimed in the universal declaration of human rights by the French Revolution. In a feminist oriented article, it is not necessary to recall that this declaration forgot women and that the French revolutionists very properly guillotined 'excited' feminists such as Olympe de Gouges who had the bad taste to point it out. What is important to notice is the significance of setting up the abstraction 'equality', which contains its own dynamics, so that it was responsible a century later for the feminist movement and is still pertinent today.

In order for an internal, spiritual happening to survive, be passed on and be sedimented so that it becomes a well implanted tradition and even seems quasi-natural, it must be able to rely on the firm support of social-cultural surroundings. That was once the case for religion and is today for science. Most critics of science use its own weapons, that is, objectivity, rationality and a critical spirit.

Between social choice and personal choice, group mediation must exist; an intellectual process is difficult and must be encouraged by masters, colleagues, disciples. Recall the intense sociability of the Greek philosophers surrounding Socrates, as described by Plato: intellectual research went along with strong interpersonal relationships, with affection and even love and sexuality, so that the difficult and beautiful abstract flowers of reasoning and dialogue might be given birth and support. This affective stimulation was and is lacking for women and has played against them[17].

7. Criticisms of science

With its universalistic aims, science has behaved as a conqueror. In reaction, critics have arisen. The more powerful one is, the more critics one gets.

Three periods can be distinguished. In the 17th and 18th centuries, science belonged to a minority of people who fought for recognition from the whole society. Science had first to create its own ways of thinking, working, its community; its publications.

In the last century, science has become well established and tends towards hegemony. Here begins the real critique. The romantic movement refuses the cold separation between intelligence and emotion and is aware of the dangers and excesses this separation might carry. A woman, Mary

Shelley, created the Frankenstein character.

Worth mentioning here are two streams of thought which define themselves as scientific but nevertheless incorporate severe criticisms of some aspects of science: Marxism points out the relationship between science and society; psychoanalysis may provide a critical description of the scientist.

New criticisms of science have emerged in recent decades, the new feature being the participation of scientists themselves in making the criticisms. One can understand this internal criticism as due to the loss of prestige of the profession, which has become bureaucratic. The average scientist is part of a great machine, having little freedom[18], [19].

There is also great disillusionment with the capacity of science to bring about progress. Reason, seemingly triumphant in the 18th century, has changed into narrow, short-sighted rationalities[20].

Following the student and women's movements, in the 1970s there was a stream of radical critiques of science. All that had been set apart from science—traditional knowledges, eventually religions—was rediscovered. In the area of philosophy of science, dogmatic positivism has been replaced by the sceptical relativism school, which wants to take science as one among many human belief systems.

This is the general context in which the women's movement comes to take up the question of science. I am not quite sure whether there is any theme which is really specific to the women's movement's critique of science. It is certain that the peculiar situation of women makes them emphasise some of the features of science and very dynamically make them apparent.

This is the case for *witchcraft*: repression of witches especially hit women. The women's movement was entitled to take up this particular theme as an illustration of women's repression[21].

The witch is the marginal woman who posseses some threatening, non-institutionalised knowledge. The witch evokes woman who 'drops out', who for one reason or another refuses to submit to her cultural role. When she is young and beautiful she seduces, when she is old and ugly she frightens (something that the Danish writer Karen Blixen seems to have been aware of and been able to use).

It is not surprising that it is a woman anthropologist in France who tackled the problem of witchcraft in a novel way. Jeanne Favret-Saada approached it in such a deep manner that she became involved in witchcraft, a dangerous and rich experience which enabled her, after she regained self-possession, to tell us much about it.[22]

While I was working on this article, I listened to two pharmacists on the radio telling about their work with traditional drugs. They take medicine men seriously, question them and then investigate their traditional drugs in the laboratory. In both cases there is respect for both traditional knowledge and modern science. But the approach is also internal in the first case[23].

The theme of *ecology* is particularly close to women, including the roughness with which nature is often treated. Relevant here is the thesis

defended by Carolyn Merchant in her study of the birth of science and the metaphors which were used to describe it[24].

In general, as seen earlier, women resist drastic scientific divisions. In the world of science, women, because they hold human relationships in higher esteem, tend to choose teaching rather than laboratory research. Similarly, Evelyn Fox Keller has pointed out the different, more respectful relationship that Barbara McClintock had with her study 'object'[6].

In the same way, the women's movement has from its start insisted upon 'self-help' and self-consciousness. I must emphasise the recent contributions of women to the techniques of dance, song and holistic gymnastics: self-consciousness is indeed one of the necessities and one of the riches of today's women.

In quite another area. the critique of science is carried out with the very tools of science: women make us aware of the male-centrist bias. To quote only one example, the ethnologist Levi-Strauss describing a village activity: "The *whole village* left the day after in about thirty pirogues, leaving us alone with the *women* and the *children* in the *abandoned houses*[25].

From a critique of a suspicious sociobiology which too easily jumps from the biological to the social level, to the denunciation of discourses which use the notion of nature without much critical spirit, there is a *scientfic criticism* of the male-centred deviations in science which began to exist along with the critical character of science, and should exist as long as patriarchy does.

Another type of critical approach aims at reaching the very foundations of scientific thought. It is considered in the next section.

8. A feminist/feminine science?

"A more fundamental project now confronts us. We must root out sexist distortions and perversions in epistemology, metaphysics, methodology and the philosophy of science—in the 'hard core' of abstract reasoning thought most immune to infiltration by social values." This is the self-definition of a project which produced a book with 14 articles[26].

These questions are fully legitimate and are very difficult. Their boldness should be credited to the lively and creative stream of reflection in the women's movement. I must confess that the arguments are not yet fully convincing.

Let me first remark that most of the criticisms do not really reach the 'hard core' which is so difficult to deal with, but go on developing themselves around political philosophy which goes back to the beginnings of the women's movement, or developing themselves against some biological theories, which is not new either.

When the 'hard core' is really challenged, Aristotle is a favourite target. He is indeed one of the central charachers in the development of science and, at the same time, a coarse, rude. unrefined misogynist, Lynda Lange writes, "Challenging Aristotle's sexism requires that we re-evaluate the soundness of the rest of his thought".

This conclusion is not evident at all. It does not accept the separation which takes place in scientific thought: Aristotle's misogyny does not necessarily invalidate his discoveries in logic, which eventually were taken up by other, nonmisogynist, thinkers (they are not all women's haters). From the beginnings of science, scientists have proceeded to sort out what was valid in Aristotle and what was coarsely wrong: the latter does not just concern women.

Criticisms which recall the philosphical, metaphysical and psychoanalytical backgrounds of scientific thought are always interesting, because they help us introduce some space between currently dominant habits of thought and their justification. However we must not forget the incredible efficiency of this type of thought which is the main reason for its adoption today including by its own critics. It may be useful and necessary to reinstitute a place for other ways of thinking, but they should be taken as complements and not rivals with scientific thought.

Moulton notes that the fundamental rule of philosophy is based on an 'adversary method' where women are disadvantaged. I have noted how the research atmosphere is not appropriate to women. However, truth is only built by opposing others' opinions, and aggressiveness is present in women as well as men (the differences being in modes of socialisation).

Other critiques, especially in France, have questioned the formalism in science.[27] This is again, I think, the wrong way to get hold of the reality of science. Formalism is a reconstruction occurring after the main break, abstraction, has been achieved. Feminist criticism here happens again to use ideas from the general critique of science, without being aware of it.

To imagine what science would have been if it had been built only by women is a science fiction exercise, and science fiction is far from useless to science. The dream of a feminist science should, however, be careful to remember the misadveuture of those who tried a 'proletarian' science with Lyssenko.

If scienee is taken as a thought approach together with a social encouragement, science is neither bourgeois nor proletarian, neither male nor female, even if male bourgeois scientists are indeed in a dominant position in it. Women's resistance to it should be aware of choosing the right targets.

The scientific approach is an emancipation from philosophy. Women will not succeed in bringing philosophy back into science, even if philosophical, psychoanalytical, historical, feminist and feminine viewpoints on science are very necessary to humans, who cannot be satisfied with science by itself.

9. Conclusion: outlooks and strategies

Feminisms. Feminism seems to spring up in waves. There was the one at the turn of the century and the one of the 1970s. I wrote about that the rhythm of social relationships between the two sexes is different from so-called universal historical development; it reacts to the different states of the society where it happens to be.

Nineteenth century feminism was a response to the universality demanded by the French Revolution. It asked for equality for women. The corresponding strategy was entryism into male society, refusal of discrimination.

1970s feminism, on the contrary, insisted on sex differences and fought for a reassertion of the traditional feminine values: pacifism, consideration of human relationships, refusal of competition, morality, interiorisation. The same argument that was applied to science can be applied to these values: they are universal, they are not possessed only by women, and they are indeed proposed by mixed social streams today. However, social or even perhaps biological circumstances mean that they are found more often in women's groups.

In a situation where feminism is first of all a necessary reaction against two injustices (discrimination and devaluation), there is one danger that it must avoid: being trapped in the reaction phase and, in an overestimation of women, making the adversary patriarchy responsible for everything and only negative. A third phase is necessary, in a dialectical movement, where the complexity of societies and problems are taken into account. The women's movement is not independent of society-wide ideologies. The nineteenth century wave was influenced by socialisms, the 1970s one by Third World liberation movements from which it took its name. The feminist critique of science is, in many respects, influenced by the general critique of science

This only confirms the essential point that we, as women, belong to a man-made society. We do participate in its universal properties but, as a plus, we also have our own specificities. The two kinds of feminism which are present in any women's group, egalitarian and differential feminism, can also be seen in the intervention of women in science.

Feminist presences in science. For what concerns *epistemology*, I have defended the thesis that it does not differentiate along gender lines. The danger here is the ease of deviations, due to the size of the present scientific institution. There is a parallel with law, which has not always been fair to women, but gives us weapons to fight against injustice. In the same way, the scientific approach provides intellectual weapons which must be used by feminists.

The intellectual effort which is called upon by science is heavy, and it is necessary that a satisfactory *emotional atmosphere* help it. Here, sisterhood, mutual encouragement. should prevail over the internal rivalries which too often occur in oppressed groups.

The choice of research *subjects*, and the *viewpoints* from which they are treated, do call for great watchfulness, acute criticism and creativity which can be seen to be exercised by feminists, especially in those domains which concern women and human beings.

One last level is the *social spinoff* of science and, in a more subtle way, what may be called its *social congruences*. A spinoff is, for example, the technical use of nuclear physics; a congruence is this hyperspecialised,

technocratic and technicist society which is ours. In the first case, a direct application, in the second, the same structure envelops scientific knowledge and social organisation. Here, we find women more sensitive to over-armament, ecology and bioethics and also critical of technicist society.

An essential marginality? When one looks at the strength of the techno-scientific structure today, one may predict that if more women are going to participate in it, with the growth of competition, they will continue to occupy places of second rank. That may seem rather pessimistic, but my impression is that, after the second feminist wave of the century, the current phase is digesting the recent conquests: the recognition of the existence of patriarchy, bodily freedom, the theoretical possibility of choice in life and work and, above all, the entrance of women into culture, which might be the major event of the century.

The first priority is that women take hold of the until now male-dominated culture, that they make its intellectual tools theirs, in order to build another culture where we shall be actively, consciously present. Secondly, we may expect women to be, for a long time, a minority in science and also in philosophy where new questions are posed (those which are considered secondary as they primarily concern women[28], [29]). There is a need to face these facts and start the reflection from the long-term 'vocation' of women to be on the margins of society. □

Notes

1. This article is a shortened version of an article in French : it rests on a variety of experiences, approaches and reflections in and on science. The interested reader may consult J. Feldman, 'Le Savant et la Sage-femme', *Impact. Science et Societe*, Vol. 25, no. 2 (1975), pp. 133-143 ; J. Feldman, 'People, knowledge and science', in T. Segerstedt (ed.), *Ethics for Science Policy* (Pergamon Press, 1979), pp. 133-144 ; J Feldman, *Voyage mal poli a travers Le Savoir et al Science* (Tierce, 1980) ; Armatte et la, *Le Sujet et l'Objet Canfrontations* (Editions du CNRS, 1984) ; J. Feldman et F. Laborie (eds.), *Le Sujet et l'Object : Implications* (Editions du CNRS, 1986).

2. Dorothy Nelkin, 'L'energie nucleaire dans le discours feministe', *Sociologie et Societes*, Vol. 13, no. 1 (1981), pp. 147-160,

3. Rossana Rossanda, 'Sur la question de la Culture Feminine', *Peuples Mediterraneens*, nos. 22-23 (Jan-June 1983), pp. 287-305. Articles originaux : Orsa minore, via Muzio Clemente 68/A, 00193, Roma, Italia, no. 0, ete 1981 : no. 6, mai 1982.

4. Londa Schiebinger, 'The history and philosophy of women in science : a review essay', *Signs*, Vol. 12, no. 12 (1987), pp. 305-332.

5. See for exrmple Alice T, Shafer, 'Women and mathematics', in Lynn Arthur Steen, *Mathematics Tomorrow* (New York and Berlin : Springer Verlag, 1981).

6. Evelyn Fox Keller, *A Feeling for the Organism* : *The Life and Work of Barbara McClintock* (San Francisco : Freeman, 1983).

7. K.C. Cole, 'Hers', *The New York Times*, 3 December 1981.

8. Londa Schiebinger, op. cit. note 4, p. 323.

9. Londa Schiebinger, op. cit. note 4, pp. 327-328.

10. Henri Atlan, *A tort et a raison. Intercritique de la Science et du Mythe* (Paris : Le Seuil, 1986).

11. *Le fait feminin* (Paris : Fayard, 1978).

12. In the same manner, the recognition of the existence of the 'unconscious' by psychoanalysis does not prevent development of the capacities of cousciousness. The philosophical option of the impossibility of a hard reductionism (where everything is brought back in physics) does not prevent the scientist pursuing all possible reductions in scientific knowledge (see Atlan, op. cit. note 10).

13. Albert Jacquart, 'L'inne et l'acquis. A propos du concept d'heritabilite', in *Le fait feminin*, op. cit. note 11, pp. 113-119.

14. Andre Langaney, Chacun de nou sest une femme', *Le Monde*, 28 December 1982.

15. Luce Irigaray, *Ethique de la difference des sexes* (Les Editions de Minuit, 1984),

16. Cf. 'Centre-periphery analysis of science', *Philosophy and Social Action*, Vol. 13, nos. 1-4 (1987) pp. 9-56.

17. I illustratc the statement by the case of the above quoted physicist who seems to reduce his relations to women to mockery (may be for him a sign of tenderness !). He makes it clear to the scientist applicant that her first problem is not the discovery of the laws of nature but the affirmation of herself in a male-dominated world (R. Feynman, *La nature de la Physique* (Le Seuil, 1980), pp. 215-216).

18. J. Feldman, 'La Science en mutation', in Armatte et al., op. cit. note 1, pp. 21-38.

19. Lewis Mumford, *Le Mythe de la Machine* (Paris : Fayard, 1973-74) [*The Myth of the Machine* (New York : Harcourt Brace. 1967)].

20. Sonia Dayan-Hesbrun, 'La critique de la rationalite chez Jurgen Haberamas', in Feldman and Laborie, op. cit. note 1, pp. 33-44.

21. In France, a review named 'Sorcieres' was issued from 1976 to 1981.

22. Jeanne Favret-Saada, *Les mots, la mort, les sorts ; la sorcellerie dans le Bocage* (Paris : Gallimard, 1977). See also J. Feldman and F. Laborie, 'Rencontre avec Jeanne Favret-Saada autour de la sorcellerie', op. cit. note 1 ; J, Feldman, 'Une demarche de science exemplaire, ou comment la prise en compte de la subjectivite du chercheur rend plus scientifique sa science', in Armatte et al., op. cit. note 1, pp. 229-250.

23. Jean-Marie Pelt and Jacques Fleurentin, *Guerir par les plantes : de la tradition a la science* (France-Culture, 3-7 August 1987).

24. Carolyn Merchant, *The Death of Nature : Women, Ecology and the Scientifie Revolution* (New York : Harper and Row, 1980).

25. C. Levi-Strauss, *Les Bororo* (1930), cited in C. Michard-Marchal and C. Ribery, *Sexisme et Sciences humanies* (1982).

26. Sandra Harding and Merrill B. Hintikka (eds.), *Discovering Realitv : Feminist, Perspectives on Epistemology, Metaphysics, Methodology and Philosophy of Sciences* (Dordrecht : Reidel, 1983).

27. Seminaire Limites-Frontieres, *Femmes et Formalisme* (1985).

28. Edmee Mottini-Coulon, *Essai d'ontologie specifiquement feminine* (Paris : Vrin, 1978).

29. Catherine Chalier, *Les Matriarches : Sarah, Rebecca, Rachel et Lea* (Paris : Les Editions du Cerf, 1985).

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Can a Feminist Critique of the Masculinity of Scientific Knowledge provide a Blueprint for a Less Inhumane Science ? Evelyn Fox Keller and the Feminist Dream of a Degendered Science.

ANN DUGDALE

The assumption that there is something anomalous about women doing science is still entrenched in Western industrial society despite the success of many women who have worked as scientists, and a long history of struggle by women and their supporters to overcome such views (Alic 1986 ; Rossiter 1982.) A feminist critical engagement with science must both unpack the masculine gendering of science and pose the question of how a different science might by characterised. There has been considerable recent interest in such a project amongst Western feminists (e.g. see Brighton Women and Science Group 1980 ; Hubbard, Henifin and Fried 1982 ; Sayers 1982 ; Rose 1983 ; Harding and Hintikka 1983 ; Bleier 1984 ; Irigaray 1985 ; Keller 1985 ; Harding 1986 ; Birke 1986 ; Bleier 1986 ; McNeil 1987). Despite their many differences these feminists approach scientific knowledge as historically and socially contingent. They share a desire for the encoding of women's experience into scientific knowledge. No-one imagines that this will occur simply by breaking down the barriers to woman's involvement in scientific occupations and training. Rather, the problem of women in science has been redefined as challenging the very epistemology of science. It is not a question of equality for women within scientific institutions which are already masculine, but of a new science which women can practise as women.

One of the earliest feminist critiques of science to clearly argue simultaneously that science was masculine but that women should struggle to participate in this domain in order to perform science differently, was the work of Evelyn Fox Keller. Moreover, Keller stressed the importance of women's possible contribution to science as the means of reforming the destructive monster which science had become. The urgent task faced by

women scientists, long considered by many feminists as highly suspect for their involvement with what was seen as a masculine enterprise, was to humanise science. Perhaps it is not surprising that Keller, an American feminist and bio-physicist, became involved with such a project which promised to resurrect women scientists from their position as traitors from the point of view of a feminist politics, to that of saviors of men and women from nuclear annihilation. (For examples of feminist critiques of science as patriarchal 'tools of the oppressor' see Ehrenreich and English 1979 ; Merchant 1980 ; Griffin 1984). Through her work on the politics and rhetoric of scince Keller made no compromises in concerding that science was anything but masculine, as a practice and as a knowledge. But by recognising science as a social activity governed by socially negotiated norms, and scientific knowledge as a social construction which necessarily involved the intervention of a human subject between the real physical world and sciences accounts of that world, Keller, among others, opened the scientific disciplines as a field of feminist struggle.

This paper is divided into three parts. The first discusses some of the different ways in which the masculinity of science has been thought about by various feminist theorists. The second elaborates the approach taken by Keller. In the third section I discuss some problems that I think limit and undermine Keller's radical critique of the masculinity of science.

How can Science be Masculine ?

In what sense can it be claimed that scientific knowledge, including its laws, observations and models, is gendered ? One approach that feminists have taken to this question is to contest authorised stories of what is to count as nature, showing that they embody masculine interests. Particularly during the eighteenth and nineteenth centuries, scientific accounts (which constituted Western cultural meanings of nature), were highly privileged in debates about human nature and social order. Science was seen as describing what was essential to human nature and such accounts were used by both conservative and reform movements in political struggles over social practices. Rousseau for example appealed to nature as that which existed prior to arbitrary political and social regimes and could thereby provide a standard against which social conventions could be arbitrated.

Political and social movements of the twentieth century also appeal to 'nature'. Feminism has, at times, attributed to women an essential female nature which was excluded from the public sphere, thereby damaging the public interest. Anti-feminists have cited nature as providing limits to the flexibility of the human 'raw material' that is shaped by social practices (McMillan 1982). Scientific knowledges such as evolutionary biology, primatology, sex difference research and sociobiology are important. They affect the concrete material conditions of peoples—lives, who has access to education, how menstruation is experienced, which jobs are deemed suitable for whom, how a society responds to domestic violence. Not surprisingly,

women have contested these areas of scientific research which lexplicity incorporate and support male viewpoints and interests. Women's experience of scientific knowledge as an oppressive force through its promulgation of such 'facts' as our smaller brains, more delicate constitution and nimbler fingers, has alerted us to the political nature of scientific knowledge. We have experienced the non-neutrality of science with respect to interests.

Women have always realised the stakes involved in the construction of scientific stories about our 'underlying' biology which encode current unequal power relations between the sexes. Masquerading as politically unmotivated, such knowledges are all the more difficult to discredit because of the claim that they are objective and the manner in which they are legitimated through the institutional backing of laboratories. universities and medical science. Scientific 'facts' are spoken by those individuals who are authorised to produce accounts of the physical world deemed to be universally true (mostly men), and are rendered uncontestable by those who are not experts (including almost all women). This is the first meaning of the claim that science is masculine. Science, as a body of knowledge, is seen as being produced mainly by men, and consequently as having, perhaps unwittingly, incorporated masculine interests. Scientific knowledge is seen as masculine in so far as it supports sociopolitical struggles which maintain the domination of women by men (Haraway 1986 ; Hubbard 1979 ; Bleier 1984 ; Sayers 1982).

A second approach which has been taken to the problem of the masculinity of science is to challenge science as a masculine culture (Easlea 1983 ; Traweek 1988). The scientific community is seen as one in which men have shaped the *activities* of science. Masculine values such as competitiveness, 'cold', 'hard, reason, aggression and arrogant self-confidence, have become positively valued and operate as criteria of success. Characteristics associated with femininity, such as co-operation, a concern with human relations, an application of the complexity of nature and of our necessarily partial viewpoint, have been negatively valued and excluded. Such a masculine ethos in the scientific community is seen as exerting a selection pressure which continues to favaur the entry and advancement of men socialised into such masculine behaviour patterns. Moreover, the masculine culture of science is seen as affecting the cognitive content of science.

Evelyn Fox Keller (1977), reflecting on her experience in a scientific research group, argued that masculine perspectives within the scientific community, which favoured hierarchy, competition, and instrumentalism (in conjunction with post-sputnik external political pressures for experimental success), affected paradigm choice in the American physics research community of the 1950s and 1960s. According to Keller the definition of doing legitimate physics, and therefore the criteria for the validity of knowledge claims shifted. The kind of research which followed Einstein's approach of asking questions about fundamentals such as space, time and matter, was, says Keller, replaced by "operationalism" which focused on technical success and getting formulae to work.

This approach explains how masculine interests 'get into' scientific knowledge claims. It extends the first approach in so far as it is not necessary to infer masculine interests from the scientific knowledge claims, which, with respect to such statements as Newton's laws, begins to sound a little far fetched. Keller links masculinity with the 'hard' physical sciences rather than simply with those 'soft' sciences whose claim to objectivity could be conceded as premature.

However, neither of these approches employs a symmetrical analysis of the relationship between the culture that is seen as producing unequal power relations between the sexes and scientific knowledge. Even Keller's explanation of the masculinity of particular approaches to research relies on a prior judgement that only certain scientific accounts are not objective. It is only those scientific knowledge claims that are seen as presenting a distorted 'reflection' of the natural world for which an explanation needs to be sought. It is always a matter of asking why such 'false', or partial theories were accepted. Only in this negative way is the sex/gender system seen as influencing or otherwise 'getting into' scientific knowledge. No explanation is sought for the success of other scientific knowledge claims which, Keller leads her readers to believe, somehow escape the stamp of masculinity. Keller's analysis of the masculinity of scientific knowledge is therefore limited.

A third approach moves from attempting to correct scientific theories and models by ensuring that they include women's viewpoint, to the claim that all science is masculine. This approach analyses the norms and methods on which the special epistemological status of scientific knowledge is based. The object under discussion is not simply the current activities of a scientific enterprise distorted by its enmeshing in patriarchal social structures, but the actual ideal model of science, its epistemology. The masculinity of science is connected to such statements as that science aims for objectivity, or that the scientific method ensures the impartiality of the observer, or that scientific theories are universally valid. The exclusion of such culturally labelled feminine resources as subjectivity, nurturance, and an immersion in personal relationships from the legitimate tools of knowledge construction is seen, not as accidental, but as fundamental to science.

This approach to the masculinity of science has resulted in the call for a new feminist science in which, as Hilary Rose (1983) eloquently expressed this desire, there would be a re-unification of "hand, brain and heart". Such a different science would not exist alongside 'masculine science', giving expression to women's specific perspectives, but would replace it with a genderless science that incorporated the feminine, a less partial and therefore more human(e) science which would no longer reflect a social order of domination, and consequently would no longer be destructive of nature.

Evelyn Fox Keller : for a Degendered Science

What I want to examine here is this third project in which the different

experience of women, our identity as the 'other' to the man of science, is seen as providing the basis for a different science.

I will approach this discussion through some of the work of Evelyn Fox Keller since she is among the earliest and most veciferous protagonists of this strategy. (For different views of what this approach to science involves see Rose 1983 ; Harstock 1983 ; Irigaray 1985). I want to account for both the strengths and weaknesses of this 'woman-centred' approach to science. On the one hand I do not believe that it can simply be dismissed because it is idealist (McNeil 1987). Keller's detailed analsis of the masculine sexual metaphors through which science has been represented do tell us something important about how science reproduces patriarchal society (see especially Keller 1985, pp. 43-65, 150-157). I certainly agree with Keller's assertion that the exclusion of the social, the emotional, the irrational, the subjective, from modern conceptions of the nature of scientific knowledge is highly problematic. Nevertheless I also think that it is necessary to approach with great caution strategies that prescribe the so called feminine characteristics as the basis for the revival of an old Western dream of a science that is both ontologically true and just.

Keller calls into question the commonsense view tha sex is irrelevent to which statements come to count as scientific knowledge. She shows that science is not ideologically neutral. Much of her work analyses the metaphors and images through which Western culture represents science. In several articles (Keller 1985 pp. 33-42, 75-94) Keller refers to the Baconian metaphor of science as a "chaste and lawful marriage between Mind and Nature" in which aggressive and forceful seduction (experiment and the application of the mechanical arts) "have the power to conquer and subdue her" and so "bind (Nature) to (man's) service and make her (his) slave" (quoted in Keller 1985, pp. 48, 36). Keller demonstrates that science is caught up in a network of meanings through which it acquires a sex. The legitimate activities of science and the way in which scientific knowledge statements must be exprsssed in order to be recognised as scientific, are influenced by such metaphors and beliefs about science. Keller shows that such metaphors persist today through such expressions as the 'hard' sciences and the idea that scientific thought is male thought.

The ideology of science according to Keller is neither a historical nor something immutable that is essential to reliable knowledge construction. Keller associates the ideology of science with the mechanistic world view and contrasts it with the world view of medieval knowledge systems : "No longer filling the void with living form, man learned instead to fill it with dead form. Nature, deanimated and mechanized, could now be put to the uses of men. "(Keller 1985, pp. 69-70). She sees the New Philosophers of the seventeenth century as having renegotiated cultural representations of 'man's' relation to nature. The New Philosophy depended on the assumption of an autonomous and rational subject whose relation to the physical world is one of radical separation and distance. It is this relation that Keller sees as

making science masculine. The New Philosophy constitutes not only a new approach to knowledge but also constructs man as knower in a very specific sense, that is as a person who had escaped his position in nature, and the influences of his desires, wishes and beliefs. 'Man' as the knower in scientific knowledge systems is not limited by partial perspectives, by local context, by the historical and social specificity of his position in a social order. Rather he is thought of as a universal, rational mind working on observations that are self-evident.

Keller argues that the image of the seientist projected by scientific thought reveals a series of parochial commitments that support the cultural norms of masculinity but are in contradiction with the feminine sense of self. Far from finding the universal perspective of reason or the speaking voice of nature occupying the enunciative position in scientific texts, Keller finds the image of a very partial and most peculiar man. This seems to me to be a claim about the author position in scientific documents. Scientific knowledge is a form of writing. It is a special kind of discourse, following particular rules and conventions. It is a language, a system of communication. As such, it necessarily encodes a relationship between the speaking subject and the text. The particular logic of the subject constructed by a piece of writing might be hidden, as it usually is in scientific accounts emitted beyond the walls of a laboratory, but all writing generates a position from which the text is enunciated. Modern scientifie reports produce a highly specified speaking subject and it is the nature of this subject that Keller's discussions of science reveal as masculine. We perhaps need to clarify the meaning of the term masculine.

Keller does not mean that science is determined by something essential to being biologically male. Masculinity and femininity, she says, are not fixed, natural characteristics of male and female individuals. She distinguishes between sex (those bodily characteristics which are biologically given), and gender—socially produced traits and behaviours determined by historically changeable social practices. Nor does Keller simply mean that the scientist is male and displays a set of personality traits that Western culture deems appropriate for men. These characteristics include instrumental reason that only considers objects from the point of view of their enhancement of material interests ; objectivity which is opposed to the subjective experience of the body and the emotions ; or, to take just one more example, the ability to extract the part from the whole, to think abstractly and to reduce complexity to simple formulae. Keller' argument is not only that there are men and women scientists that do not conform to cultural stereotypes of masculinity. There is also a sense in which she is claiming that science itself is gendered. Representations of science place science in the same position in relation to nature as man is normally placed in relation to woman. Furthermore, science is attributed with the same characteristics as Western culture ascribes to men.

For example, Keller shows how stories still current in shaping the way in which scientific knowledge is understood in modern societies, that is as a

progressively more complete and more accurate reflection of the real world, reveal the trace of the sexualisation of science. For Keller, Bacon's metaphors do not merely illustrate the nature of science, they are constitutive of it. Contemporary popular understandings of the scientific method as minimising personal bias and subjective interests construct the relationship between the scientist and the world in exactly the same manner as Bacon's metaphors. The unknown, natural world remains a voracious and dangerous feminised space which must be held in check, controlled by, and put to use for the purposes of rational, dispassionate man—the scientist. Uudoubtedly such accounts of science reproduce a masculine view of sexual relations. What Keller hopes to reveal is that, far from guaranteeing the objectivity of scientific knowledge and therefore its political neutrality, the very commitment that science claims to make to objectivity and the escape from limited contextual, social and personal viewpoints, masculinise scientific knowledge. Science is produced in the image of a highly parochial masculine subjective self. Keller writes.

> A feminist critique of objectivity looks at the window through which the scientist views the world and irreverently sees not simply nature unveiled, but the reflection of a particular image of self. It sees an image of self as autonomous and objectified. And we ask if it is not the very investment in impersonality, the assumption of having escaped the infiuences of our own desires, wishes and beliefs—even more than the confidence of actual accomplishment—that constitutes the special arrogance of the modern scientist and, at the same time, reveals his peculiar subjectivity. (Keller 1983, p 16)

Keller goes on to argue that if science is masculine because it reflects the patriarchal masculine subject, then the cause of the masculinity of science is the sex/gender system which produces such human subjects. The origin of the failure of current scientific disciplines to be universally progressive is their reflection of the masculine sense of self. Even though this masculine individual is not presented in Keller's work as the inevitable unfolding of a male biological identity, I think that the orientation of much of Keller's work around the question of the cause of the masculinity of scientific knowledge is highly problematic. Particularly worrying is her placement of the masculine individual as the cause of the failure of science to live up to its promise of providing a knowledge which is universally progressive, because concomitant to this is her espousal of the incorporation of the feminine identity as the basis for a new, less destructive science. In the next section I will elaborate the limitations and political problems with this strategy.

Some problems with Keller's model of the Masculinity of Science

Keller argues that modern twentieth century cultures have a science that is masculine and therefore destructive, as the outcome of a patriarchal social order, as the consequence of the impinging of social structures which function to reproduce male supermacy. But, such social structures are seen as

separate from science, as merely shaping science through the mediation of individuals. Rather than asking how scientific accounts erect and maintain themselves as masculine systems of meaning, Keller looks for the cause of the sexualisation of scientific knowledge in the individuals who have traditionally taken up the place of scientist. Perhaps unwittingly, her conception of the masculinity of scientific knowledge remains contained within the bounds of the very story of the objectivity of science that her critique places under attack.

Traditional philosophy argued or assumed that science is objective and therefore universally progressive, in the sense that it benefits all social groups, because it is produced by individuals possessing universal reason. Keller argues that science is masculine because it is produced by masculine individuals. Keller breaks with the philosophical tradition on which commonsense notions of science still in part rely, in so far as this tradition always begins with the individual, assumed to be a universal rational being. This individual is assumed to be autonomous and fundamentally unaffected by social experience. Keller, on the other hand, always refers to the individual scientist as a socially produced gendered person. However, for Keller, it is still the characteristics of the individual that determine the nature of scientific knowledge.

Scientific knowledge is conceptualised in Keller's texts as the product of intervention of a historically formed (masculine) subject mediating between the 'real' world of objects and the scientific account. To the extent that Keller goes along with the traditional picture of the nature of scientific knowledge, her work repeats the assumption, evident in such accounts of science, of a natural split between a real world of objects and the self. This undermines the demand Keller makes for the reincorporation of the subjective into science. Her article "Gender and Science" (1985, pp. 75-94) for example argues that the dichotomy between subject and object, the masculine perspective of distance, is the ideology of modern science and precisely because it is ideology, it explains the failure of science to be truly objective. But Keller's work retains a commitment to the subject/object split and this prevents her from analysing this split as an ideological construct. Keller is able to question the relationship between subject and object as it is presented in the ideology of science, but she unable to question the dichotomy itself.

Keller's focus on science as the reflection of a masculine identity results in further problems when it requires, as the logic of her argument does, the specification of the masculine subject so that science can then be analysed for its reproduction of this image. Keller is led to offer her readers an objective knowledge of the masculine subject. Not only does she want to infer their interests from their position in society, a strategy which assumes that individuals act rationally, but Keller wants a detailed knowledge of the masculine self, both conscious and unconscious. It is only through such an account that Keller is able to convince the reader that those characteristics of all of the scientific disciplines such as the separation between subject (scientist) and object have something to do with masculinity.

Keller uses psychoanalytic theory, particularly object-relations theory, to provide a knowledge of the subject, both masculine and feminine (Keller 1985, pp. 67-115). Object-relations theory has played an important role in American feminism (Choderow 1978, Dinnerstein 1976). It provided an explanation of why patriarchal structures were so persistent and of how the external sexist social order was internalised by both men and women without resorting to such conceptions as the innate inferiority of women. It provides Keller with a scoially based explanation of the acquisition of different genders by most men and most women starting from the assumption that both sexes are essentially the same, an assumption that is crucial to Keller's argument about the possibility of a non-ideological science ; a gender-neutral science that reflects a truly human producer.

Object-relations theorists argue that the sexual division of labour, which ensures that almost all parenting of infants is done by women, results in different experiences for male and female children which produces differences in their perception of themselves as autonomous human beings, separate from their mother. Girls are more likely to maintain a sense of continuity with the mother's body and so are more likely in later life to admit to and enjoy the pleasures of merging with another, secure in the knowledge of one's basic autonomy and sense of self. Boys, according to object-relations theory, are more likely to experience anxiety in this process of the development of boundaries between self and other. This process is made doubly difficult for boys who must not only define themselves as separate from the mother, but must repudiate the secret desire to merge with the mother a second time in order to define their gender identity. The persistence of these infantile fears and desires into adult life can result in men adopting an exaggerated and overly rigid sense of autonomy. It is precisely such individuals who would be attracted to, and wish to maintain, a science that had an ideology which emphasised the radical separation between subject and object and denied the presence of secret personal desires.

Object-relations theory thus provides Keller with both a knowledge in which masculinity is constructed as a stable and knowable object, a property of persons seen to be socially influenced, and a mechanism for explaining how science came to be masculine. The problem is that it is precisely the characteristic of science to present itself as essentially a descriptive enterprise that is in question in Keller's work. The reader cannot help but wonder how object-relations theory acquires its authority. Why should we privilege it as communicating the truth about gendered subjects, as being free from patriarchal distortion ?

There is one more serious problem which I want to discuss in relation to Keller's model of the masculinity of science. This arises when Keller moves from showing how masculine perspectives have shaped the science we have, to the reconstructive enterprise of suggesting how science might change so that it incorporates the feminine and produces a more complete, human understanding of the natural world. Having recognised the 'objectivity' of

scientific knowledge as a fiction which reflects masculine wishes and desires, Keller's solution to the problem posed by the masculinity of science is to reform science by making it gender neutral. At one level this involves the identification of resources that have been excluded from science, showing that they are indeed at work in the construction of scientific khowledge, but have been subjugated. Keller's biography of the Nobel Prize winner and cyto-geneticist, Barbara McClintock (Keller 1983) attempts to show that resources that our culture arsociates with femininity can result in legitimate scientific knowledge. McClintock is depicted as using feminine resources normally excluded from scientific practice. Included among these are :

(1) Intuition, guesswork and the solving of problems by irrational means.

(2) A relational perspective that resists the reduction of a systems com-plexity to simple mechanism.

(3) Emotional involvement with her objects of study and a passionate commitment to her ideas.

(4) The dissolution of the subject/object boundary between her own sense of self and the chromosomes that she studied.

However, femininity does not simply describe a set of positive behaviours, values and interests that have been historically devalued, as Keller seems to imply. The meaning of terms such as masculinity, rationality and objectivity only exist in relation to the concepts of femininity, irrationality and subjec-tivity. The first set of meanings is produced through the exclusion of the second set. For example the possibility of imagining an objective knowledge depends on the suppression of the producers' subjectivity, their involvement with the uneertainties and limited, context-dependent perspective of their personal history. Neither a feminine identity nor a subjective way of knowing have independent referents.

Keller's demand for the addition to service of sabjectivity and objectivity, and for the addition of perspectives which current cultural practices produce as feminine, does not recognise the historical structuring through which male domination has constructed these dichotomies. They are not immutable givens that need to be fully represented to prevent the present distortions of humanness and science. They are socially constucted divisions which generate power relations between social groups. It is not that in the first place there is a difference between subjective and objective means of knowledge cons-truction, or between masculinity and femininity, which are then represented in language and other systems of meaning. The evaluation of masculinity and objectivity as superior is not something that is done to neutral representations of real objects so as to justify socal structures of male domination and the privileging of scientifice knowledge. Keller is claiming that knowledge is socially constructed. It is important to recognise not only that scientific representations of the natural world are always alredy political, but that all systems of meaning encode and generate power effects.

Inagining scientific knowledge production as a process which excludes the activity of a subject and its necessary involvement with historical, accidental and contextual interests, is already a symbolic construction. In Keller's conceptual scheme the sex/gender system exists prior to and outside of science in the first instance and is then reflected in scientific accounts. What we need to do is to analyse the tactics that science, as a system of representations not only 'about' nature but also 'about' itself, employs to valorise masculinity and so reveal the mechanisms whereby science participates in the production of patriarchy.

Conclusion

The interpretation of the question of the masculinity of science as a question about causes, and the acceptance of scientific knowledge as the product of subjects seen as the centre of their own action, takes a feminist critique of science in a dangerous direction. As Keller admits, her work is often read as the specification of a feminine identity that will produce a "better" science, not in any political sense, but in the sense that it would be a more accurate reflection of nature (Keller 1987). Even though Keller ascribes this identity as a possible achievement for both men and women, this has the effect of colluding with traditional patriarchal systems of representation which reduce woman to a symbol of the irrational, the emotional, the subjective.

Once the universal human subject at the centre of the scientific text is recognised as masculine, it is simply not enough to demand his replacement with a different subject, a feminised subject (either male or female) who will properly fulfil the function of that universal masculine author and guarantee the authenticity of science's accounts of the physical world. Once we admit that science is a social process and that it always bears the mark of its limited cultural prespective, we admit the impossibility of guaranteeing the truth of scientific knowledge claims and of judging which claims are no longer flawed by gendered perspectives. The does not signal an end to the political struggle between feminism and science, but the necessity for feminist involvement in what has been called the fierce fight to construct reality (Latour and Woolgar 1979, pp. 243). This does not mean an acceptance of the rules of the game which currently are involved in determining which statements can be recognised as science. It does mean that a science which incorporates different values and which admits its political nature is a science that must be struggled for. Such a science cannot be relied on to somehow, win through because of a natural superiority in representing more completely the truth of the natural world. □

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