Technoscience

The Politics of Interventions

Kristin Asdal, Brita Brenna and Ingunn Moser (eds.)

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Contact info Unipub:
T: + 47 22 85 33 00
F: + 47 22 85 30 39
E-mail: post@unipub.no
www.unipub.no

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Introduction

Kristin Asdal, Brita Brenna, Ingunn Moser

The Politics of Interventions

A History of STS

> … I will use the word *technoscience* from now on, to describe all the elements tied to the scientific contents no matter how dirty, unexpected or foreign they seem …
>
> *Bruno Latour*[1]

> Technoscience extravagantly exceeds the distinction between science and technology as well as those between nature and society, subjects and objects, the natural and the artifactual that structured the imaginary time called modernity.
>
> *Donna Haraway*[2]

This book has a dual purpose. It introduces readers to the cross-disciplinary field of science and technology studies, also referred to as studies of science, technology and society (STS). It is also an anthology of articles written by authors currently working in the field of STS. The common theme of this historical introduction to STS and the contributors to this book is the different ways that the political is addressed in STS research. Both Donna Haraway and Bruno Latour, whom we have drawn upon to introduce and create a framework for this project, have established important premises for these discussions. Simply put, the history we relate deals with the tension between Haraway and Latour. It deals with STS as a field of research with a political engagement tied to social movements and STS as a field of research with an articulated goal of conducting better, more relevant studies of science. But this is to oversimplify it, of course. In our discussion, we want to shed light on the way in which "the political" has been discussed and practiced in various ways throughout the history of STS. Through our selection of articles, we also want to provide examples of how political engagement and various forms of intervention are thematized and practiced in the field today.

Latour introduced the term *technoscience* to STS, and Haraway has used it both with and against Latour. For Latour, the concept of technoscience suggests that there are no pre-determined boundaries for what constitutes technology or science, the social or the technical, science or politics. There is no "science" on the one hand and "society" and "values" on the other. These are dividing lines found only in our theories and imaginations. Instead we should follow the actors and study how they create reality through the diversity of their practices and material resources, Latour proposes.[3]

Perhaps we have never been modern, as Latour asserts in his book of the same title.[4] The boundaries between science and society, the technical and the social, have never been absolute. In any case, boundaries we have taken for granted are being reconfigured today. Research being conducted on the so-called cutting-edge is making the boundaries between science and technology, science and society, nature and culture, subjects and objects, the natural and the artificial, highly problematic. One figure used by Haraway to emphasize this point is Du Pont's OncoMouse™, the world's first patented animal. As a carrier of the onco-gene, a gene that caused the mouse to develop cancer, the mouse was a promising figure. Could it solve the cancer puzzle? Or as Du Pont declared in its own advertisement for the OncoMouse™: "Available to researchers only from Du Pont, where better things for better living come to life".[5]

As the world's first patented animal, the OncoMouse™ has, precisely, lost its status of being just an animal. The mouse is a creation of science. Its natural environment, its arena for physical and genetic development, is the laboratory and the regulatory institutions in a powerful nation-state. The OncoMouse™ is an invention. At the same time, it remains a living creature. In combination, it is a vampire of sorts – according to Haraway. It is a vampire that does what vampires are supposed to do: pollute natural categories. What is subject and object in this story and where are science's naked facts versus value-laden politics? There are politics in technoscientific activities, Haraway points out. Technoscience metes out chances to live or die. Some win, some lose. But who?[6]

Latour is no less political – or concerned with politics. But where Haraway is explicit about her connections to political activism and social movements, Latour is explicit about the exact opposite. In his engagement with the politics of nature, he emphasizes that he is not himself a member of the ecological movement.[7] For Latour, the political challenge is to conduct better, more relevant studies of science. Thus this has been more of an academic project. More recently, however, this approach has become more oriented towards participation and cooperation with the actors in the field in a process of experimentation and learning. These actors include, but are not limited to, activists and social movements. They also encompass

researchers, politicians and average citizens – everyone who is a stakeholder or representative in a politicizing process. This also implies a concern with how something becomes a political issue, how matters of fact become matters of concern, what role the sciences play in these processes, and how scientific facts and objects become problematic and politicized.

Along with Haraway and Latour, we will argue that science *intervenes* in nature and politics, and that this approach provides a much better way of understanding what scientific activity *is* than do old notions about how science discovers and describes reality. In this way, the issue of politics is placed at the core of knowledge production. Science and technology are ordering activities that are also materially productive. They generate reality rather than discovering or revealing it. They continually bring about new, transformed, material realities. In other words: they are *technoscience*.

This book also takes a broader view in an effort to investigate in what ways science is in politics, and what political issues science and technology take part in creating. In so doing, the book deals with empirical studies of science, the politics of science, and empirical studies of politics – with methodologies and resources used in science studies.

By making room for this approach, we also want to highlight the non-productive power of science. Not all forms of scientific intervention are equal in their capacity to bring about change, gain a foothold, create a political issue, stimulate political engagement or create solid realities. In emphasizing this point, we draw on a feminist literature, which has presented a double critique: on the one hand, feminist scholars have shown how certain forms of knowledge become powerful and are enlisted in processes of oppression; on the other hand, they have underscored the local and contingent nature of science, in which a number of different actors and movements are vitally important. In the field of STS, the feminist tradition has sometimes been viewed as marginal. With "the political" as one's starting point, feminism cannot be ignored – not only because feminism has always kept alive issues of politics in science and science in politics, but also because feminist science critics have always sought to justify, situate and practice science in new ways. Consequently, we regard feminist issues, tools and texts to be amongst the most challenging and productive in the field of STS.

The social relations of science

Many people have commented that defining the boundaries of STS is both an extremely easy and an extremely difficult task. Any introduction to the field will

necessarily be situated and partial. It will require boundary setting, with some actors, texts, practices and connections being brought to the fore and others being set aside. We follow Michel Foucault in that historical writing always begins and ends with contemporary questions and concerns.[8] Our focus on "the political" as a theme and resource limits how we present and view the field.[9] It is not our goal to write a complete history of the field. Instead, in our introduction, we want to highlight some conditions and discussions from the 1970s and 1980s that have given impetus to the field and have led to the approaches we are interested in and the articles we have selected. We also want to draw attention to some of the connections that have helped to shape the field, but that are seldom given credit when histories of STS are written. Thus, this anthology and its introduction are both an appreciation and an intervention.[10]

The practices and consequences of science have always been accompanied by critical reactions.[11] A crucial event, however, was the mobilization and use of nuclear physics to produce weapons of mass destruction. This generated intense criticism from the scientists themselves, from other parts of academia and from the world at large, and in time it led to the emergence of a widespread peace movement. A broader critique of science and technology, grounded in social movements, first arose in the wake of 1968 and the radicalization of students and employees at universities in the western world. Put succinctly, we can say that the background for this new criticism was the shock over the Vietnam War and the enlistment of science in the military-industrial complex, also known as the military-industrial-scientific complex. Also important were the discovery of the presence of DDT and other pesticides in the food chain, problematic transfers of industrialized agriculture (the Green Revolution) to less developed countries, and socio-biological theories on the necessity of the patriarchy and the intellectual superiority of the white race. For many people these experiences undermined their belief in science as a neutral, progressive force that would produce the best results if left to its own logic. Science was involved in war, conflict and oppression. Science came to be seen as a tool used by those who wielded power. In response, associations for social responsibility in science were organized, movements to enlist science and technology to serve the people were mobilized, demands and attempts were made to democratize science and technology, and critiques and analyses were developed of the social relations and contexts of science. Of particular importance to the development of the field of STS were the movements within Great Britain and the US, which we will discuss here.

The Radical Science Movement and the Sociology of Scientific Knowledge (SSK) were two of the social and intellectual movements that came to formulate critiques of scientism and positivism – that is, the belief that science is a neutral,

internally-driven supplier of neutral knowledge and a progressive force. They also reformulated existing theories of the relationship between science, technology and society. At the same time, a heated debate was waged between these schools of thought on politics, relativism and science, which greatly influenced the development of science and technology studies. The Radical Science Movement mobilized researchers and students in the natural sciences and at technical colleges, and gained particularly strong support in Great Britain and the US. Communicating through journals such as the *Radical Science Journal* and *Science for the People*, they pursued a strategy of remaining part of the natural science disciplines while creating alliances with social movements outside the universities. Within SSK, however, many researchers left the natural sciences in favour of sociological studies of natural science. More so than the Radical Science Movement, SSK was an academic programme. It was primarily associated with the UK, especially the Science Studies Unit in Edinburgh, but similar groups were established at other British universities and in other countries, including France, the Netherlands, Germany and the US.

The Radical Science Movement and SSK thus represent the tension that this introduction took as its point of departure: the tension between the critique of science as an activist project and as an academic project. Both forms of science critique and study were crucial to the development of the field that would become STS. Therefore, in this introduction we will discuss these traditions, in addition to presenting other important contributions from the 1980s, such as feminism, the sociology of technology and actor-network theory.

The Radical Science Movement

Based on Marxist political economy, the goal of the Radical Science Movement was to understand the underlying political, economic and social forces that shape the development of science and technology. The movement drew upon the work of scientific Marxism and authors such as Boris Hessen, John D. Bernal and Joseph Needham.[12]

For activists and authors such as Hilary Rose and Steven Rose, the thesis of the two societies played a central role.[13] This argued that natural science and technology in capitalist society must by necessity serve the aims of capitalism and reproduce the power structures, institutions and social relations of this social order. The liberating potential of scientific rationality will be repressed and restrained until a new social system, the socialist one, with different values and social relations in both production and reproduction, emerges from the struggle. This scientific Marxism held firm to a belief in science as the paradigm for rationality and to the

possibility of objectivity. It represented a different approach to the critique of science and technology than the German-inspired critique of rationality, which was built on Marxist approaches from Georg Lukács through the Frankfurt School to Herbert Marcuse and Jürgen Habermas. In contrast to the Frankfurt School tradition, these scientific Marxists did not regard science and technology per se – or instrumental rationality – as oppressive and alienating. As constituted here, the problem was ideological, and therefore biased, research.

But the concept of ideology was a highly contentious issue within the Radical Science Movement as well. Not everyone read Marx in the same way. Some members of the movement, such as those involved in the Radical Science Journal Collective, who were inspired by Lukács, did not necessarily view ideology as a distortion, but rather as a condition of possibility for scientific and technological practice in general. Robert M. Young – professor of history of science at Cambridge, founder of the Radical Science Journal and one of the most important figures in the development of analyses in the Radical Science Movement – put it like this: "Science *is* social relations."[14]

So *which* social relations were they concerned with? A central theme for the Radical Science Movement was the enlistment of science and technology in what was viewed as the military-industrial-scientific complex. Later, analyses were expanded to include the role of science in legitimizing racial differences and, more generally, critiques of socio-biological theories of human nature.[15] Feminists in the movement developed analyses and critiques of relationships between science and gender, especially between biology and gender, but also between engineering, the military, war and gender. These discussions addressed issues such as biological and medical constructions of women's bodies and of reproduction. For example, female biologists attacked attempts by socio-biologists to demonstrate that male dominance and female subordination were biologically based and "completely natural". Ruth Hubbard, Hilary Rose, Sally Hacker, Donna Haraway and Maureen McNeil should all be mentioned in this context.[16]

The Sociology of Scientific Knowledge (SSK)

SSK approached science studies in quite a different way. While the Radical Science Movement viewed its own activities as both critical and political, SSK developed an identity within science studies that was primarily academic. The goal of SSK was to investigate and contribute to the conceptualization of how science *really* works and progresses – not in theory, as in the established philosophical legitimizations – but in practice. Through this approach, they wanted to

home in on the actual scientific content and production of knowledge as a social and cultural process. They sought to provide an alternative to, and a critique – a scientific critique – of, positivism and scientism.

In articulating this new programme that delved into the actual production of knowledge, in practice, SSK built on the later works of Ludwig Wittgenstein, Mary Douglas, Mary Hesse and Thomas Kuhn – but in particular, Kuhn's *The Structure of Scientific Revolutions* of 1962. They understood his work on paradigms and paradigm shifts as addressing how various cultural resources, including abstract models and concepts, as well as material and physical practices, were mobilized in a distinctive form of nitty-gritty puzzle-solving activity.

In line with this, they viewed the social not as a disruptive element needing to be purged from science, but rather as an ever-present, necessary component of scientific knowledge. In David Bloor's formulation of the new research programme in 1976, known as "The Strong Programme", this emerged as a demand for symmetry. Rather than explaining scientific successes by referring to strictly epistemic and extra-social elements, and explaining rejected theories or failures by using social elements, the same sociological methods, conceptual tools and analyses should be used to explain *both* successes and failures. In other words, it was not only scientific successes that should be explained. The hypotheses and theories that had been discarded and disappeared from history should be studied on their own terms, regardless of how they were judged by posterity.[17] The way to do this was to study the development of fields of knowledge and then focus on controversies within these fields. The rationale was that it was here that the various interests, values and cultural resources of science would manifest or reveal themselves.[18]

As previously mentioned, SSK is usually associated with the Strong Programme, and thus with the Edinburgh School or the Science Studies Unit in Edinburgh, with David Bloor and Barry Barnes being the most prominent figures. However, SSK became institutionalized through a network of similar groups at other universities in Europe and North America, not least through the forums and arenas established by year-book projects, associations, conferences and journals, with the journal *Social Studies of Science* playing an especially important role in this regard. Many of the works produced by the Edinburgh School were highly philosophical and theoretical. Barry Barnes and David Bloor made a greater contribution to the conceptualization and theorizing of scientific practice than to empirical studies. The empirical studies of controversies had a primarily historical orientation, as exemplified by Steven Shapin's work. In other locations, such as Bath, empirical, sociological studies of controversies were pursued. The Empirical Programme of Relativism (EPOR) was also developed here based on the work of Harry Collins, who emphasized different stages in social studies of science: identification of interpretive

flexibility, that is, of the many potential interpretations and articulations of scientific questions and "facts"; the description of mechanisms of closure; and the linking of these mechanisms to the broader social structure.[19]

Another approach focused on studies of scientific texts, rhetoric and persuasion. Scientific texts and descriptions by researchers do not necessarily give a good picture of actions and attitudes. We first need to gain a better understanding of the textual practice, it was asserted. Studies in this tradition, for instance, looked at how observations get translated into texts and how these textual representations are again translated and used to construct and stabilise facts.[20] Textual practices were also studied as an integral part of scientific practice within the ethnomethodological and ethnographic traditions in the mid-1970s.

The goal of ethnomethodology was to see how the social is produced and maintained through the various layers of social interaction. In contrast to a conventional sociologist, whose goal would be to describe the social order and the interactions found "in" society, an ethnomethodologist would assert that the social does not exist in isolation from social interactions. That is, the social order does not exist as a given, beforehand, but instead is something always under construction. The goal is not to explain that which is special, but to interpret the ordinary, the common.[21]

The ethnomethodological approach became an important inspiration for constructivist studies of science and technology and laboratory studies in particular. These focused on the observation of practice in laboratories. The goal was to understand unfinished knowledge, "science in the making", rather than knowledge that had already been judged by history and been "black boxed". Karin Knorr-Cetina, Michael Lynch, Bruno Latour, Steve Woolgar and Sharon Traweek conducted studies of laboratory practices from different perspectives.[22] The laboratory has since achieved a position as the privileged, exemplary location in which to conduct studies of science, knowledge production and power.

Despite their differences, the earlier works had at least one thing in common. They explained the content of science by mobilizing a concept of interest. At first, this concerned professional interests, and therefore also conflicts of interest and heated debates between different academic areas of expertise and sub-disciplinary traditions, and the power and ability of various disciplines to explain phenomena and results. Nature itself was seen as allowing different interpretations, and therefore could not be used as a judge. Scientific results were *underdetermined* and had to be settled and judged in other ways. This was set in an interpretative framework in which ideas, concepts and theories were understood as instrumental tools, or even weapons, mobilized by strategic actors in a social context. This approach could explain why some beliefs were adopted instead of others, and why and how some beliefs persisted as stable features in a given context. Later, this internalist concept

of interest was expanded to include what was seen as scientifically external factors, such as religious, political and economic positions and interests.[23]

The concept of interest and the methods used to investigate interests in SSK were hotly contested, however. It was argued, for example, that projecting interests onto actors, interactions and interpretations was, if not naïve, then at least non-reflexive and highly problematic. Others argued that if the focus was placed strictly on the social factors and interests articulated by the actors themselves, and it was shown how these functioned in research settings, then these problems could be avoided. Still others argued that interests were precisely what was at stake and were being produced in these very same interactions. Hence studies should address how both nature and scientific theories and positions on nature are mobilized in larger controversies and conflicts in contemporary society, and thus are part of, and contribute to, the outcome of these.[24]

Thus, a number of works were produced consisting of detailed studies of the emergence and development of new fields of research, of scientific controversies, and not least, of power struggles, negotiations and consensus-building related to the meaning of empirical results. The SSKers found a number of mechanisms, processes, practices, choices and negotiations that proved to be quite ordinary, local and social. These could not be explained either by a distinctive form of rationality or by a special scientific procedure or logic. The conclusion was that science is a question of social negotiations, and is therefore *socially* constructed.

However, because of the laboratory studies, an important shift occurred. The laboratory studies approached science and scientists in the same way that anthropologists had approached exotic tribes in faraway lands: as producers of *material culture*. In so doing, the anthropologists of science turned their attention toward one of the most esoteric and powerful tribes in the modern world, and studied the scientists, the people in the "fact factories" who continually "arrive at the goods that continuously change and enhance our "scientific" and "technological" society," as Karin Knorr-Cetina writes.[25]

It was asserted that if science studies could not find anything extraordinary, specific or "scientific" in the daily activities of the creators of science, it must be because they attended only to the cognitive and social, not to the material local setting, the instruments or, in particular, the inscription devices through which solid facts are established.[26] In the approach of the anthropologists of science, knowledge production was understood as intricate work that constructs facts as reliable and objects as solid. To the degree that facts, objects, truths and solutions are able to move between different contexts, to be transferred and become more than local, methods, techniques, instruments and tools are also moved. At the same time, small "translations", changes and adaptations to a new context are continually occurring.

Consequently, constructivism in STS turned toward an understanding of scientific facts and reality as being created in specific, material relations, rather than being revealed, discovered – or interpreted. Gradually, emphasis on the material also challenged the understanding of reality and knowledge as being *socially* constructed.

Debates on relativism

Between different parts of SSK and the Radical Science Movement, then, there were both similarities and deep-seated differences. For instance, the Radical Science Movement read and drew upon many of the same works and authors, such as Mary Hesse, Mary Douglas and Thomas Kuhn. Hesse's work on the role of metaphors in science and Kuhn's theory of paradigms and paradigm shifts were also viewed by the Radical Science Movement as an opportunity to understand science as a set of social activities. The Lukács-inspired segment of the Radical Science Movement operated with a concept of ideology that involved an understanding of science as culture, rather than attempting to judge between legitimate and illegitimate interests. But one issue on which the Radical Science Movement clearly defined itself in opposition to SSK's programme concerned the relativism embedded in the principle of symmetry – that is, that scientific successes and failures should be explained using the same methods and conceptual tools and that researchers should and could remain neutral in relation to the controversies they studied. They saw relativism as a combination of cynicism and intellectual laziness. Not least, they regarded it as politically unacceptable.

The Radical Science Movement therefore held firm to the possibility of a better science, referred to as a successor-science, which would not let go of rationality – that is, the understanding of science as a specific, privileged form of rationality. It was important to hold on to this rationality, not least in the fight against fascism, racism and irrational forces. One point of contention between Radical Science and SSK, thus became the issue of "poor" or ideologically-biased science, such as racism in the new field of socio-biology and genetics. Within Radical Science, it was crucial to be able to argue with authority and scientific objectivity against, for example, racist science.

In contrast, the SSKers dissolved scientific rationality in various social practices. This did not mean that they had given up the belief in scientific knowledge, still less in nature or reality. What they argued was that knowledge was relative and that it varied according to the different environments in which it was created. They shifted the debate on good and poor science from questions of true and false to

questions of normal and deviant scientific practice within a given research community or a given research culture.

For activists in the Radical Science Movement, this standpoint was highly provocative.[27] After all, the goal was to promote better science for the good of the people, to take the side of the weakest in society and to generate knowledge in their interest. Maureen McNeil's double review of Barry Barnes' and David Bloor's books from 1974 and 1976 made the point clear. First she commends them, writing: "These two sociologists thus provide several tidy little studies substantiating many of the claims of the Radical Science Movement." But her critique is harsh: "Their project is doomed from the beginning because its total immersion in a "scientific" (in the sense of one that completely endorses and seeks to replicate the values implicit and explicit in contemporary natural sciences) sociology means that it has no vantage point from which to assess scientific knowledge."[28]

The reflexive turn and the feminist challenge

SSK, then, viewed natural science as a social construction, as relative to a social context, but its ideal of objectivity was hardly distinguishable from the one it criticized. To be sure, the Strong Programme had a point about reflexivity, which emphasized that the same methods used to study the natural sciences should also be used to study the social sciences – including the sociology of science. In practice, however, this view never made any impact.[29]

The many attempts to persuade others that science and technology were social constructions triggered discussions about what the consequences would be of applying the same arguments to the social sciences and to work conducted within the field of STS. This lent inspiration to experiments and reflection on the field's own knowledge production. The inspiration also arose from the more general reflexive or linguistic turn that set much of the agenda for discussions of the basis for social science and cultural studies in the 1980s. What these traditions have in common is that language is no longer seen as a neutral, transparent tool, and that a categorical division between the language of daily life and the language of science is rejected. Instead, emphasis is placed on how reality is always constituted through language. There are no neutral paths to reality, no paths except through a language that also constitutes reality. One consequence of this position is that it calls into question traditional assertions that science possesses a privileged, truer form of knowledge.

Some SSKers explicitly rejected the challenge posed by the debate on reflexivity. Others did not address it. Still others insisted that reflexivity was not a problem, but a resource. For a period there was a discussion within SSK about the various ways

of exploring and incorporating these challenges. The new critical project entailed deconstructing all strong knowledge claims, including those made by SSK. In practice, this took the form of texts that in various ways, such as through dialogues or the voices of authors giving running commentaries on each other, sought to deflate the authority of the author and destabilize the scientific knowledge claims. They wanted to investigate science as narratives.[30]

Looking at STS as a whole, the reflexive turn also manifested itself in other ways. The relativistic positions held within SSK encountered other discussions of how knowledge gains legitimacy, of the potential for a "successor science" and of the challenge of generating better knowledge. What challenged the neutral researcher position most profoundly were the feminist discussions of science. These discussions have since become central to STS. This started earlier within the Radical Science Movement, but has been expanded primarily in feminist theory and philosophy. The feminists encountered the same challenge that we have identified in the tension between Radical Science and SSK: better knowledge for the good of oppressed groups versus a radical critique of science that risked undermining the potential for authoritative knowledge.

If science and technology had been male dominated arenas, which addressed men's interests and needs, and in so doing helped to legitimize and solidify a system in which women are exploited and oppressed, then how could it be argued that science and technology could be used for the common good, for liberation, democratization and efforts to achieve a more peaceful world? But equally, could one afford to abandon science? This dual challenge made its mark on feminist discussions of science. One of the strongest, most well-known positions was, and still is, standpoint feminism. It is based on a Marxist reading of Hegel's theory of the master-slave dialectic, which supports the argument that one sees things differently from different standpoints, and that one sees better from a standpoint of oppression. The strategy involves choosing a standpoint and giving a voice to the lives and experiences of the weak and oppressed. Some of those who formulated and developed this position in the 1980s include Nancy Hartsock, Hilary Rose, Dorothy Smith and Sandra Harding.[31]

Philosopher of science Sandra Harding brought to light a fundamental difference between academic feminists.[32] On the one hand, there were those feminists who supported increased efforts to recruit women to the sciences in order to eradicate sexist science and democratize it. They believed in the capacity of scientific norms and methods to generate good, objective science, if only social bias in research could be eliminated. Sexist research is bad science – if we can weed it out, we can create better science. In this tradition, priority was given to identifying forgotten female scientists and including them in the canon of science history. Moreover,

there were a number of campaigns and theories emphasizing the gender equality perspective: more women in research would lead to better research.

On the other hand, Harding called attention to those feminists who criticized science by contending that the real problem is science-as-usual. This critique of science-as-usual came in different varieties, in which the division between radical and socialist feminists played a central role. The radical feminists, who viewed science and technology as an expression of power relationships based on radical differences between the genders – that is, the different natures or psychological structures of men and women originating in oedipal traumas and conflict – went farthest in their rejection of the entire modern scientific project and of what they perceived to be its violent, oppressive rationale.[33] The socialist feminists were more closely aligned with the Radical Science critique. In other words, they viewed science and technology as an expression of social power structures, but they still insisted on the need for scientific knowledge and a concept of objectivity. Their project intended to bring about a new and different science, a successor science, and their strategy for achieving this was to start by unearthing subjugated knowledge, i.e. knowledge from the lives and experiences of women.[34]

Based on the critique of science-as-usual, Harding introduced the concepts of "strong objectivity" and "strong reflexivity".[35] By applying these concepts, she challenged the traditional philosophical boundaries between the context of discovery and the context of legitimation. Harding argues that strong objectivity requires one to take in and reflect on the *entire* knowledge process from the formulation of questions to the legitimation of the final knowledge claims. It also requires that the researcher or subject of knowledge be open to the same critical inquiries as the object of knowledge.[36] The fact that Harding holds on to the concept of objectivity is indicative of her belief that it is still possible and necessary to make knowledge claims. Harding stresses the necessity of viewing politics as an integral part of the knowledge process and of incorporating this into the practices. To a much greater extent than SSK, the aim of Harding and other feminists is to use scientific knowledge to promote change. In this way, their reflexive project strives to get a purpose beyond destabilizing and dissecting knowledge.

Industrial sociology and technology studies

In the previous section we tried to show how the feminist critique of science, and works addressing epistemological questions, took on importance in the development of the field of STS. Similarly, the issue of gender became important for research into working life and technology. Many key feminists in STS have a

background in fields that we consolidate in this introduction under the heading of industrial sociology.[37] This field is also essential for understanding the place and position of technology studies in STS.

"Classic industrial sociology", as we call it, did not involve a critique of science, but rather systematic investigations of a *social arena*, the workplace, especially the workplace of the industrial factory. This was seen as an important arena for technological change, characterized by clearly articulated interests, opposing views and conflicts. The theoretical inspiration came from Marx, but this time from the analysis of labour processes, that is, an analysis of the significance of technological change for working conditions, of control over one's work and of the need for qualifications and skills. Harry Braverman and his 1974 book *Labour and Monopoly Capital: The Degradation of Work in the Twentieth Century* played a key role.[38] The aim of this book was to show how technological changes have been designed to replace the need for skilled labour, thereby strengthening control over production by capital and the capitalists.

Industrial sociology had a strong orientation toward technological determinism, as did much of the literature on technology. Technological determinism can be seen as having two components. Firstly, that the nature of technology and the direction of change are unproblematic or pre-determined, perhaps subject to an inner technical logic or economic imperative. Secondly, that technology has necessary and determinate "impacts" upon work, economic life and society as a whole. Technological change thus produces social and organizational change.[39]

In the 1980s, however, technological determinism was increasingly questioned, with David Noble's 1984 book *Forces of Production* playing an important role in this.[40] Noble explicitly called into question Braverman's analyses, arguing instead that technology is socially shaped, but the ability to make choices and take action is curtailed by the political-economic logic that prevails in the capitalist system. Studies in this tradition identified social processes, interests, goals and conflicts occurring within specific work situations. Attempts were made to track the influence of various actors on technological changes and innovations, and to show how power was exercised and reproduced in these processes of change. The findings showed that work had been degraded, depleted of qualifications and skills, exposed to stricter control and intensified through the introduction of new technology.

In the context of the broader confrontation with technological determinism, we want to call attention to two books. One is *The Social Shaping of Technology* edited by Donald MacKenzie and Judy Wajcman.[41] In their introduction, the editors write, "Our question is, what shapes the technology in the first place, before it has "effects"?"[42] An important point of departure for the editors is how the social shaping of technology is an economic shaping of technology. In this way, they stress

that technological development is a part of societal development. This emphasis on the economic causes of technological change also illustrates the strong connection to industrial sociology and, in general, to earlier critiques of capitalism, even though a number of articles in the anthology focus on local variations.[43]

Perhaps the book's true break with previous research lies in its special emphasis on how the gender segregated society influences technological change. In the highly male-dominated field of technology studies, this book made room for ten articles written by women, out of a total of 22, most of them with an explicit gender orientation. While feminist approaches within the tradition of industrial sociology had shown how women are exposed to, and affected by, the introduction of new technology in the workplace, and how work associated with technology is a male arena that excludes women, the approach presented in *The Social Shaping of Technology* put greater emphasis on local differences and the potential for action. This meant that it did not entail the kind of social determinism in which, for example, women were always defined as victims of technological advancement. Because of the new orientation toward micro-level studies, women and women's work also became more visible within technology studies. Previously, technology studies had been conducted at the macro-level, where "the workplace" was often treated as a single entity. From this perspective, the workplace was usually the place where technology was regarded as the most "advanced" and had come the "farthest", and consequently, it was also a workplace where women did not have much of a presence. The new approach, as Anne-Jorunn Berg and Merete Lie point out, made it possible to study how women interpreted and actually used various forms of technology. Even though intentions were "baked into" the technology, this did not mean that certain results were the inevitable consequence. From a feminist position, the more paramount goal was to show women as active participants and competent in relation to technology.[44]

Industrial sociology, more so than science and technology studies, was viewed and defined as a branch of sociology. (STS has always defined itself as a cross-disciplinary field and not as a discipline or profession.) As a result, industrial sociology achieved greater legitimacy and an institutional foothold within the social sciences. In many western countries where the impact of critics within SSK or the Radical Science Movement was limited, industrial sociology, or labour process studies as they also were called, held a strong position. An obvious example of this is Norway, where the tradition for studies of work and technology has been crucial to the establishment of institutions that conduct research into working life and, not least, into legislation. On account of this, Norway as well as the other Scandinavian countries have emerged as especially important examples in this area: "Scandinavia

and Norway have played a special role in international work life research: they have been cast as a kind of real-life utopia."[45]

The most important tradition was perhaps the sociotechnical, which built on the cooperation among the various actors of working life and wanted to democratize the workplace with several objectives in mind: increased efficiency, increased participation and improved working conditions. New technologies were seen to present new opportunities to organize work. In the 1970s another, more conflict-oriented tradition arose that emphasized worker participation in the introduction of new technology through direct cooperation with the labour unions.

Industrial sociology shared the political, action-oriented approach with parts of the new social shaping and feminist technology studies community. Researchers and research projects have intervened in working life and developed a cooperative relationship with the relevant actors. The goal has been to improve conditions for workers, not least through promoting increased participation in the development and use of technology in the workplace. Similarly, the feminist approach has been based on enhancing the visibility of women's work, improving their working conditions and ensuring their participation in technological development. Researchers within this tradition, who focus on power relations and active participation, stand in stark contrast to the "lonely", neutral researcher subject portrayed within SSK. These aspects of work life research are important to the discussions and challenges that constructivism has been confronted with in recent years.

The other book which may serve as an important landmark in the confrontation with technological determinism is *The Social Construction of Technological Systems* of 1987, edited by sociologist of technology Wiebe Bijker, SSKer Trevor Pinch and historian of technology Thomas Hughes.[46] The book also represents a meeting of different traditions, and brings together the fields of the history of technology, the sociology of technology and science studies. Two trends are important here: firstly, the resources and vocabulary used in science studies were transferred to technology studies; and secondly, technology and science studies became more open to using the resources and work methods of historians – that is, empirical case studies with an awareness of situated change and local differences.

The book established a set of theoretical tools and vocabularies for studies of technology or technological systems. The use of science studies' resources entailed in part a direct transfer of the Empirical Programme of Relativism (EPOR) from science studies to technology studies. The principle of symmetry should not only be valid for science, but also for technology studies. Again, the point was not only to study successes, but also the technological solutions that were discarded and had disappeared from history – and to study them in the same manner. Technology's "black boxes" should be opened through sociological deconstruction to highlight the

interpretative flexibility inherent in any given technology. This would be done by investigating how technologies are culturally constructed, designed and interpreted.

Furthermore, the relevant social groups and their interpretations should be identified, along with the problems and solutions they generated. The next step consisted of tracing the negotiations that led to the gradual disappearance of interpretive flexibility and the stabilization of technology. In this context, technological development is seen as a heterogeneous process that can take many directions as a result of interaction and negotiations among various social groups, rather than as a linear, stepwise, internal research process. This programme has been dubbed the Social Construction of Technology (SCOT).[47]

The book also contained an article by historian Thomas Hughes that introduced the concept of the "seamless web" of technology and society, an approach to technology through system metaphors. This implied an effort to integrate the social, economic and political aspects of technology and to link the micro and macro levels. He cautioned against the conventional view in which economic, social, organizational or legal components were regarded simply as the social context, as the social backdrop for technological development, or as the external environment. The organizational and the social elements are part of the system, and they must be if the system is to function. In this way Hughes argues in favour of studying the technological system, whereas SCOT came to place greater emphasis on individual technologies or artefacts.[48]

Hughes' approach became radicalized in a third approach introduced in the same book: the Actor-Network Theory (ANT). ANT wanted not only to break with the division between technology and society, but also between human and non-human actors. It is not a given who can be actors in technological development and which characteristics they possess, ANTers argued. People, technology and natural phenomena can all be components in materially heterogeneous actor-networks and take on the role of actors.

ANT intended to radicalize the principle of symmetry, which required all knowledge claims to be treated equally and to be explained sociologically. It demanded that "the sociological" – or "the social" – be studied with the same radically open method as one studied nature, science or technology. This school is most closely associated with Madeleine Akrich, Michel Callon, Bruno Latour and John Law, and we will return to this in our discussion of individual articles and authors.

Although marginal in this book, one approach which became very important was a feminist programme placing the consumer or the user at the centre of the network. "I focus on the consumption junction", writes Ruth Schwarz Cowan, "the place and time at which the consumer makes choices between competing technologies, and tries to ascertain how the network may have looked when viewed from the

inside out..."[49] She therefore opened up the possibility for technological development to be understood from the perspective of consumers and their interpretations and impact on the technological process of change, rather than on the basis of innovations, development and production. In so doing, she also helped to alter the basis on which women are viewed as actors in the technological process of change.

Co-production

The various methodological approaches introduced in the previous sections took part in attempts in the 1980s to escape from the closed discussions of internal versus external factors, actors versus structures, micro versus macro – not to mention all the attempts to understand how interests, the external or macro, became involved in the internal aspects of science and technology.

In various ways, many researchers turned toward what later became known as the co-production of science, technology and society.[50] Rather than taking for granted the modern division between the internal and the external, the focus shifted to investigating how the boundaries between these activities and institutions arose in the first place, and how they actually functioned. The goal of these new studies was to learn how the internal and the external, science, technology and society developed in conjunction.

One book that took part in, and greatly influenced, this new direction is *Leviathan and the Air-Pump: Hobbes, Boyle and the Experimental Life* from 1985 by Shapin and Schaffer.[51] The book tells the story of an air-pump, experimental science, and a controversy between Robert Boyle and Thomas Hobbes in the period following the civil war in England in the second half of the 1600s. The air-pump was supposed to answer one specific question: whether a vacuum, a space without air, actually existed. As part of a wider discussion, this question concerned how a foundation for knowledge, authority and power could best be built. By creating consensus on the way to establishing matters of fact, perhaps a foundation could be found to safeguard peace. Boyle's strategy, the one which prevailed, was to look to nature and conduct experiments in which nature would reveal itself, witnessed by distinguished, neutral men without self-interest in the matter. Boyle believed that this method would produce an independent, objective knowledge base for political discussions.

The practice prescribed by Boyle established new norms for what science was, how nature could best be studied and how truth about nature could be arrived at. According to Shapin and Schaffer, a new scientific form of life had been created. Boyle played a role in shaping three fundamental technologies for this form of life: a material technology – the air-pump; a literary technology – the unbiased form

of writing that could safeguard the transfer of the experiments with the pump to those who were not direct witnesses; and a social technology – the way in which experimental philosophers should relate to each other and to knowledge claims.

What emerged here, then, were not just constructions of nature in the form of facts and theories about nature, but constructions of science qua social institutions with a set of practices, norms and rules, and most crucially, new boundaries and a new distribution of work and power between various social institutions. The result was the emergence of a new, specifically modern social order that included, but was not limited to, the emergence and establishment of a new form of science – experimental natural science. Shapin and Schaffer assert, in fact, that Hobbes and Boyle were equally concerned with *both* science *and* politics, and did not see these as being clearly segregated. The outcome of this controversy, however, was that Hobbes' definition of politics gained acceptance, whereas Boyle's definition of science won out – with the result that these two spheres and activities became delineated and segregated. Thus, Hobbes, Boyle and the air-pump all took part in establishing the modern divisions between nature, society, politics and religion, which today are virtually naturalized.

As this discussion shows, Shapin and Schaffer go further than the SSK tradition in many ways. Firstly, they delve deeply into the content, while also investigating how these supposedly internal scientific discussions and practices are part of contemporary political and religious power struggles. Secondly, they are not satisfied with having demonstrated and explained how science was mobilized and used in conflicts over interests and power struggles in society at large. They take a totally new direction by showing how a new form of science arises in conjunction with, or is co-produced with, a new form of social order. Not least, they show how this new form of science was crucial to the dislocation and rearrangement of relations between social institutions that took place during the same period.

Another way of approaching the confrontation with these same divisions goes via Foucault. This can be seen in one of the early collaborative projects between Callon, Latour and Law in the 1986 anthology *Power, Action and Belief: A New Sociology of Knowledge?*.[52] In his article, Law addresses the division between ideology and structure, or belief and structure, and argues that the sociology of knowledge, which is based on this division, is in crisis. Divisions such as these should instead be understood as a question of practice. This concerns "the problem of the reciprocal relationship between knowledge and structure as this is mediated through practice," writes Law in reference to Foucault.[53] Another issue was also raised, which became important in later works combining the legacy of Foucault with science studies: the issue of the microphysics of power, or as Law writes, "the tools, so to speak, of social control".[54] Both SSK and Foucault emphasize

the productive and enabling aspects of power.[55] Power is not just power *over*, in a negative sense implying repression or domination. Power is also power *to*, in a positive sense. But the tradition's of history of science and science studies inspired by Foucault, including the new laboratory studies, goes further than SSK in its understanding of practices, including scientific and technological practices, as materially productive and effective. Here we see an important difference in emphasis, both from the focus of the Radical Science Movement on right or correct knowledge and SSK's focus on knowledge as a social construction. The focus has been moved, not away from knowledge per se, but toward how scientific knowledge works and participates in shaping and reshaping the society that it is a part of and is developed together with. As such, technoscience cannot be reduced to knowledge, interpretations, representations or *social* constructions. In Latour's terms of the time, these are tools for shaping and reshaping society and reality; they are "politics by other means".[56]

Thus, there were many people involved in articulating the argument that scientific facts, technological artefacts and the society they are a part of are *co-produced*. This argument was developed from different positions and with different backgrounds and resources. But the French School within science studies took the argument one step further in the reflexive demand that the social sciences, and social science concepts and constructions, be subjected to the same form of critical investigation as natural science's constructions.

The reason for this, Callon argues, is that social constructivist studies create a striking asymmetry that places the social sciences in a privileged position, naturalizes their objects/subjects and knowledge production, shields them from critical investigation, and ensures that they have the last word in all discussions. These studies turn the traditional hierarchies on their head. What we get is a different kind of privileged knowledge based on "the social", representing the same safe, secure foundation that nature previously represented for the natural sciences. Callon wants to depart from this way of creating a safe, secure foundation, since he views it as being no better than its opposite, scientism.

Another important approach to the study of co-production is what we call feminist studies of technoscience, an area in which Haraway has been a driving force. She has applied the concept of co-production to a critical reading of Shapin and Shaffer's interpretation of the modest witness.[57] Haraway praises Shapin and Shaffer for their effort to shed light on how the object – nature – and the subject – the modest witness – were created in the same process. But what kind of person is the modest witness? Haraway asks. It was *men* who could appear as neutral and unmarked, who did not let their judgment be influenced by interests or other subjective factors, as Shapin and Schaffer portray it. And why was it a certain type of man, with a certain

set of masculine virtues, who was modest? What did this new modest witness have to do with other notions of gender held at the time? Is it not also possible to say that gender was co-produced in this process, that not only did a new kind of science and a new kind of scientist emerge, but also a new kind of gender?

Technoscience is a process in which subjects and objects are made. It is not only the scientific facts, and the researchers who happen to be present, which are made and remade. The entire set of cultural categories is assessed and re-assessed in this process, Haraway argues. Gender (and race and class for that matter) cannot be turned into stable realities if the *theories* suggest that everything in the studies is at stake and open to debate.

Networks and critiques

The articles in the first section of this anthology made important contributions to the debates on methods, theory and politics in STS at the close of the 1980s and beginning of the 1990s. By starting off with articles by Susan Leigh Star, Michel Callon and Donna Haraway, we want to show how debate and discussion were opened up on the basis of different traditions. Although the three authors employ different themes and methods, their articles are closely related to each other and share a number of assumptions. As a result, we believe that these articles also highlight and define each others' concepts and methods.

First of all, in their own unique ways these three authors emphasize how science and technology are cultural practices, and how they are central phenomena to the construction of society. Their thematization of co-production underscores that not only must science and technology be studied as cultural and social phenomena, but in order to understand society, to do social science, technoscience must also be studied in relation to how it creates interests, projects, meaning and social reality. There is a continuum, a seamless web, between science, technology and society, and consequently, technoscience is not something fundamentally different that confronts us, but something that constitutes social reality. In this way, the studies are part of an effort not only to explain science through the social and political, but also to explain the social and political as the effects of science. Star is perhaps the author who gives greatest weight to the consequences of technoscience, of how these effects create standards and conventions that enable specific forms of subjectivity, and disable others. Callon looks at how scientists ascribe identity to such different elements as scallops, fishermen and researchers, while Haraway in her article formulates a new concept of objectivity which grasps that the social, material and the political shape our – that is, all scientists' – knowledge projects and how this occurs.

Secondly, the authors thematize how language is constitutive of the realities we apprehend with our analyses. Callon works to create a new vocabulary which can describe and explain controversies about science and technical content and controversies about the elements of society with the same means. All knowledge claims and viewpoints are treated as if they had the same truth value, as it was stated in the SSK's radical programme of symmetry. Sociology should abstain from judging or prioritizing the various scientific knowledge claims, and no interpretations should be censored. But as previously mentioned, Callon adds that the symmetry principle must be expanded to include negotiations about the social or society as well as negotiations about nature. To do this, we need a new vocabulary, Callon argues. Sociology must not only explain the many and conflicting viewpoints in a technical or scientific controversy in the same terms; sociology must also use the same vocabulary when switching between and describing the social, natural and technical sides of the same controversy. Callon's article is like a training drill and a compilation of such a vocabulary, applied to a special case. He discusses a scientific controversy about the causes of the fall in scallop stocks – a popular, highly-prized delicacy in France – in the St. Brieuc Bay, and three marine biologists attempt to develop a more "sustainable" strategy for harvesting the stock in the future as well. And the vocabulary he applies to this case enables him to treat both scientific and social controversies symmetrically. The terms *problematization*, *interessement*, *enrolment* and *mobilization* are four steps in a general process called *translation*, and are tools for conducting what at the time Callon called a *sociology of translation*. This vocabulary is not taken from the actors' own vocabulary; it is a set of terms that makes it possible for the observer to treat the process symmetrically. It is possible to use an infinite number of vocabularies, argues Callon, but it is more important to choose a vocabulary that makes it possible for sociologists to convince their colleagues that the choice is correct.

Star and Haraway also stress the importance of these linguistic tools. But in contrast to Callon, who asserts that any vocabulary can get the job done, Star and Haraway are concerned with showing in a concrete way how language is a source of one person's power and another's powerlessness. "Power is about *whose* metaphor brings worlds together and holds them there," writes Star in her article "Power, technology and the phenomenology of conventions…" She emphasizes how metaphors create bridges between different worlds. People, she says, are part of communities of practice; they inhabit many different communities or worlds at once. Metaphors are used as a means of uniting these worlds. The question then becomes whose metaphors can bring these worlds together and give them stability. In the study of conventions, of how some orders become stable, the power contained in naming and providing metaphorical meaning becomes crucial.

Of these authors, Haraway is perhaps the one who makes the most out of the meaning of language, in the sense that she not only discusses what our terms do in scientific practice, but she also formulates new terms and works with reformulating old terms as a part of her scientific practice. By taking what she calls "border creatures" like the cyborg, the transgenic OncoMouse, the coyote and the FlavrSavr Tomato as her points of departure, she uses these figures as a means for imagining other ways of living, for imagining other worlds.[58] When she wrote *A Cyborg Manifesto* in the mid-1980s, she portrayed the cyborg as a monster, a border figure that could be used to question established truths and make possible the politicization of science and technology. Boundaries between gender, between people and machines, or between animals and people are constructed, but nonetheless effective, and they are continually being created. In this sense, it is also language and metaphors that give power. Because language participates in giving meaning to and shaping these boundaries, it is important whose definitions prevail. Moreover, Haraway not only insists that how we describe, figure and turn the language is central to how we *understand* science and technology in culture, and for how we as critical STSers *do* science and technology studies. The practices of the scientists and technologists also involve interpreting and establishing meaningful terms that help to shape the world, and that are the object of conflict. Science is world-changing narratives, Haraway argues, and in the analyses of these narratives she makes greater use of the interpretative practices of the humanities than the two other authors.

Thirdly, Star, Haraway and Callon are interested in presenting and giving agency to actors in a way that can be called anti-humanist. With the concept of the actor-network, Callon took part in making it possible to conduct studies of society in which non-humans, such as machines and nature, were given a new status as actors. This perspective has aroused both head-shaking and strong opposition, but at the same time, Haraway and Star show how efforts to endow the "research objects" with various types of agency is a common feature of ANT and different types of politically-motivated feminism.

As we mentioned, the basis of Callon's social theory is that objects and subjects are made and sustained by means of ongoing translations and transformations in networks of relations, referred to as actor-networks.[59] One key to understanding this position and critique can be found in semiotics. Put succinctly, ANT adheres to a material, expanded version of semiotics, also called relationism or associationism, which studies how things come into existence as a result of the set of relations of which they are a part. It is not only the meaning that is relational: natural science's truths, technology's material dimensions, and sociology's actors and subjects exist only as the effect of the set of relations they constitute. These entities circulate in a network of translations, displacements and transformations.

Within this semiotic framework, the social cannot be understood as comprised of agency and social structure, or as stretched between these two poles. It involves processes, something that comes into existence, and which is ascribed characteristics, competence, agency, positions and relations from the network, something which is continually being constructed and arranged, rather than being a given in the order of things. Representatives of ANT stressed that they had no theory about what was human, and thus social, and that what is called human or social must be seen as the effect of the attribution and distribution of status, positions and characteristics, rather than as essences or natures. People are not always subjects, and things are not always objects. Categories such as subjects, objects and actors must be understood as results, as effects. They cannot or should not be defined a priori.[60]

Accordingly, Callon proposes using the term "actor" in the same way that semiotics uses the term "actant", specifically, in a way that does not distinguish between human and non-human actors. Baboons, scallops and electric car batteries all can be actants, in addition to fishermen and researchers. And the sociologist does not need to change registers when he or she moves from the technical to the social or from nature to society. This widely discussed point must be understood against the backdrop of semiotic theory. In semiotics an actant is any entity which has a position in a discourse, which is ascribed agency and described as the cause or origin of an occurrence. As a starting point, a distinction is not made between human and non-human actants. Whether or not actants are ascribed humanity is secondary.

Star emphasizes human experiences and subjects. Although she views subjectivity as constructed and multiple, she holds onto a concept of subjectivity, in contrast to ANTers, who to a greater extent place things, sciences and technologies in the centre stage, and views humans (along with artefacts) as effects of the process. But the desire to study subjectivity and identity does not mean that Star supports *social* constructivism, which argues that society is what *is*, while artefacts are socially constructed. In the article in this anthology, Star criticizes the British sociologists who argue that there *is* and *must be* a moral division between machines and humans and that attempts to undermine this division are dehumanizing. In contrast, she argues that both subjects and objects are constructed along the way – we neither can nor should take an existing social or natural reality as our point of departure. But in contrast to the ANTers, as she interprets them, she wants to look at how the many subjects are shaped when new networks and standards are created, how both powerful and marginalized positions are created. While network-builders can participate in several different networks, unite them, and show their strength through their ability to change registers and master their own networks, the position of others is to be enrolled in a number of networks without the opportunity to build bridges and form relations that give strength. The multiple personality

disorder is the extreme variant of this position, of which everyone is more or less a part. And this position of being partially inside and partially outside a number of networks provides a basis for analysis, Star asserts. The position of monsters is a good starting point. Monsters are marginal in many networks and fall outside many standards, and in terms of analysis, studies from their perspectives provide better opportunities to discover how standards and networks function, Star argues. We can all be monsters, as members of several different social worlds. Even though Star focuses mainly on the human experience, she also emphasizes how subjectivity is not centred, and on how it is created through networks of social, natural and technical dimensions.

Haraway also works to redefine the term "actor" in the social sciences and humanities. By using the term "material-semiotic actor", she wants to present the knowledge object as an active part of what she calls the "apparatuses of bodily production". Objects are not just resources for our knowledge and science's knowledge. They are active and co-creating, even though they are never unproblematic and can determine how we discuss them. When she uses the term "situated knowledge", she wants to show that knowledge objects are actors with life and agency. They are not discovered or revealed through scientific practice. Instead, narratives about the real world require that we converse with, and participate in a social relationship with, the objects. These objects are not simply technological apparatuses with agency, but a nature with agency. Narratives about a real world must therefore contain a form of conversation, in which nature and the world are not just passive resources for our narratives, but are active partners – with an independent sense of humour. In this way, this article deals with the question of objectivity in feminism, and asks how a "real" world assumes a place in and defines our knowledge projects.

The fourth and final aspect we want to highlight as a common theme of these three articles is closely tied to the preceding point and deals with how the authors think about the political. This is where the crucial differences in the actor-network approaches and the feminist challenges of Star and Haraway emerge. Callon opens his article by writing that his goal is to outline a new approach for studying the role of science and technology in the structuring of power relationships. Star states it even more succinctly: "This is an essay about power," she writes. But their view on how power relationships can best be studied, and on what basis, is different, and in her article Star presents an influential critique of the network mode of thought. Star opens with a critique of the power perspectives in the actor-network approaches, which she illustrates with Callon's and Latour's works. She argues that the ANTers see only through the eyes of the powerful, and that they base their studies on actors who have the power to ally themselves with others, build networks and empires, in other words, entrepreneurs. They follow the actors, but only those with the power

to make their will prevail. Studies of this type not only describe these powerful actors, but help to shore up their power, she argues. As an alternative to these studies that fortify and affirm the powerful actors, she introduces feminism and interactionism, which she says will show both *that* and *how* it can be done differently in studies of technology and science.

Whereas in the 1980s ANT emphasized the powerful actors' interpretations, understandings, actions and constructions, the ecological traditions Star draws on focus on the interpretations and actions of everyone involved and describes the environments in which science and technology are created, as "social worlds". The difference between these traditions lies primarily in how the relevant actors to be studied are defined and whose perspectives are considered to be important.

One of the cues she takes from the ecological approach is to look at a number of different *translations* that take part in the construction of scientific knowledge, and to investigate these by including many different positions in an effort to describe numerous perspectives. *All* the actors – not just the powerful ones – simultaneously attempt to interest others in their own interpretations and goals. And the end result (or the temporary result) of these attempts is constructed through what Joan Fujimura calls processes of negotiation, articulation, triangulation and debate, and sometimes also through force, or "administrative persuasion" by members of other social worlds who attempt to install their own "definitions of the situation" when these different worlds meet.[61]

With this ballast, Star criticizes the ANTers, as previously mentioned, for not seeing more than one part of this world. ANT loses sight of those who perform the invisible work of maintaining the networks, for there are many groups involved in maintaining and protecting networks. It also loses sight of the invisible work that consists of building an identity on the margins of, or in relation to, several networks where others build and hold the power. Star wants to begin her studies in a different place. She is interested in the pain of being squeezed into, or out of, particular roles. Consequently, her motto is to study the networks from the bottom up, taking as a starting point the marginal actors, those who are made silent, fall by the wayside, or are only spoken on behalf of and do not themselves have a voice in the networks. This position may recall the positions held in both standpoint feminism and industrial sociology, to name some of the Marxist-inspired positions we have discussed previously. But Star complicates this picture, insisting that identities and personalities are multiple, or in other words: we are all part of and participants in many networks. Which positions are strong or weak is not pre-determined by factors such as one's place in the production or patriarchal structure; everyone participates in a number of different networks, and everyone is marginal within different types of networks.

This does not mean, however, that in principle everyone is equally powerful, or that we can resign ourselves to the fact that everyone is slightly marginal in different places. Rather, it is a question of keeping an eye out for who is squeezed out of the network or into standards they have not wished for themselves and must live with, without their voices ever being heard, either by researchers or by network-builders.[62]

How do we conduct science and technology studies that are not blind to the way in which gender, class and race is co-created and re-created? Perhaps it is time to re-evaluate and re-figure the modest witness, as Haraway argues in her article of the same name.[63] The modest witness, which has lived amongst us for three hundred years, not only establishes guidelines for how technoscience is produced, but also for how we tell our stories and construct reality. Can we create other stories, can we give the concepts new content, refigure them to create better, more inhabitable stories? We need a new, strong programme for science studies, Haraway asserts - one that does not shy away from an ambitious project for symmetry. At the centre of these studies stand the humans and the positions from which the knowledge emanates, as well as the target group of the knowledge and the status of the knowledge that is generated.

For this programme, then, we need a modest witness, one who is able to carry out critical reflexivity, who also is actually concerned with putting forth knowledge claims, and who is not afraid to make assertions about the world. It is not reflection, but diffraction, creating new and changeable patterns, making a difference, which is the aim of creating and articulating new, modest witnesses. Witnesses who are not unmarked and neutral, but engaged and localized.

From a feminist starting point, then, Haraway has introduced a different approach in order to call into question the social and natural boundaries taken for granted by social science researchers. In her article *Situated Knowledges*, she argues that scientific knowledge always creates differences. For radical and feminist projects, therefore, this involves participating in this field and helping to create other differences, says Haraway, because science is too important to be left to "the others". She therefore distances herself from SSK's demand to stand on the sidelines and be neutral. On the contrary, she stresses that it is impossible not to be situated, that is, localized and positioned, and consequently also involved, in relation to knowledge claims.

Because there are no innocent positions, it is not possible to stand outside, no matter how reflexive one tries to be. Reflexive knowledge also creates differences, but only as reflections of the same differences, Haraway argues. Viewed in this way, relativism is merely a reflection of the objectivism it deconstructs – it also claims to be able to see without being visible and localized itself. Haraway's reflexivity project

thus entails making all knowledge claims and subject positions visible and open to critical investigation. On this topic she shares similarities with Sandra Harding, as we mentioned earlier. But Haraway calls into question standpoint feminism's belief that one sees better and generates better knowledge from oppressed and marginal positions. What a position entails is not a given, she would argue. All positions must be investigated. It is about working to "become answerable for what we learn how to see".[64]

But Haraway's project also underscores the significance of how we construct knowledge objects, and she objects to a reflexive approach in which the "I", the author herself, plays a central role. She wants to show how the "objects" are active co-creators in the knowledge process. In this sense, the symmetry principle is important because we confer a voice and the right to speak to entities that are not human, and this has to be based on other ideals than neutral distance. Therefore, situated knowledge involves situated conversations, as she has formulated it. From this standpoint, she also converses with other constructivist positions, but with an explicitly political agenda.

Modest interventions

All the authors of the articles we have selected for this book expand on these critical engagements with SSK and actor-network studies in one way or another. The book intends to present *both* the space that was created in their efforts to shift the grounds for practices of science, criticism and politics, *and* some of the ways that new figures, relations and engagements have been realized. The engagements triggered great experimental activity, not only in regard to the modes of representation (such as in the discussions of what the situating of knowledge could entail), but also in ways to be engaged, to participate and be political, not to mention places and practices in which to intervene.[65] While some of these researchers direct their energy and focus on participation in processes involving users, patients, representatives and stakeholders in research and politics, other attempts query and interfere with the conditions for the practices, and with how they are imagined, enacted and legitimated, for instance, in philosophy.[66]

To be involved, then, is a requirement for being in the game. Our descriptions and stories, in STS and feminist technoscience studies as well as in medicine or politics, are part of the action, not outside it and merely reporting on it. With Annemarie Mol we could say that we are involved in *enacting* realities rather than representing them. And our enactments interfere with other enactments and theories at work in the same context.[67] This was what, among other things, early actor-network studies

were accused of – that they reproduced science's narratives about itself and its relationship to the world, about science as heroic agency. This criticism was based on the contention that these studies, in the same way as the research they studied, did not reflexively take into account that they took part in enacting and building worlds, that they distributed power, agency and chances in life, and therefore were political – and even conducted a kind of "ontological politics".[68]

So how, then, do we live, practice, represent and interfere in productive and responsible ways? In this section, we have grouped together the articles that share similarities in terms of the locations, practices and actors they are concerned with, the objects they focus on, and their mode of intervention.

Locations

In view of the criticism that early actor-network studies were managerialist, functional and collusive, an obvious challenge lay in the question of just *how* one should start and focus, set the framework and cut, and thus also what was made central and peripheral, large and small, meaningful and not, in the relations that were included and studied.

As previously mentioned, one of the first people to work with networks in this way, i.e. by starting in other places and making other actors central, was Ruth Schwartz Cowan. Susan Leigh Star made this into a programme by encouraging the study of networks from the bottom up, beginning with those on the margins, and pursuing the question of who profits from this and who does not. Also, Madeleine Akrich's studies of technology transfers focused on users and every day user situations, on differences and displacements between various contexts and technosocial networks, and on the different scripts and antiscripts that were negotiated through these encounters.[69] And Emily Martin investigated how scientific theories on immunity, HIV/AIDS and sexual reproduction were constructed in such diverse settings as the classroom, community projects, support groups, work places and the mass media, as well as research laboratories and clinical settings.[70]

Similarly, all the articles in this section focus on settings in which practical, everyday engagement with scientific knowledge and technological artefacts plays a central role. For instance, the article by Moser and Law focuses on the efforts of disabled people to create passages and continuity in their lives, biographies and daily activities. Specifically, they investigate how technologies and material events are part of this struggle, sometimes in ways that are enabling, and other times in ways that both disable and exclude people with non-standardized bodies. Deborah Heath's article deals with a research laboratory, but in a hospital setting where the connections to clinical work and to the use and users of medical genetics are paramount.

The article by Marianne de Laet and Annemarie Mol on the fate of the bush pump in the countryside in Zimbabwe challenges STS, innovation studies and engineering science all at once with a story that turns upside down established views about which locations are most important, where invention and innovation takes place, how innovations are ensured success and expansion and which strategies are most effective for achieving this. And Vicky Singleton investigates how new public health policies work themselves into and become realized in the practices of the local community; how they contribute to producing and shaping that community; and how the distribution of tasks, agencies, competencies, statuses and responsibilities become opened up and negotiated through that intervention.

All these authors demonstrate that the laboratory is not the only place where new realities are created and politics is exercised. The power and ability to represent, translate and shape reality is neither centred in formal political institutions, nor in science. On the contrary, realities are created and enacted in many different locations, practices and relations, and the connections between them, and the coherence of what has been created, is not a given. The question of which enactments prevail and become more real is thus an empirical question of the nature and character of the connections – and the boundaries – between different locations, practices and enactments.

Objects

So these articles stand out from earlier studies of co-production both in the locations, practices and actors they investigate, and in the way they investigate the connections between these different locations, practices and enactments. Moreover, the *objects* that these researchers focus on are different from the objects that actor-network studies, laboratory studies, SSK and STS have traditionally focused on. In Heath's article, for instance, the central focus is not so much on the construction of facts about the genetic basis of Marfan's Syndrome as on the interactions and boundary negotiations between the medical-genetic lab science and the users, their representatives, clinical practices, sponsors and financial supporters. And when focusing on genetic research, it also deals with how research must be understood as material, embodied and involved interactions, rather than as distant, disinterested witnessing.

In the article by Moser and Law, this shift from investigating how scientific facts and objects are constructed to looking at which other realities they are created for and with becomes even clearer. Here attention is paid to the formation of subjectivities and how subjectivities emerge in embodied, material and technological

relations, but also to how technologies are involved in disabling and enabling arrangements, and how these open up or shut down access to valued subjectivities.

The article by De Laet and Mol also examines a form of subjectivity, or a form of subject-object co-production. But instead of asking what kind of user-subjectivities are made possible by, and co-produced with, standardized technologies, they turn the discussion toward the question of what kind of technologies, innovations and development are made possible by, and co-produced with, different types of researcher, engineering or inventor-subjectivity. They show that it is not necessarily the disengaged researcher or the ordering, controlling engineer, creating universal methods and solutions based on approved standards and patent systems, who has the greatest success. On the contrary, the example from Zimbabwe of the bush pump illustrates a different, alternative innovator – and a different, alternative type of innovation, or object. The bush pump develops and changes in a flexible manner according to the local settings, conditions and needs it encounters, and precisely for that reason it prevails and creates new social and material realities – "development".

The focus of Singleton's study is on health policies and practices, and in particular how these incorporate and enact normativities. In a similar manner to De Leat and Mol, Singleton shows that the new realities created at the local level are not unanimously determined or shaped by centralized attempts to define norms and targets and to develop strategies and plans for reform. But what is unique about the UK's New Public Health Plan, she explains, is that while the plan defines central, general and ambitious norms in ways we are used to, it also seeks to ensure diversity, flexibility and adaptation to local needs and different ways of life. It challenges medical science's claim on expertise and authority in health matters, and it seeks to distribute them in new ways. The question then becomes how these sets and types of normativities – in tension, but also in process – get transported and work their way into new health practices, the local community and new forms of citizenship.[71] And how the research that follows it, through evaluations, critiques or other interferences, contribute to that process.

The point, Singleton stresses, is not that medicine on the one hand, and health policy on the other, are normative, intervening and therefore political, while our critical revelations and descriptions are not, or at least ideally should not be, involved in power and its dispositions. As previously mentioned, involvement is a requirement for participation. For Singleton, then, the question is whether and how one's interventions can help to make visible, and perhaps keep open, new possibilities and alternative realities.

Modest interventions

It is here we arrive at the *modest interventions*. We have borrowed the subtitle for this section of the anthology from Deborah Heath, in order to describe what it is that unites these articles' ways of working with the political in STS. Heath describes her own research as an intervention, or rather a set of modest interventions, which in turn have an entire set of different meanings. Firstly, she plays on the term "the modest witness", the observer who apparently allows nature to step forward and speak for itself without any involvement on the observer's part. Heath, on the other hand, describes how the modest practices that she was introduced to in genetic research on Marfan's Syndrome are embodied, material, active, interactive and very involved. In this way, she helps to refigure the modest witness and its literary practices. Secondly, Heath participates actively in the efforts to create meeting places and interaction across boundaries between genetic research, clinical practice, patient organisations, sponsors, research funding and the daily life of people with Marfan's Syndrome in the context in which she works, in the US. Here she is an actor in the field, partly an ally and partly an observer at the same time. She also calls these interventions modest. Thirdly, Heath also intervenes in natural science itself, in the genetic research in which she participates, by asking questions about the boundaries of this research and about alliances, connections and boundaries between the research and other contexts and institutions, such as the research department of the hospital and the daily lives of the patients. Last but not least, Heath's article is also an intervention in, or interference with, the traditions of SSK, laboratory studies and actor-network studies in STS. She studies local, embodied technoscientific practices and compares the variants of these local knowledges and practices. In particular, she is concerned with the networks that link the laboratories with other worlds, with the enactment of boundaries between them, and not least, the border traffic between them.[72]

These are classic interests and themes of ANT studies, and of laboratory studies as well, to some extent. But Heath does other things in addition that clearly set her work and texts apart from ANT, laboratory studies and SSK: she tests these traditions against feminist and cultural studies discourses about the significance of embodiment, embodied knowledges and mindful bodies; about the presence and participation of the researcher; about commitment and investments that cannot be reduced to power games; and how this can be accounted for and represented in written form. In her own texts, Heath reflects on her experiments with other ways of being a researcher – more active, visible, emotionally engaged and participatory – and other ways of bearing witness to these practices and activities. The goal, she says, is to explore, challenge and perhaps change the boundaries between local,

situated knowledges. She does this by focusing on translocal meetings both "inside" and between scientific cultures, and between scientific cultures and other worlds "outside". These are the meeting places where the relations and mutual obligations between the inhabitants of different communities, each with their local knowledges and practices, are put at risk.

Similarly, Vicky Singleton is also a participant in, and an observer and analyzer of, the new health practices and normativities that emerge in the realization of the new public health policies in her community in the UK. However, Singleton also uses STS, feminism and ANT tools and research to speak to, and interfere with, a strong tradition of health research and medical sociology in the UK. This body of work attacks the new public health policies and initiatives because they are normative and moral, and strive to shape and discipline people's lives, ways of living and subjectivities.[73] For Singleton, the fact that these health practices and policies are normative is not grounds for criticism per se. The question is which and what kind of normativities the new public health policies enact, how and to what extent they are new, and how they meet and interfere with normativities in the local setting. That is, what occurs and results *in practice*. As stated earlier, it is by no means a given that public health discourses and policies will be enacted in other settings and practices in ways that were foreseen. This is an argument for the kind of empirical case studies of science and policy in action that STS promotes.

Furthermore, both Singleton and de Laet and Mol interfere by appreciating and supporting stories, practices and realities that often go unnoticed or are seen to be marginal. Instead of criticizing stories, practices and realities that the authors do not want to contribute to, they emphasize the alternatives – and thus help to make them bigger, adding to their reality and improving their chances of winning the struggle over what realities to make. The article on the bush pump also interferes in precisely this way. It interferes with engineering, innovation and management studies by demonstrating an alternative and passionate form of agency, organization and project management in a highly successful contribution to innovation and development in rural Africa.

But the article also disrupts and challenges another underlying assumption of both engineering and STS. This is the idea that "immutable mobiles" are a precondition for the transport and circulation of scientific facts and technological artefacts. According to Latour, an "immutable mobile" is an object that is well-defined, unambiguous and stable. It can be mobile, move and spread to other locations precisely because the network in which it circulates helps to keep all the elements and relations stable, and in so doing, fixes and reproduces the object so that it is identical.[74] However, De Laet and Mol demonstrate that not only is a certain degree of adaptation and translation necessary when objects are introduced into new

contexts, but also that there are other approaches which can be just as effective as standardization. At least in some cases, the circulation and adaptation of objects, such as the bush pump, are much better served by a more fluid and flexible approach to what defines the object, how it works and what counts as working. And the object does not disintegrate or lose its identity. On the contrary, it becomes more stable the more it is adapted to new locations. The bush pump is thus not immutable; rather it is a "mutable mobile". The argument is therefore that stability and identity do not necessarily always rest on fixed relations, but on difference, change, mutability, adaptation and fluidity as well.

The story of the disabled woman, Liv, in Moser and Law's article could in a sense be seen as another example of the fact that we are surrounded by mutable mobiles as well as immutable ones. The analysis of how both disability and ability, and consequently agency and subjectivity, are the effects of a series of specific configurations of material relations, and passages between these, also emphasizes the formation of agency, subjectivity and embodiment as a dynamic process. But also important here is the fact that this process supports the production of continuity and unity – that is, identity and transformation. Liv is recognizable as the same person, and she also actively builds this continuity in her life and biography. She does so in spite of having lived through many radical disruptions in her life, and even though her daily life is often filled with shifts between situations in which she is constituted as independent, autonomous, competent and capable of rational decision-making, and situations in which she is made dependent and her powers of judgment and ability to take responsibility are called into question.[75]

By approaching questions of subjectivity and embodiment in this way, Moser and Law intervene in feminist discussions as well as in social science, STS and rehabilitation medicine. They do so by decentring agency and subjectivity from individualized bodies, in which agency and subjectivity have been seen to be contained and fixed, into a much larger network of relations that includes corporeal relations, technological arrangements and, in a broader sense, material arrangements. They also interfere by showing how highly valued contemporary subjectivities are equally effects of specific arrangements, participation in practices, and attributions – rather than givens. And they demonstrate that much of the time we move or even oscillate between attaching and detaching, making us continuous and discontinuous, being active and passive, and autonomous and heteronomous. Not that we are in control, though: we move and are moved, perform and are performed, in precarious interactions and practical arrangements.

Furthermore, the articles also interferes in STS, and ANT in particular, by showing that while claiming to bracket questions related to subjectivity, their model of subjectivity in practice has been extremely narrow, assuming that the only possible

subjectivity is that of a general in command: a rational and strategic subject making discretionary decisions about how to allocate resources, set priorities, and make sacrifices in order to win the battle and stay in power. Both Liv and the unselfish, passionate, loving and caring originator of the Zimbabwean bush pump make a mockery of these deeply entrenched social science notions of the strategic, power-oriented actor, as well as of technoscience being reducible to a game of power.

From laboratory studies to ecology, economics and politics

It would not be accurate to characterize the group of articles in the last section of this anthology as *modest* interventions. On the contrary, these authors use science studies' methods and resources to intervene and turn new objects and locations into objects of study: politics and public administration, economics and ecology. This type of non-modest form of intervention applies especially to Latour's book *Politics of Nature* published in French in 1999. His main argument can be summed up briefly by saying that Nature with a capital N does not exist – and if it did, we would wish that it did not.

The theme Latour addresses is not entirely new in ANT, science studies in general or Latour's work in particular. Just think of Callon's article about scallops or Haraway's work as discussed under the section above on networks and critiques. A number of Latour's earlier works raise related issues. And in his book *We Have Never Been Modern,* Latour uses today's environmental crises to rethink the distinction between nature and society.[76] In other words, how can we address the politics of nature if we continue to see the world around us as fundamentally split in two, where those who are labelled cultural or social scientists only have two choices – either they leave nature to natural science and take natural science's conceptions of nature for granted, or they go to the opposite extreme and argue that environmental problems are social constructions and thus can be reduced to the interested parties, the social power struggle, that "lies behind the scenes"? In his article here, Latour attempts a two-fold intervention into the traditions and positions of philosophy and of environmental policy.[77]

What Latour attempts to do is to insist on not excluding the material, natural objects, while struggling to maintain a balance so as not to fall into the two well-worn positions described above. The philosophy of science has long shown that we have no direct access to nature, but this does not justify the social-constructivist argument, claims Latour. [78] He addresses the social-constructivist position with an argument about the historicity of natural objects. The subtext of the social constructivists is that nature has not changed at all. The more we insist on the social

constructivist argument with respect to nature, the more we avoid addressing what has actually happened with the nature that we have abandoned to science and the scientists. [79] But Latour not only questions our ideas of nature, he wants to do the same with our idea of being human. From Latour's standpoint, or more generally from the standpoint of the actor-network theory he helped to develop, an individual cannot be understood as a free, autonomous being. We enter into relationships with things and with natural objects – and more than that: this is how we become human.

Thus, his position implies a confrontation with humanism, but he does not substitute humanism with a towering, superior nature – or "Nature" – in the singular definitive form. On the contrary, Latour's argument is that political ecology has nothing to do with "Nature" as such, and political ecology has never been about nature unsullied by human hands. Instead, it is about infinite ties or relations that always lead to human participation in one form or another. Thus for Latour, political ecology is not about Nature, but about the complicated relationships between beings and things: regulations, equipment, consumers, institutions, habits, calves, cows, pigs and broods.

This again can be linked to a critique of science, most explicitly formulated by Haraway, who argues that the political practice we call science cannot be changed into a better and more benign activity unless we address humanism, where we humans put ourselves in the centre as the only ones who have agency. Haraway's point is not that we need new representations, but rather new forms of *practice*, other life forms that bring humans and non-humans together again.[80]

For Latour his point of entry and objective are thus the same as they were with respect to the *philosophy* of science: instead of starting out from the *theories* of natural science or environmental activism, he wants to look into their actual practices. Thus, his intention is to show that a "nature" or "science" possessing complete authority and hegemony does not exist. For Latour, as for Callon, it is rather a question of pointing out this lack of hegemony and what they have chosen to describe as "rich confusion" – that is, the various ways humans and non-humans, objects, nature and people are intertwined.[81]

This turn towards ecology attends to politics – in at least two ways. First of all, it implies an explicit desire to democratize or politicize science. The objective is to carve out space for politics, where previous practices attempted to abandon politics by referring to facts of nature or science. [82] This is a crucial aspect of Latour's programme, not least in his encounter with established but deeply problematic environmental positions.

Secondly, the field of politics is made into an object of empirical studies in the same way that the laboratory had been earlier. At least this is the challenge. But

how? By following the actors' practices rather than their expressed programmes or theories. Thus the challenge also implicates a specific position on behalf of the author. At least in principle, it does not follow in the tradition of the critical intellectual. Instead, it entails taking the actors seriously in a way which implies that the actors' own practices are just as relevant and interesting as the researchers' theories.

The recent turn towards empirical studies of politics within STS parallels a turn to empirical studies of economy and economics.[83] Callon's 1998 book *The Laws of the Markets* is an example of this. In this approach, Callon maintains, perhaps even strengthens, the goal of not positioning oneself outside the practical and theoretical work performed by the actors. The role of the sociologist is to cooperate with actors in a process of experimentation, innovation and learning. In so doing, Callon seeks to level the difference between sociological expertise and everyday knowledge.[84]

When ANTers, such as Callon, turn toward economic sociology, this can be viewed as an extension of the objection they raised in the early 1980s against taking the social scientist´s object of study – the social – for granted. The social sciences, just like the natural sciences, take an active part in producing what they describe. This is also the case for economics. Economics "performs, shapes and formats the economy, rather than observing how it functions," Callon argues.[85] This critique is of immediate relevance to economic sociology, which has lived by criticizing economic theories for lacking a basis in reality. The theory that the rational, economic actor does not exist *in reality* has been one of crucial importance to economic sociology. From this position economic sociology has attempted to supplement the models of economics.

Callon and others turn this problem on its head. Instead of criticizing economics for deficient models, we must investigate how economics, through its theories, helps to create precisely this kind of rational, calculating actor, they argue. From this perspective, economics is understood as a material practice, a form of technology, and not as a theory standing in a distant or weak relationship to its object of study. Thus, the challenge is to find ways to study economics as a set of technical, material events and locations. "Calculating," Callon writes, "is a complex collective practice which involves far more than the capacities granted to agents by epistemologists and certain economists".[86] Thus, this draws on a recurring theme in ANT which explores the conditions and material arrangements that enable agency in different arenas – with the market being one of these. A crucial question is what new realties or objects emerge and come into existence through these technologies.

But when politics and economics are turned into objects of study within STS, this does not occur exclusively with the help of science studies methods. A distinct co-production has occurred with the tradition of Foucault, specifically his notion of governmentality and the focus on the technologies or practices of government,

and laboratory studies with their emphasis on the production and emergence of new entities and/or objects.[87] "We live in a technological society," Andrew Barry writes.[88] His work moves in an area spanning laboratory studies, Foucault-inspired studies of governmentality, and feminism. Central to this way of addressing politics is that science and technology is not made external to the political field. Instead, scientific and technological practices and forms of knowledge are understood as being fundamental to politics, as being practices that sometimes open up, and sometimes close down, politics.

Turning science studies toward politics involves taking a non-reductionist approach when studying politics, governmentality and public administration.[89] On the one hand, governmentality is not exclusively tied to the state. In the tradition of Foucault, government is viewed instead as a set of practices operating across categories such as states and markets, public and private. On the other hand, politics does not only involve human actors and movements. Instead, politics is seen as a form of practice which comes into existence through a large number of material arrangements and technical objects. In combining science studies and the governmentality tradition of Foucault, the objective is to bring together studies of politics and science, technology and administration. In so doing, the goal is to open up the possibility for studying the contents of politics and administration. This stands in contrast to a one-dimensional focus on power games, social positions and interests.

This renewed interest in politics is not exclusive to STS. Is not the danger that the concept of politics will become watered down, that everything, much too easily, will be labelled politics or political? Just as it takes work to produce scientific facts, however, it also takes work to produce politics and the political, as Barry points out. Thus, political events are rare, and enabling the political is a laborious affair. The challenge is to conduct empirical studies of politics, understood as practice in contrast to politics as a formal, strictly institutionally localized activity, in an effort to study how genuine political events may occasionally emerge in the midst of ordinary non-political events.

In his 2001 book *Political Machines: Governing a Technological Society*, Barry makes a link to Callon's concept of "framing" by showing how objects and locations can move from being self-contained and indisputable to being objects of political dispute, thus being opened up and having their boundaries redrawn. Callon's concept of framing is inspired by the concept of positive and negative externalities developed in economic theory. Callon bases his discussion on a classic example in economics: how a company that pollutes creates negative externalities because the damage inflicted by the pollution is not manifested in the form of costs for the company. In the language of economics, a market failure therefore occurs. This description of economic reality has given, and continues to give, rise to demands

for green taxes, putting a price tag on nature, for economic incentives, etc. When applying these concepts as a starting point for empirical studies of politics, however, it is no longer the narrow focus of economics and markets that matters, but rather how these boundaries between the inside and outside, i.e. the factory and its environment, are created, challenged and renegotiated.

Science studies today, then, have turned toward economics in the form of financial markets and stock exchanges, just as in an earlier period they had turned toward the laboratory.[90] Kristin Asdal's work based on a historical case related to pollution problems stemming from the release of fluorine from an aluminium factory, a case of the sort that Callon uses to illustrate his argument, takes part in this renewed interest in studying economics as well as politics using the methods of science studies. But instead of homing directly in on "the economy", Asdal studies how nature encounters the factory and the realities produced on the shop floor.[91] How do the actors and entities outside the factory become a matter of concern, a political issue, in the encounter with the company? And what kind of issue is it?

Like Barry, Asdal draws on the governmentality tradition of Foucault – including the challenge of including resistance and conflict in such analyses. How do different forms of resistance and opposition get linked to the state and centralized power - and what effects does this have on the contents of politics? This approach is inspired by a feminist critique, reworked in Asdal´s article into a focus on politics not as a question of *one* will or of *one* desire, but of politics as encounters and confrontations between desires and projects.

Asdal draws on Latour's politics of nature while turning his argument on its head. Instead of demonstrating that the issue always involves nature in its particularities – *that* river, *the* factory – she attempts to show that nature with a capital N is an entity that emerges through technical, political and scientific practices, specifically in the encounter with the factory and the economy.[92] At the same time, she draws on feminist critiques that have sought to show how resistance and critique, the user or the citizen, have played a crucial role in shaping science and politics, but have been excluded from the analysis.

In her contribution here, Asdal illustrates the importance of resistance to the shaping of political issues, indeed to establishing an *issue* in the first place. At the same time, however, the attention is turned away from *whom* – which actors take part – to the *relations* that help to shape the contents of politics in particular ways. She points out how an external green nature can emerge by excluding an entire set of relations. Through this relational perspective, in which "nature" is understood as a result of encounters between other desires (such as the goal of the company), she also makes space for the non-productive power of science. As we stressed at the beginning of this book, not all forms of scientific intervention are equal in their

capacity to bring about change, gain a foothold, create political issues or stimulate political engagement.

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What forms of intervention have power and significance, create issues and stimulate engagement? This theme, which we concluded the previous section with, can also serve as the entry point into the final and concluding section of this book: a conversation between two central actors in the field of STS, Maureen McNeil and John Law. Their individual biographies can be seen as personifications of the map we began with in this introduction. On the one hand, the history of the field is characterized by a tension between Radical Science and SSK. On the other hand, the field also encompasses an encounter and a mutual exchange between these two approaches.

McNeil and Law's work in STS has spanned a thirty-year period. Although they have worked with different themes and different theoretical traditions, they have also participated in a collective STS history. On the basis of our account of STS history, focusing on its different ways of addressing the political, we have invited McNeil and Law to participate in a discussion of the ways in which this intellectual field has been transformed by a set of new influences, approaches and challenges. We will allow them to conclude with their assessments of the forms of intervention that have power and significance in STS today.

Notes

1 Bruno Latour, *Science in Action* (Cambridge: Harvard University Press, 1987), 174-175. In this Latour leans on a longstanding Heideggerian tradition.
2 Donna Haraway, *Modest_Witness@Second_Millennium.FemaleMan©_Meets_OncoMouse™*, 3, *(NY: Routledge, 1997)*.
3 Latour, *Science in Action*.
4 Bruno Latour, *We Have Never Been Modern* (New York and London: Harvester Whitesheaf, 1991).
5 Haraway, *Modest_Witness*, 81.
6 Haraway, *Modest_Witness*, part 2, chapter 1.
7 Bruno Latour, *Politics of Nature. How to bring the Sciences into Democracy* (Cambridge, Ma.: Harvard University Press, 2004 [1999]), the introduction, 6.
8 Michel Foucault, "Nietzsche, Genealogy, History" in Faubion, James D. (ed.) *Michel Foucault. Aesthetics, method, and epistemology, Vol.2 of Essential works of Foucault 1954-1984* (New York: The New Press), 369-392. Also see E. Schaanning, *Fortiden i våre hender: Foucault som vitenshåndtør* (Oslo: Unipub, 2000), chapter 2.2.

9 Other histories of the field have also been written. See e.g. D. Edge, "Reinventing the Wheel" in Jasanoff et al., eds., *Handbook of Science and Technology Studies* (London: Sage Publications, 1995) and S. Traweek, "An introduction to cultural, gender and social studies of science and technologies" in *Culture, Medicine and Psychiatry*, no. 17, 1993. For an introduction to the early period of SSK and debates on the philosophy of science that include Merton and Popper, see S. Sismondo, *An Introduction to Science and Technology Studies* (Malden: Blackwell, 2004), and for Nordic readers see Vidar Enebakk, *Mellom de to kulturer. Oppkomsten av vitenskapsstudier og etableringen av Edinburgh-skolen 1966-76 (Between the Two Cultures: The Origin of Science Studies and the Establishment of the Edinburgh School,* Norwegian language only*)* (Doctoral thesis, University of Oslo, 2005).

10 Here we draw on Vicky Singleton, this volume, who develops the notion of appreciation as intervention.

11 This book is premised on research in STS which demonstrates that science is not just one thing and that it does not have one common form of practice. The social consequences of various forms of science are also radically different. In an introduction such as this, however, we have chosen to refer to "science" in the singular.

12 See e.g. B. Hessen, "The Social and Economic Roots of Newton's Principia" in N. Bukharin et al., eds., *Science at the Crossroads*, (Moscow: Kniga, 1931). Reprinted with a new introduction by Joseph Needham (London, 1971). See also J.D. Bernal, *The Social Functions of Science*, (London: Routledge, 1939) and J. Needham, *The Grand Titration*, (London: Allen & Unwin, 1969).

13 H. Rose, "Feminist/Gender Studies of Science: An Overview of the Field" in *Genus, Teknik och Naturvetenskap – En Introduktion till Kvinnoforskning i Naturvetenskap och Teknik* (*Gender, Technology and Science – An Introduction to Gender Research in Science and Technology,* Swedish language only) (Stockholm: FRN, 1992).

14 R.M. Young, "Science is Social Relations" in *Radical Science Journal*, no. 5, 1977, 65-129.

15 For a history (and an extensive bibliography) of the Radical Science Movement, see Hilary Rose and Steven Rose, *The Radicalization of Science* (London: Macmillan, 1976). Also see Rose and Rose, *Science and Society* (Harmondsworth: Allen Lane & Penguin, 1969); Ruth Hubbard and M. Lowe, eds., *Genes and Gender II: Pitfalls in Research in Sexual Gender* (New York: Gordian Press, 1979); Ruth Hubbard, S. Henefin and B. Fried, *Women Looking at Biology Looking at Women* (Cambridge: Schenkman Publishing, 1979); Les Levidow and Bob Young, eds., *Science, technology and the labour process: Marxist studies* (London: CSE Books, 1981); R.C. Lewontin et al., *Not in Our Genes. Biology, Ideology and Human Nature* (London: Penguin, 1984).

16 An important earlier work is Ethel Tobach and Betty Rossof, eds., *Genes and Gender* (New York: Gordon Press, 1978). Also see the anthology Ruth Bleier, ed., *Feminist Approaches to Science* (New York: Pergamon Press, 1986) and Ruth Hubbard, *The Politics of Women's Biology* (New Brunswick: Rutgers, 1990). The work of Sally Hacker should also be mentioned here. See Hacker, *Pleasure, Power and Technology: Some Tales of Gender, Engineering* and *the Cooperative Workplace* (Boston: Unwin Hyman, 1989).

17 David Bloor, *Knowledge and Social Imagery* (London: Routledge and Kegan Paul, 1976), and Barry Barnes and David Bloor, "Relativism, Rationalism and the Sociology of Knowledge" in Martin Hollis and Steven Lukes, eds., *Rationality and Relativism* (Oxford: Basil Blackwell, 1982).

18 Steven Shapin, "History of Science and its Sociological Reconstructions" in *History of Science,* Vol. 30, 1982a.

19 Harry M. Collins, "Introduction: Stages in the Empirical Programme of Relativism" in *Social Studies of Science*, vol. 11, no. 1, Feb 1981; Harry M.Collins, "An Empirical Relativist Programme in the Sociology of Scientific Knowledge" in Karin Knorr-Cetina and Mike Mulkay, *Science Observed. Perspectives on the Social Study of Science* (London: Sage Publications, 1983).

20 Karin Knorr-Cetina and Mulkay, eds., *Science Observed*; Mike Lynch and Steve Woolgar, "Introduction: Sociological Orientations to Representational Practice in Science" in *Representation and Scientific Practice* (Cambridge, Ma.: MIT Press, 1990).

21 See Harold Garfinkel, *Studies in Ethnomethodology* (Englewood Cliffs: Prentice-Hall,1967).

22 For some previous publications, see Michael Lynch, *Art and Artifact in Laboratory Science: A Study of Shop Work and Shop Talk in a Research Laboratory* (London: Routledge and Kegan Paul, 1985); Karin Knorr-Cetina, *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science* (Oxford: Pergamon Press, 1981); Bruno Latour and Steve Woolgar, *Laboratory Life: The Construction of Scientific Facts* (Princeton: Princeton University Press, 1979); Latour, *Science in Action*; Sharon Traweek, *Beatimes and Lifetimes: The World of High-Energy Physics* (Cambridge: Harvard University Press, 1988).

23 See Steven Shapin, op.cit., 1982a; "Discipline and Bounding: The History and Sociology of Science as Seen through the Externalism-Internalism Debate", *History of Science*, Vol. 30, Part 4, No 90, Dec. 1982b, 333-369; Donald MacKenzie, *Inventing Accuracy: A Historical Sociology of Nuclear Missile Guidance* (Cambridge, Ma.: MIT Press, 1990); and *Knowing Machines: Essays on Technical Change* (Cambridge, Ma.: MIT Press, 1996).

24 See the contributions by Steve Woolgar, Mike Lynch, Michel Callon, and John Law in the *Social Studies of Science* special issue on laboratory studies, Vol. 12, No. 4, Nov. 1982.

25 Karin Knorr-Cetina, "Laboratory Studies: The Cultural Approach to the Study of Science" in Sheila Jasanoff et al., eds., *The Handbook of Science and Technology Studies* (London: Sage, 1995), 141. Latour and Bloor also refer to this reversal turning the anthropological gaze towards "home" or the modern world. See Latour, "Foreword", 2. rev. ed., *Laboratory Life: The Construction of Scientific Facts* (Princeton: Princeton University Press, 1986) and Bloor, *Knowledge and Social Imagery* (Chicago: University of Chicago Press, 1991 [1976], 3.

26 Bruno Latour, "Give me a laboratory and I will raise the world" in K. Knorr-Cetina and Mulkey eds., *Science Observed.*

27 One of the works at the heart of the conflict was Arthur Jensen's research on variations in intelligence among human populations and between various social and ethnic groups, published in *Genetics and Education* (London: Methuen, 1972). Jensen's research was discussed in Barry Barnes' *Scientific Knowledge and Sociological Theory* (London: Routledge and Kegan Paul, 1974), in which Barnes came to the conclusion that Jensen's work was closer to normal scientific practice than the critique against it, and that the powerful social interests within and behind the critique lie more strikingly "outside of science" than those underlying Jensen's work. This interpretation in Barnes has since been used by the Radical Science Movement as a worst case example of the nihilistic politics found in social constructivist texts.

28 Maureen McNeil, "Science's Narcissism: Sociology of Knowledge as a Methodology for Explaining the Form and Content of Scientific Knowledge", *Radical Science Journal*, Vol. 6-7, 160. This controversy is discussed in V.Enebakk, *Mellom de to kulturer*, 339.

29 This critique was also formulated within SSK. See e.g. Paul Tibbetts, "Representation and the realist-constructivist controversy" and Mike Lynch and Steve Woolgar, "Introduction: Sociological Orientations to *Representational Practice in Science*" in Mike Lynch and Steve Woolgar eds. *Representation in Scientific Practice* (Cambridge, Ma.: MIT Press, 1990).

30 See e.g. Steve Woolgar, ed., *Knowledge and Reflexivity: New Frontiers in the Sociology of Knowledge* (London: Sage, 1988).
31 See e.g. the articles by Nancy Hartsock and Dorothy Smith in Sandra Harding, ed., *Feminism and Methodology* (Bloomington: Indiana University Press,1987) and Hilary Rose, "Feminist Standpoints on Science and Technology" in Ewa Gunnarsson and Lena Trojer, eds., *Feminist Voices on Gender, Technology and Ethics* (Luleå: Centre for Women's Studies at Luleå University of Technology, 1994).
32 See Sandra Harding, *The Science Question in Feminism* (Milton Keynes: Open University Press, 1986) and Harding, *Feminism and Methodology*.
33 See e.g. the articles in Patricia Hynes, ed., *Reconstructing Babylon. Women and Technology* (London: Earthscan Publishing, 1989).
34 It is a slight paradox that these feminist critics led women away from the study of science and technology instead of toward it. On the one hand, there was a tendency to say that science and technology is the enemy – infused with masculine, control-oriented thinking, and consequently women should not study science and technology. On the other hand, for female researchers who wanted to study society from the perspective of women's experiences and with women as the focus, there was little to be gained by studying science and technology – simply because there were no women in the field! Neither was the experiential world of women understood as being linked to science and technology. As Anne-Jorunn Berg said, femaleness, or femininity, is often produced through an active deconnection from technology rather than a connection with it. See Anne-Jorunn Berg and Merete Lie, "Feminism and Constructivism: Do Artifacts Have Gender?" in *Science, Technology & Human Values*, vol. 20, 3, Summer 1995, and Berg, "Digital Feminism", *STS Report*, vol. no. 28, Trondheim, NTNU, 1996.
35 This has been developed in a number of works, including 1986 op.cit., 1987 op.cit., and *Whose science? Whose Knowledge?* (New York: Cornell University Press, 1989).
36 Harding, *Feminism and Methodology.*
37 Examples of this body of work include Cynthia Cockburn, *Brothers: Male Dominance and Technological Change*, (London: Pluto Press, 1983) and Cockburn, *Machinery of Dominance: Women, Men and Technical Know-How*, (London: Pluto Press, 1985); Wendy Faulkner and E. Arnold, eds., *Smothered by Invention: Technology in Women's Lives* (London: Pluto Press, 1985); Juliet Webster, *Office Automation: The Secretarial Labour Process and Women's Work in Britain* (Hemel Hempstead: Harvester Wheatsheaf, 1990); Merete Lie and Bente Rasmussen,"Kan 'kontordamene' automatiseres?", Sintef-IFIM, Trondheim, 1983; Merete Lie et al., eds., *I menns bilde. Kvinner, teknologi og arbeid* (Trondheim: Tapir, 1988).
38 Harry Braverman, *Labour and Monopoly Capital: The Degradation of Work in the Twentieth Century* (New York: Monthly Review Press, 1974).
39 R. Williams and D. Edge, "The Social Shaping of Technology: A Review of UK Research Concepts Findings, Programmes, and Centers" in T. Cronberg and K. H. Sørensen, eds.: *Similar Concerns, Different Styles? Technology Studies in Western Europe*, COST A4 Proceedings, European Commission, Luxembourg, p. 240.
40 David Noble, *Forces of Production: a social history of industrial production* (New York: Knopf, 1984).
41 Donald MacKenzie and Judy Wajcman, eds., *The Social Shaping of Technology* (Milton Keynes: Open University Press, 1985).
42 Ibid., Introductory essay, 8.

43 See e.g. Donald MacKenzie's study of missiles in MacKenzie, *Inventing Accuracy: A Historical Sociology of Nuclear Missile Guidance* (Cambridge: MIT Press, 1990). In his book MacKenzie demonstrates how military and political interests guided missile development.
44 For a history and analysis of these changes in feminist technology studies, see Berg and Lie, "Feminism and Constructivism: Do Artifacts Have Gender?" op.cit. For feminist studies that address these same conflicts, see Cynthia Cockburn and Susan Ormrod, *Gender and Technology in the Making* (London: Sage, 1993) and Cockburn and Ruza Fürst Dilic, eds., *Bringing Technology Home: Gender and Technology in a Changing Europe* (Buckingham: Open University Press, 1994).
45 Knut H. Sørensen, "A Sociotechnical Legacy? A Note on Trajectories and Traditions in Norwegian Research on Technology and Work" in Knut H. Sørensen, ed., *The Spectre of Participation. Technology and Work in a Welfare State* (Oslo: Scandinavian University Press, 1998), 1.
46 Wiebe Bijker, Trevor Pinch and Thomas P. Hughes, eds., *The Social Construction of Technological Systems: New Approaches in the Sociology and History of Technology* (Cambridge: MIT Press, 1987).
47 SCOT did not, however, problematize the social order in the same way as technology. The social groups and actors, equipped with interests, goals and a technological framework, were taken for granted. What constitutes a relevant social group, an actor, is also defined and stated beforehand. One important difference in relation to the British social shaping approach, with which SCOT shared many commonalities, was the setting aside of questions about power and society or the larger social context that technology was a part of. SCOT was different because its proponents asserted that they would not use the concept of power – or power structures, underlying social forces, a political-economic dynamic that limits opportunities to choose and that reproduces power, etc – as an explanation, but instead would focus on the opportunities that actually exist to act and make choices.
48 See Thomas P. Hughes, "The Evolution of Large Technological Systems" in Bijker et al., eds., *The Social Construction of Technological Systems.* Also see his large-scale work: Hughes, *Networks of Power: Electrification in Western Society, 1880-1930* (Baltimore: John Hopkins University Press, 1983).
49 Ruth Schwartz Cowan, "The Consumption Junction: A Proposal for Research Strategies in the Sociology of Technology" in Bijker et al., *The social construction of technological systems,* 263.
50 See for instance S. Jasanoff, eds.: *States of Knowledge. The Co-production of Science and Sosial Order* (London: Routledge 2004).
51 Steve Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle and the Experimental Life* (Princeton: Princeton University Press, 1985).
52 John Law, ed., *Power, Action and Belief: A New Sociology of Knowledge?* (London: Routledge and Kegan Paul, 1986).
53 John Law, "Editor's introduction: Power/knowledge and the dissolution of the sociology of knowledge" in Law, *Power, Action and Belief*, 3.
54 Ibid.
55 See the interview in this anthology with Maureen McNeil and John Law on the concept of power in SSK. For a discussion of Foucault's concept of power, see Colin Gordon, ed., *Power/Knowledge: Selected Interviews and Other Writings 1972–1977* (Brighton: Pantheon, 1980).
56 Bruno Latour, "Give me a laboratory and I will raise the world". Also see Latour, *The Pasteurization of France* (Cambridge: Harvard University Press, 1988 [1984]). Andrew

Pickering makes similar remarks in Pickering, ed., *Science as Practice and Culture* (Chicago: University of Chicago Press, 1992, 361).

57 Donna Haraway, *Modest_Witness*, part 2, chapter 1.

58 Donna Haraway, "A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century" in *Simians, Cyborgs, and Women. The Reinvention of Women* (London: Free Association Books, 1991). First published in *Socialist Review*, 1985. The cyborg literature has grown enormously in recent years, but for an introduction to cyborg literature see Chris Hables Gray et al., *The Cyborg Handbook* (New York: Routledge, 1995) and for an introduction and discussion of the cyborg concept in Norwegian, see Kristin Asdal, Anne-Jorunn Berg, Brita Brenna, Ingunn Moser, Linda Rustad: *Betatt av viten, Bruksanvisninger til Donna Haraway* (Oslo: Spartacus,1998).

59 While in the "good old days" the representatives of ANT were perhaps more concerned with how the networks of connections both gave things stability and defined their relative "size", power and significance, they have gradually become more interested in how things can undergo continual change and at the same time maintain a degree of continuity which makes them recognizable. But to be able to see and describe these processes, topographical metaphors other than those based on regions or networks are needed. Annemarie Mol and John Law have suggested fluidity as an alternative metaphor for such a project. See Mol and Law, "Regions, Networks and Fluids: Anaemia and Social Topology" in *Social Studies of Science*, vol. 24, 1994.

60 See e.g. Bruno Latour, "On Actor-network-theory. A few clarifications" in *Soziale Welt*, 1997, and "On recalling ANT" in John Law and John Hassard, eds., *Actor Network Theory and After* (Oxford: Blackwell Publishers, 1999).

61 Adele Clarke and Joan Fujimura, *The Right Tools for the Job. At Work in Twentieth Century Life Sciences* (Princeton: Princeton University Press, 1992) and Joan Fujimura *Crafting Science: A Sociohistory of the Quest for the Genetics of Cancer* (Cambridge, Ma.: Harvard University Press, 1996).

62 Susan Leigh Star, here.

63 Donna Haraway, "Modest Witness: Feminist Diffractions in Science Studies" in Peter Galison and David J. Stamp eds., *The Disunity of the Sciences: Boundaries, Contexts, and Power* (Stanford, Cal.: Stanford University Press, 1996).

64 Donna Haraway, here.

65 See for instance Sharon Traweek, *Beamtimes and Lifetimes. The World of High Energy Physicists* (Cambridge, Ma.: Harvard University Press, 1988); Emily Martin, *Flexible Bodies: the role of immunity in American Culture from the days of polio to the age of AIDS* (Boston: Beacon Press, 1994); Donna Haraway op.cit., 1992, Deborah Heath, here, John Law "On the subject of the object: Narrative, Technology, and Interpellation", *Configurations*, Vol. 8, No.1, 2000, 1-29, and "Machinic Pleasures and Interpellations" in Brita Brenna, John Law and Ingunn Moser eds., *Machines, Agency and Desire*, (Oslo: TMV Report, University of Oslo, 1998); and Baukje Prins, "The ethics of hybrid subjects: feminist constructivism according to Donna Haraway", *Science, Technology & Human Values*, Vol. 20, No.3, 1995, 252-267.

66 Two examples of such interventions in philosophy are Annemarie Mol, *The Body Multiple* (Durham: Duke University Press, 2002) and Bruno Latour, *Politics of Nature* (Cambridge: Harvard University Press, 2004).

67 The concept of enactment is taken from Mol's works. For an introduction and discussion, see Mol *The Body Multiple*.

68 For an introduction to this concept, see Annemarie Mol, "Ontological Politics" in Law and Hassard, eds., *Actor Network Theory and After.* Also see John Law, *After Method*, (London: Routledge, 2004).
69 See e.g. Madelaine Akrich, "The De-scription of Technical Objects" in Wiebe Bijker and John Law, eds., *Shaping Technology/Building Society* (Cambridge: MIT Press, 1992).
70 Emily Martin, *Flexible Bodies.*
71 This focus on the tension and ambivalence that lie at the core of technoscientific objects and practices, and how these constitute these same objects and practices, rather than being a sign of unsuccessful constructions and processes, processes in which one has not succeeded in making things clear, definite and stable, recurs throughout Singleton's works. See e.g. her "Feminism, Sociology of Scientific Knowledge and Post-modernism: Politics, Theory and me", *Social Studies of Science,* Vol. 26, 445-468 and "Stabilizing Instabilities: the role of the laboratory in the United Kingdom Cervical Screening Programme" in Marc Berg and Annemarie Mol eds., *Differences in Medicine: Unravelling Practices, Techniques and Bodies* (Durham: Duke University Press, 1998).
72 Also see Deborah Heath, "Locating Genetic Knowledge: Picturing Marfan Syndrome and Its Travelling Constituencies" in *Science, Technology & Human Values*, vol. 23, No. 1, 1998.
73 See e.g. Alan Petersen and Deborah Lupton, *The New Public Health: Health and Self in the Age of Risk* (London: Sage, 1996).
74 The concept of immutable mobile was introduced in Latour, *Science in Action.*
75 For a further investigation and analysis of subjectivity, ability and disability in bodily and material relationships, see Ingunn Moser, *Road Traffic Accidents: The Ordering of Subjects, Bodies and Disability* (Oslo: Unipub, 2003).
76 Also see Bruno Latour, "Arrachement ou attachement á la nature" in *Ecologie Politique,* 15, 1993,15-26, which is a criticism of the work by French philosopher Luc Ferry, and Latour, "Moderniser ou écologiser. A la recherche de la Septiéme Cité" in *Ecologie Politique* 13, 1995, 5-27. The article we are publishing in this volume is a more recent version of this article.
77 These two points have been developed further in Kristin Asdal, "Returning the Kingdom to the King. A Post-constructivist Response to the Critique of Positivism" in *Acta Sociologica*, vol. 48 (3): 253-261 (2005) and in Asdal, "The Problematic Nature of Nature. The Post-constructivist Challenge to Environmental History" in *History and Theory. Studies in the Philosophy of History*, vol. 42 (4), 2003, 60-75.
78 Latour, *Politics of nature*, 68.
79 Ibid, 52.
80 Donna Haraway, "Otherworldly Conversations, Terran Topics, Local Terms", *Science as Culture*, Vol. 3, part 1, No. 14, 1992.
81 M.Callon and B.Latour, "Don't throw the baby out with the Bath school! A reply to Collins and Yearley" in Pickering, *Science as Practice and Culture,* 361.
82 Bruno Latour, *Politics of Nature*, Introduction and chapter 1.
83 Donald MacKenzie and Yuval Millo, "Constructing a Market, Performing Theory: The Historical Sociology of a Financial Derivatives Exchange" in *American Journal of Sociology,* no. 109, 2003, 107-145; Donald MacKenzie, "Long-Term Capital Management and the Sociology of Arbitrage" in *Economy and Society*, no. 32, 2003, 349-380; Fabien Muniesa, "Un robot walrasien – cotation électronique et justesse de la découverte des prix" in *Politix*, no. 52, vol. 13, 2000; and Vincent-Antonin Lepinay, "Les trolls sont-ils incompétents? Enquêtes sur les financiers amateurs" in *Politix*, no. 52, vol. 13, 2000.

84 Andrew Barry and Don Slater, "Introduction: the Technological Economy" in *Economy and Society*, vol.31, no. 2, May 2002, 175-193.
85 Michel Callon, "Introduction: The Embeddedness of Economic Markets in Economics" in *The Laws of the Markets* (Oxford: Blackwell Publishers, 1998).
86 Ibid.
87 See Graham Burchell, Colin Gordon and Peter Miller eds., *The Foucault Effect. Studies in Governmentality. With Two Lectures by and an Interview with Michel Foucault* (Chicago: University of Chicago Press, 1991).
88 Andrew Barry, *Political Machines: Governing a Technological Society* (London: Athlone Press, 2001).
89 Ibid, 174.
90 See e.g. Michel Callon, "An Essay on Framing and Overflowing: Economic Externalities Revisited by Sociology" in Callon, ed., *The Laws of the Markets* (Oxford: Blackwell Publishers, 1998); Andrew Barry, "The Anti-political Economy" in *Economy and Society,* nr. 2, vol. 31, 2002.
91 Miller et al 1994, 121, referred to in Andrew Barry, here.
92 This is developed in K. Asdal: *Politikkens teknologier. Produksjoner av regjerlig natur*. [*The technologies of politics. Productions of governable nature*](Oslo: Unipub 2004)

Part 1: Networks and Critiques

Michel Callon

Some Elements of a Sociology of Translation

Domestication of the Scallops and the Fishermen of St. Brieuc Bay*

Scallops and fishermen

Highly appreciated by French consumers, scallops have only been systematically exploited for the last twenty years. In a short period they have become a highly sought-after gourmandise to the extent that during the Christmas season, although prices are spectacularly high, sales increase considerably. They are fished in France at three locations: along the coast of Normandy, in the roadstead of Brest, and in St. Brieuc Bay. There are several different species of scallops. Certain ones, as in Brest, are coralled all year round. However, at St. Brieuc the scallops lose their coral during spring and summer. These characteristics are commercially important because, according to the convictions of the fishermen, the consumers prefer coralled scallops to those which are not.

Throughout the 1970s, the stock at Brest progressively dwindled due to the combined effects of marine predators (starfish), a series of hard winters which lowered the general temperature of the water, and the fishermen who, wanting to satisfy the insatiable consumers, dredged the ocean floor for scallops all year round without allowing time to reproduce. The production of St. Brieuc had also been falling off

* From John Law (ed.) *Power, Action and Belief. A new Sociology of Knowledge?* © *Sociological Review Monograph* 32, 1986. Reproduced with the kind permission of *Sociological Review Monograph*.

steadily during the same period, but fortunately the Bay was able to avoid the disaster. There were fewer predators and the consumer's preference for coralled scallops obliged the fishermen to stay on land for half the year. As a result of these factors, the reproduction of the stock decreased less in St. Brieuc Bay than at Brest.[1]

The object of this study is to examine the progressive development of new social relationships through constitution of a "scientific knowledge" that occurred during the 1970s.[2] The story starts at a conference held at Brest in 1972. Scientists and the representatives of the fishing community assembled to examine the possibility of increasing the production of scallops by controlling their cultivation. The discussions were grouped around the following three elements.

1. Three researchers who are members of the Centre National d'Exploitation des Oceans (CNEXO)[3] have discovered during a voyage to Japan that scallops are being intensively cultivated there. The technique is the following: the larvae are anchored to collectors immersed in the sea where they are sheltered from predators as they grow. When the shellfish attain a large enough size, they are "sown" along the ocean bed where they can safely develop for two or three years before being harvested. According to the researcher' accounts of their trip this technique made it possible to increase the level of existing stocks. All the different contributions of the conference were focused around this report.
2. There is a total lack of information concerning the mechanisms behind the development of scallops. The scientific community has never been very interested in this subject. In addition, because the intensive exploitation of scallops had begun only recently, the fishermen knew nothing about the earlier stages of scallop development. The fishermen had only seen adult scallops in their dredges. At the beginning of the 1970s no direct relationship existed between larvae and fishermen. As we will see, the link was progressively established through the action of the researchers.
3. Fishing had been carried out at such intensive levels that the consequences of this exploitation were beginning to be visible in St. Brieuc Bay. Brest had practically been crossed off the map. The production at St. Brieuc had been steadily decreasing. The scallop industry of St. Brieuc had been particularly lucrative and the fishermen's representatives were beginning to worry about the dwindling stock. The decline of the scallop population seemed inevitable and many feared that the catastrophe at Brest would also occur at St. Brieuc.

This was the chosen starting point for this paper. Ten years later, a "scientific" knowledge was produced and certified; a social group was formed (the fishermen of St. Brieuc Bay) through the privileges that this group was able to institute and preserve; and a community of specialists was organized in order to study the scallops and

promote their cultivation. Basing my analysis on what I propose to call a *sociology of translation*, I will now retrace some part of this evolution and see the simultaneous production of knowledge and construction of a network of relationships in which social and natural entities mutually control who they are and what they want.

The four moments of translation

To examine this development, we have chosen to follow an actor through his construction-deconstruction of nature and society. Our starting point here consists of the three researchers who returned from their voyage to the Far East. Where they came from and why they act is of little importance at this point of the investigation. They are the primum movens of the story analyzed here. We will accompany them during their first attempt at domestication. This endeavour consists of four moments which can in reality overlap. These moments constitute the different phases of a general process called translation, during which the identity of actors, the possibility of interaction, and the margins of manoeuvre are negotiated and delimited.

The problematization, or how to become indispensable

Once they returned home, the researchers wrote a series of reports and articles in which they disclosed the impressions of their trip and the future projects they wished to launch. With their own eyes they had seen the larvae anchor themselves to collectors and grow undisturbed while sheltered from predators. Their question was simple: Is this experience transposable to France and, more particularly, to the Bay of St. Brieuc? No clear answer can be given because the researchers know that the *briochine (Pecten maximus)* is different from the species raised in Japanese waters *(Pecten patinopecten yessoeusis)*. Since no one contradicts the researchers' affirmations, we consider their statements are held to be uncontestable. Thus the aquaculture of scallops at St. Brieuc raises a problem. No answer can be given to the following crucial question: Does *Pecten maximus* anchor itself during the first moments of its existence? Other questions which are just as important accompany the first. When does the metamorphosis of the larvae occur? At what rate do the young grow? Can enough larvae be anchored to the collectors in order to justify the project of restocking the bay?

But in their different written documents the three researchers did not limit themselves to the simple formulation of the above questions. They determined a set of actors[4] and defined their identities in such a way as to establish themselves an obligatory passage point in the network of relationships they were building.

This double movement, which renders them indispensable in the network, is what I call *problematization*.

The interdefinition of the actors. The questions formed by the three researchers and the commentaries that they provided bring three other actors directly into the story: the scallops *(Pecten maximus)*; the fishermen of St. Brieuc Bay; and the scientific colleagues. The definitions of these actors, as they are presented in the scientists' report, are quite rough. However it is sufficiently precise to explain how these actors are necessarily concerned by the different questions which are formulated. These definitions as given by the three researchers themselves can be synthesized in the following manner.

1. *The fishermen of St. Brieuc*: they fish scallops to the last shellfish without worrying about the stock; they make large profits; if they do not slow down their zealous efforts, they will ruin themselves. However, these fishermen are considered to be aware of their long-term economic interests and, consequently, seem to be interested in the project of restocking the bay and approve of the studies which have been launched to achieve this plan. No other hypothesis is made about their identity. The three researchers make no comment about a united social group. They define an average fisherman as a base unit of a community which consists of interchangeable elements.
2. *Scientific colleagues*: paritcipating in conferences or cited in different publications, they know nothing about scallops in general nor about those of St. Brieuc in particular. In addition, they are unable to answer the question about the way in which these shellfish anchor themselves. They are considered to be interested in advancing the knowledge which has been proposed. This strategy consists of studying the scallops in situ rather than in experimental tanks.
3. *The scallops of St. Brieuc:* a particular species *(Pecten maximus)* which everyone agrees is coralled only six months of the year. They have only been seen as adults, at the moment they are dredged from the sea. The question which is asked by the three researchers supposes that they can anchor themselves and will "accept" a shelter that will enable them to proliferate and survive.[5]

Of course, and without this the problematization would lack any support, the three researchers also reveal what they themselves are and what they want. They present themselves as "basic" researchers who, impressed by the foreign achievement, seek to advance the available knowledge concerning a species which had not been thoroughly studied before. By undertaking this investigation, these researchers hope to render the fishermen's life easier and increase the stock of scallops of St. Brieuc Bay.

This example shows that the problematization, rather than being a reduction of the investigation to a simple formulation, touches on elements, at least partially

and locally, which are parts of both the social and the natural worlds. A single question – Does *Pecten maximus* anchor? – is enough to involve a whole series of actors by establishing their identities and the links between them.[6]

The Definition of Obligatory Passage Points (OPP). The three researchers do not limit themselves simply to identifying a few actors. They also show that the interest of these actors lie in admitting the proposed research program. The argument which they develop in their paper is constantly repeated: if the scallops want to survive (no matter what mechanisms explain this impulse), if their scientific colleagues hope to advance knowledge on this subject (whatever their motivations may be), if the fishermen hope to preserve their long-term economic interests (whatever their reasons), then they must (1) know the answer to the question, How do scallops anchor?, and (2) recognize that their alliance around this question can benefit each of them.

Figure 5-1 shows that the problematization possesses certain dynamic properties: it indicates the movements and detours that must be accepted as well as the alliances that must be forged. The scallops, the fishermen, and the scientific colleagues are fettered: they cannot attain what they want by themselves. Their road is blocked by a series of obstacles-problems. The future of *Pecten maximus* is threatened perpetually by all sorts of predators always ready to exterminate them; the fishermen, greedy for short-term profits, risk their long-term survival; scientific colleagues who want to develop knowledge are obliged to admit the lack of preliminary and indispensable observations of scallops in situ. As for the three researchers, their entire project turns around the question of the anchorage of *Pecten maximus*. For these actors the alternative is clear; either one changes direction or one recognizes the need to study and obtain results about the way in which larvae anchor themselves.[7]

As Figure 5-2 shows, the problematization describes a system of alliances, or associations, between entities, thereby defining the identity and what they "want". In this case, a holy alliance must be formed in order to induce the scallops of St. Brieuc Bay to multiply.

The devices of interessement, or how the allies are locked into place. We have emphasized the hypothetical aspect of the problematization. On paper, or more exactly, in the reports and articles presented by the three researchers, the identified groups have real existence. But reality is a process. Like a chemical body, it passes through successive states. At this point in our story, the entities identified and the relationships envisaged have not yet

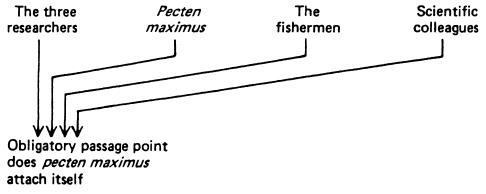

Figure 5-1

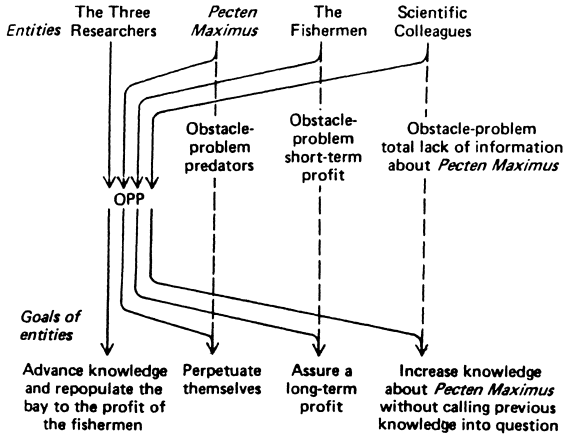

Figure 5-2

been tested. The scene is set for a series of trials of strength whose outcome will determine the solidity of our researchers' problematization.

The devices of interssement, or how the allies are locked into place. Each entity enlisted by the problematization can submit to being integrated into the initial plan, or inversely, refuse the transaction by defining its identity, its goals, projects, orientations, motivations, or interests in another manner. In fact the situation is never so clear cut. As the phrase of problematization has shown, it would be absurd for the observer to describe entities as formulating their identity and goals in a totally independent manner. They are formed and are adjusted only during action.

Interessement is the group of actions by which an entity (here the three researchers) attempts to impose and stabilize the other actors it defines through its problematization. Different devices are used to implement these actions. Why talk of *interessement*? The etymology of this word justifies its choice. To be interested is to be in between (*inter-esse*), to be interposed. But between what? Let us return to the three researchers. During their problematization they join forces with the scallops,

the fishermen, and their colleagues in order to attain a certain goal. In so doing they carefully define the identity, the goals or the inclinations of their allies. But these allies are tentatively implicated in the problematizations of the actors. Their identities are consequently defined in other competitive ways. It is in this sense that one should understand *interessement*. To interest other actors is to build devices which can be placed between them and all other entities who want to define their identities otherwise. A interests B by cutting or weakening all the links between B and the invisible (or at times quite visible) group of other entities C, D, E, and so on, who may want to link themselves to B (see Figure 5-3).

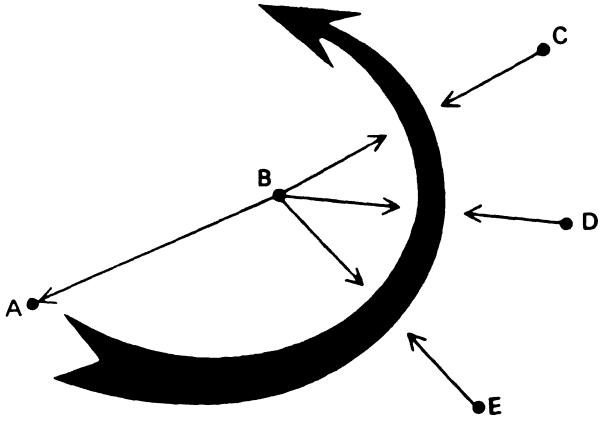

Figure 5-3

The properties and identity of B (whether it is a matter of scallops, scientific colleagues, or fishermen) are consolidated and/or redefined during the process of *interessement*. B is a "result" of the association which links it to A. This link disassociates B from all the C, D, and E's (if they exist) that attempt to give it another definition. We call this elementary relationship, which begins to shape and consolidate the social link, the triangle of *interessement*.

The range of possible strategies and mechanisms that are adopted to bring about these interruptions is unlimited: anything goes. It may be pure and simple force if the links between B, C, and D are firmly established. It may be seduction or a simple solicitation if B is already close to the problematization of A. Except in extremely rare cases when the shaping of B coincides perfectly with the proposed problematization, the identity and "geometry" of the interested entities are modified all along the process of *interessement*. We can illustrate these points by the story of the domestication of scallops.

The domestication of scallops strikingly illustrates the general *interessement* mechanisms. The three researchers are inspired by a technique that had been invented by the Japanese. Towlines made up of collectors are immersed in the sea. Each collector carries a fine-netted bag containing a support for the anchorage of the larvae. These bags make it possible to assure the free flow of water and larvae while preventing the young scallops from escaping. The device also prevents predators from attacking the larvae. In this way the larvae are protected during the period when they have no defence: that is, when they have no shell. [8] The collectors are mounted in a series on the line. The ends of the two lines are attached to floats that are kept in place by an anchorage system.

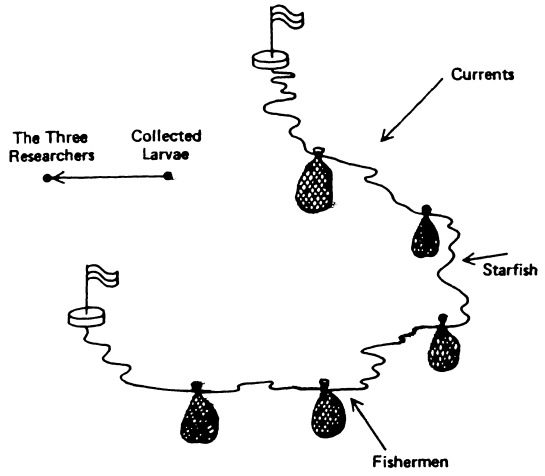

Figure 5-4

The towline and its collectors constitute an archetype of the *interessement* device. The larvae are "extracted" from their context. They are protected from predators (starfish) which want to attack and exterminate them, from currents that carry them away where they perish, and from the fisherman's dredge which damages them. They are (physically) disassociated from all the actors who threaten them (see Figure 5-4).

In addition, these *interessement* devices extend and materialize the hypothesis made by the researchers concerning the scallops and the larvae: (1) the defenseless larvae are constantly threatened by predators; (2) the larvae can anchor; (3) the Japanese experience can be transposed to France because St. Brieuc's scallops are not fundamentally different from their Japanese cousins. The collectors would lose all effectiveness if the larvae "refused" to anchor, to grow, to metamorphose, and to proliferate in (relative) captivity. The *interessement*, if successful, confirms (more or

less completely) the validity of the problematization and the alliance it implies. In this particular case study, the problematization is eventually refuted.

Although the collectors are necessary for the *interessement* of the scallops and their larvae, this type of "machination" proves to be superfluous for the *interessement* of the fishermen and the scientific colleagues. In addition, the three researchers do not intend to convince the first group as a whole. It is rather the representatives of professional organizations who are the targets of the researchers' solicitation. The three researchers multiply their meetings and debates in order to explain to the fishermen the reasons behind the extinction of the scallops. The researchers draw up and comment upon curves which "indisputably" show the incredible decline of the stock of scallops in St. Brieuc Bay. They also emphatically present the "spectacular" results of the Japanese. The scientific colleagues are solicited during conferences and through publications. The argumentation is always the same: an exhaustive review of the literature shows that nothing is known about scallops. This lack of knowledge is regrettable because the survival of a species which has increasing economic importance is at stake (in France at least).[9]

For the case of the scallops (like the fishermen and the scientific colleagues) the *interessement* is founded on a certain interpretation of what the yet-to-be-enrolled actors are and want as well as with which entities these actors are associated. The devices of *interessement* create a favorable balance of power: for the first group, these devices are the towlines immersed in St. Brieuc Bay; for the second group, they are texts and conversations which lure the concerned actors to follow the three researchers' project. For all groups involved, *the interessement* helps corner the entities to be enrolled. In addition, it attempts to interrupt all potential competing associations and to construct a system of alliances. Social structures comprising both social and natural entities are shaped and consolidated.

How to define and coordinate the roles: enrollment

No matter how constraining the trapping device, no matter how convincing the argument, success is never assured. In other words, the device of *interessement* does not necessarily lead to alliances, that is, to actual enrollment. The issue here is to transform a question into a series of statements which are more certain: *Pecten maximus* does anchor; the fishermen want to restock the bay.

Why speak of *enrollment*? In using this term, we are not resorting to a functionalist or culturalist sociology which defines society as an entity made up of roles and holders of roles. Enrollment does not imply, nor does it exclude, preestablished roles. It designates the device by which a set of interrelated roles is defined and attributed to actors who accept them. *Interessement* achieves enrollment if it

is successful. To describe enrollment is thus to describe the group of multilateral negotiations, trials of strenght, and tricks that accompany the *interessement* and enable them to succeed.

If the scallops are to be enrolled, they must first be willing to anchor themselves to the collectors. But this anchorage is not easy to achieve. In fact the three researchers will have to lead their longest and most difficult negotiations with the scallops. Like in a fairy tale, there are many enemy forces which attempt to thwart the researchers' project and divert the larvae before they are captured. First the currents: of the six towlines, four functioned correctly before different variables intervened. It appears that the larvae anchor themselves better in the innermost parts of the bay where the tidal currents are the weakest.[10]

To negotiate with the scallops is to first negotiate with the currents because the turbulences caused by the tide are an obstacle to the anchorage. But the researchers must deal with other elements besides the currents. All sorts of parasites trouble the experiment and prestent obstacles to the capture of the larvae.

> A large part of the variation is due to the way in which parasites are attracted. We have had many visitors who provoked accidents, displaced lines, entangled collectors. This immediately caused negative results. It seems that the scallops are extremely sensitive to all manipulations (displaced lines, collectors which rub against each other, etc.) and react by detaching themselves from their supports.[11]

The list goes on. A veritable battle is being fought. Currents and visitors are only some of the forces which are opposed to the alliances which the researchers wish to forge with the scallops. [12] In the triangle A-B-C which we spoke of earlier, C, the party to be excluded (wheter it is called currents or starfish) does not surrender easily. C (the starfish) has the possibility of interrupting the relationships between A (the researchers) and B (the larvae). C does this by also interesting B (the larvae) which are coveted by all.

The census done by the researcher also shows that the anchorages are more numerous between 5 meters above the sea floor and the sea floor itself. This is perhaps due to the depth as well as to the specific behaviour of the scallops when they anchor: the larvae lets itself sink and anchors itself to the first obstacle that stops its descent.[13]

The towline, an *interessement* device, reveals the levels of anchorage to the observer. The hypotheses and the interpretations of the researchers are nothing but a program of negotiations: Larvae, should we search for you at the bottom of the bay or should we wait for you on your way down in order to trap you as you sink?

This is not all. The researchers are ready to make any kind of concession in order to lure the larvae into their trap. What sort of substances do the larvae prefer to anchor themselves on? Another series of transactions is necessary to answer the question.

> It was noted that the development of the scallops was slower with the collectors made of straw, broom, or vegetable horsehair. These types of supports are too compressed and prevent water from circulating correctly through the collector.[14]

Thus a modus vivendi is progressively arranged. If all these conditions are united then the larvae will anchor themselves in a significant manner. But what does the adjective "significant" signify? To answer this question, we must introduce, as in the tripartite Vietnam conferences held in Paris, the second actor with whom the three researchers must negotiate: scientific colleagues.

In the beginning a general consensus existed: the idea that scallops anchor was not discussed.[15] However, the first results were not accepted without preliminary negotiations. The proposition: "*Pecten maximus* anchors itself in its larvae state" is an affirmation which the experiments performed at St. Brieuc eventually called into question. No anchorages were observed on certain collectors and the number of larvae which anchored on the collectors never attained the Japanese levels. At what number can it be confirmed and accepted that scallops, in general, do anchor themselves? The three researchers are prepared for this objection because in their first communication they confirm that the observed anchorages did not occur accidentally: it is here that we see the importance of the negotiations which were carried out with the scallops in order to increase the *interessement* and of the acts of enticement which were used to retain the larvae (horsehair rather than nylon, and so on). With scientific colleagues, the transactions were simple: the discussion of the results shows that they were prepared to believe in the principle of anchorage and that they judged the experiment to be convincing. The only condition that the colleagues posed is that the existence of previous work be recognized, work that had predicted, albeit imperfectly, the scallops' capacity to anchor. [16] It is at this price that the number of anchorages claimed by the researchers will be judged as sufficient. Our three researchers accept, after ironically noting that all bonafide discoveries miraculously unveil precursors, who had been previously ignored.[17]

Transactions with the fishermen, or rather, with their representatives, are nonexistent. They watch like amused spectators and wait for the final verdict. They are prepared simply to accept the conclusions drawn by the specialists. Their consent is obtained (in advance) without any discussion.

Therefore for the most part, the negotiation is carried between three parties since the fourth partner was enrolled without any resistance. This example illustrates the different possible ways in which the actors are enrolled: physical violence (against the predators), seduction, transaction, and consent without discussion. This example mainly shows that the definition and distribution of roles (the scallops which anchor themselves, the fishermen who are persuaded that the collectors could help restock the bay, the colleagues who believe in the anchorage) are a result of multilateral negotiations during which the identity of the actors is determined and tested.

The mobilization of allies: are the spokesmen representative? Who speaks in the name of whom? Who represents whom? These crucial questions must be answered if the project led by the researchers is to succeed. This is because, as with the description of *interessement* and enrollment, only a few rare individuals are involved, whether these be scallops, fishermen or scientific colleagues.

Does *Pecten maximus* really anchor itself? Yes, according to the colleagues, the anchorages which were observed are not accidental. Yet, though everyone believes that they are not accidental, they acknowledge that they are limited in number. A few larvae are considered to be the official representatives of an anonymous mass of scallops which silently and elusively lurk on the ocean floor. The three researchers negotiate the *interessement* of the scallops through a handful of larvae which represent all the uncountable others that evade captivity.

The masses at no time contradict the scallops which anchor themselves. That which is true for a few is true for the whole of the population. When the CBI negotiates with union delegates they consider the latter to be representatives of all the workers. This small number of individuals speaks in the name of the others. In one case, the epistemologists speak of induction, in another, political scientists use the notion of spokesman. The question however is the same. Will the masses (employers, workers, scallops) follow their representatives?

Representation is also an issue in the researchers' transactions with the colleagues and fishermen. Properly speaking, it is not scientific community which is convinced but a few colleagues who read the publications and attend the conference. It is not the fishermen but their official representatives who give the green light to the experiments and support the project of restocking the bay. In both cases, a few individuals have been interested in the name of the masses they represent, or claim to represent.

The three researchers have formed a relationship with only a few representatives – whether they be larvae on a collector, professional delegates, or scientific colleagues participating at a colloquium. However it may seem that the situations are not comparable. The delegates and colleagues speak for themselves while the

larvae are silent. On the one hand, they are real spokesmen, but on the other, the anchored larvae are simply representatives. However this difference disappears on closer analysis.

Let us return to the scallops. The larvae which anchored themselves on the collector are "equal" to the scallops of St. Brieuc Bay. They themselves express nothing; however, they end up having, like the fishermen, an authentic spokesman. As we have seen, the negotiations between the scallops and the researchers revolve around one question: How many larvae can be trapped? The fact that this number should be retained as a principal subject of discussion is not a result of any absolute necessity. By counting the larvae, the three researchers wish to know what they can count on their negotiations with their colleagues and the fishermen. Their interlocutors pay particular attention to the number of anchorages: the first to be convinced of the generality of the observation; the latter to be convinced of the efficiency of the device. How many electors came forward to choose their representatives? How many larvae anchored themselves on the collectors? This is the only question of any importance in either case. The anchorage is equivalent to a vote and the counting of anchored larvae corresponds to the tallying of ballots.[18] When spokesmen for the fishing community are elected the procedure is the same. From the fishing community which is just as silent as the scallops in the bay, a few individuals come forward to slip their votes into the ballot boxes. The votes are counted and then divided between different candidates: the analysis of these results leads to the designation of the official spokesman. Where are the differences in the case of the larvae? The larvae anchor themselves and are counted; the three researchers register these numbers on sheets of paper, convert these figures into curves and tables which are then used in an article or paper. These results are analyzed and discussed during a conference and, if they are judged to be significant, three researchers are authorized to speak legetimately for the scallops of St. Brieuc Bay: *Pecten maximus* does in fact go through an anchorage stage.

The symmetry is perfect. A series of intermediaries and equivalences are put into place which lead to the designation of the spokesman. In the case of the fishermen, the chain is a bit longer. This is because the professional delegates stand between the tallying of the vote and the three researchers. However, the result is the same: both the fishermen and the scallops end up being represented by the three researchers who speak and act in their name. Although no vote is taken, the agreement of the scientific community is also based on the same type of general mechanism: the same cascade of intermediaries who little by little reduce the number of representative interlocutors. The few colleagues who attend the different conferences or seminars speak in the name of all researchers involved. [19] Once the

transaction is successfully accomplished, there are three individuals who, in the name of the specialists, speak in the name of the scallops and fishermen.

The schema below shows how entities as different as *Pecten maximus*, the fishermen of St. Brieuc Bay and the community of specialists are constructed by interposed spokesmen (see Figure 5-5).

Using the notion of spokesman for all the actors involved at different stages of the process of representation does not present any problem. To speak for others is to first silence those in whose name we speak. It is certainly very difficult to silence human beings in a definitive manner but it is more difficult to speak in the name of entities that do not possess an articulate language: this supposes the need for continuous adjustments and devices of *interessement* that are infinitely more sophisticated.[20]

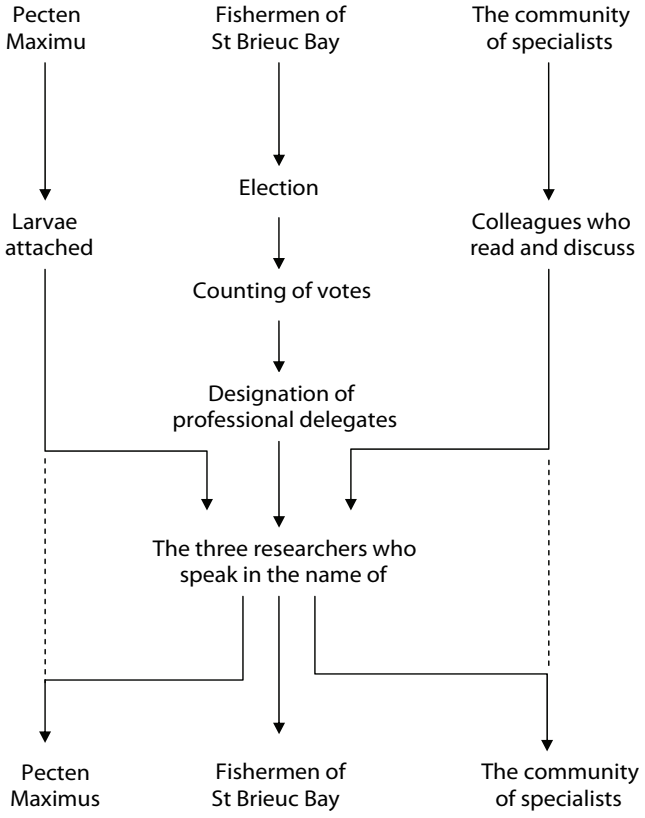

Figure 5-5

Three men have become influential and are listened to because they have become the "head" of several populations. They have mixed together learned experts,

unpolished fishermen, and savoury crustaceans. These chains of intermediaries which result in a sole and ultimate spokesman can be described as the progressive mobilization of actors who render the following propositions credible and indisputable by forming alliances and acting as a unit of force: "*Pecten maximus* anchors" and "the fishermen want to restock the bay". The notion of mobilization is perfectly adapted to the mechanisms that we have described. This is because this term emphasizes all the necessary displacements. To mobilize, as the word indicates, is to render entities mobile which were not so beforehand. At first, the scallops, fishermen, and specialists were actually all dispersed and not easily accessible. At the end, three researchers at Brest said what these entities are and want. Through the designation of the successive spokesmen and the settlement of a series of equivalencies, all these actors are first displaced and then reassembled at a certain place at a particular time. This mobilization or concentration has a definite physical reality which is materialized through a series of displacements.

The scallops are transformed into larvae, the larvae into numbers, the numbers into tables and curves which represent easily transportable, reproducible, and diffusable sheets of paper (Latour 1987). Instead of exhibiting the larvae and the towlines to their colleagues at Brest, the three researchers show graphic representations and present mathematical analysis. The scallops have been displaced. They are transported into the conference room through a series of transformations. The choice of each new intermediary, of each new representative must also meet a double requirement: it renders each new displacement easier and it establishes equivalences which result in the designation of the three researchers as spokesmen. It is the same for the fishermen transformed into voting ballots and then professional delegates whose previously recorded points of view are reported to Brest.

The obtained result is striking. A handful of researchers discuss a few diagrams and a few tables with numbers in a closed room. But these discussions commit uncountable populations of silent actors: scallops, fishermen, and specialists who are all represented at Brest by a few spokesmen. These diverse populations have been mobilized. That is, they have been displaced from their homes to a conference room. They participate, through interposed representatives, in the negotiations over the anchorage of *Pecten maximus* and over the interests of the fishermen. The enrollment is transformed into active support. The scallops and the fishermen are on the side of the three researchers in an amphitheatre at the Oceanographic Center of Brest one day in November 1974.

As this analysis shows, the groups or populations in whose name the spokesmen speak are elusive. The guarantor (or the referent) exists once the long chain of representatives has been put into place. It constitutes a result and not a starting point. Its consistency is strictly measured by the solidity of the equivalencies that have been

put into place and the fidelity of a few rare and dispersed intermediaries who negotiate their representativity and their identity. Of course, if the mobilization is successful, then: *Pecten maximus* exists as a species which anchors itself; the fishermen want the repopulation and are ready to support the experimental project; colleagues agree that the results obtained are valid. The social and natural "reality" is a result of the generalized negotiation about the representativity of the spokesmen. If consensus is achieved, the margins of maneuver of each entity will then be tightly delimited. The initial problematization defined a series of negotiable hypotheses on identity, relationships, and goals of the different actors. Now at the end of the four moments described, a constraining network of relationships or what I called elsewhere an actor-network (Callon 1986), has been built. But this consensus and the alliances which it implies can be contested at any moment. Translation becomes treason.

Dissidence

Betrayals and controversies

During recent years, sociologists have devoted numerous studies to controversies and have shown the important role they play in the dynamics of science and technology. Why and in what conditions do controversies occur? How are they ended? The proposed schema of analysis makes it possible to examine these two questions in the same way. At the same time, this schema maintains the symmetry between controversies which pertain to nature and those which pertain to society.

Is a spokesman or an intermediary representative? This is a practical and not a theoretical question. It is asked in the same manner for the scallops, the fishermen and the scientific colleagues. Controversy is all the manifestations by which the representativity of the spokesman is questioned, discussed, negotiated, rejected and so forth.

Let us start with the scallops. The first experiment or, if we use our vocabulary, act of *interessement* mobilizes them in the form of larvae anchored to collectors and in the form of diagrams discussed at Brest before a learned assembly. This group established a fact: *Pecten maximus* anchors itself when in the larval state. About a hundred larvae gathered in nets off the coast of St. Brieuc were enough to convince the scientists that they reflect the behavior of an uncountable number of their invisible and elusive brothers.

But is this movement likely to last? Will the scallops continue to anchor their larvae on the collectors generation after generation? This question is of crucial

importance to our three researchers. It concerns the future of the restocking of the bay, the future of the fishermen, and, in consequence, their own future. The years pass and things change. The repeated experiment results in a catastrophe. The researchers place their nets but the collectors remain hopelessly empty. In principle the larvae anchor, in practice they refuse to enter the collectors. The difficult negotiations which were successful the first time fail in the following years. Perhaps the anchorages were accidental! The multiplicity of hostile interventions (this at least is the interpretation of the researchers in their role of spokesman for the scallops), the temperature of the water layers, unexpected currents, all sorts of predators, epizooty, are used to explain why the *interessement* is being inefficient. The larvae detach themselves from the researchers' project and a crowd of other actors carry them away. The scallops become dissidents. The larvae which complied are betrayed by those they were though to represent. The situation is identical to that of the rank and file which greets the results of union negotiations with silent indignation: representativity is brought into question.[21]

This controversy over the representativity of the larvae which anchor themselves during the first year's experiments is joined by another: this time it is the fishermen. Their elected representatives had been enrolled in a long-term program aimed at restocking St. Brieuc Bay without a shadow of reservation and without a peep of doubt. In the two years following the first (and only) anchorages, the scallops hatched from the larvae "interested" by the collectors, after being regrouped at the bottom of the bay in an area protected by a concrete belt, are shamelessly fished, one Christmas Eve, by a horde of fishermen who could no longer resist the temptation of a miraculous catch. Brutally, and without a word, they disavowed their spokesmen and their long-term plans.

Faced with these silent mutinies of scallops and fishermen, the strategy of the three researchers begins to wobble. Is anchorage an obligatory passage point? Even scientific colleagues grow skeptical. The three researchers have now to deal with growing doubt on the part of their laboratory director and the organization which had agreed to finance the experiment.

Not only does the state of beliefs fluctuate with a controversy but also the identity and characteristics of the implicated actors change as well. (What do the fishermen really want? How does *Pecten maximus* behave? …). Nature and society are put into place and transformed in the same movement.

By not changing the grid of analysis, the mechanisms of the closure of a controversy are now more easily understood. Closure occurs when the spokesmen are deemed to be beyond question. This result is generally obtained only after a series of negotiations of all sorts which could take quite some time. The scallops do not follow the first anchored larvae and the fishermen do not respect the commitments

of their representatives; this leads the three researchers to transform the device of *interessement* used for the scallops and their larvae and to undertake a vast campaign to educate and inform (i.e., form) the fishermen to choose other intermediaries and other representatives. It is at this point of their story that we leave them in order to examine the lessons that can be drawn from the proposed analysis.

Concluding remarks

Throughout this study we have followed all the variations which affected the alliances forged by the three researchers without locking them into fixed roles. Not only was the identity of the scallops or the fishermen and the representatives of their intermediaries or spokesmen (anchored larvae, professional delegates, and so on) allowed to fluctuate but also the unpredictable relationships between these different entities were allowed to take their course. This was possible because no a priori category or relationship was used in the account. Who at the beginning of the story could have predicted that the anchorage of the scallops would have an influence on the fishermen? Who would have been able to guess the channels that this influence would pass through? These relationships become visible and plausible only after the event. The story described here, although centered around the three researchers, did not bring in any actor that they themselves did not explicitly invoke nor did it impose any fixed definition on the entities which intervened.

Despite what might be judged a high degree of permissiveness in the analysis, the results were not an indescribable chaos. Certainly the actors studied were confronted with different types of uncertainties. The situation proposed for them here is much less comfortable than that which is generally given by sociology. But their competencies prove to be worthy of the difficulties they encountered. They worked incessantly on society and nature, defining and associating entities, in order to forge alliances that were confirmed to be stable only for a certain location at a particular time. This methodological choice through which society is rendered as uncertain and disputable as nature, reveals an unusual reality which is accounted for quite faithfully by the vocabulary of translation.

First, the notion of translation emphasizes the continuity of the displacements and transformations which occur in this story: displacements of goals and interests and also displacements of devices, human beings, larvae, and inscriptions. Because of a series of unpredictable displacements, all the processes can be described as a translation which leads all the actors concerned to pass, through various metamorphoses and transformations, by the three researchers and their development project.

To translate is to displace: the three untiring researchers attempt to displace their allies to make them pass by Brest and their laboratories. But to translate is also to express in one's own language what others say and want, why they act in the way they do and how they associate with each other: it is to establish oneself as a spokesman. At the end of the process, if it is successful, only voices speaking in unison will be heard. The three researchers talk in the name of the scallops, the fishermen, and the scientific community. At the beginning these three universes were separate and had no means of communication with one another. At the end a discourse of certainty has unified them, or, rather, has brought them into a relationship with one another in an intelligible manner. But this would not have been possible without the different sorts of displacements and transformations presented above, the negotiations, and the adjustments that accompanied them. To designate these two inseparable mechanisms and their result, we use the word *translation*. The three researchers translated the fishermen, the scallops, and the scientific community.

Translation is a process before it is a result. That is why we have spoken of moments which in reality are never as distinct as they are in this paper. Each of them marks a progression in the negotiations which results in the designation of the legitimate spokesmen who, in this case study, say what the scallops want and need and are not disavowed: the problematization, which was only a simple conjecture, was transformed into mobilization. Dissidence plays a different role since it brings into question some of the gains of the previous stages. The displacements and the spokesmen are challenged or refused. The actors implicated do not acknowledge their roles in this story nor the slow drift in which they had participated, in their option, wholeheartedly. As the aphorism says, "traduttore-traditore" from translation to treason there is only a short step. It is this step that is taken in the last stage. New displacements take the place of the previous ones but these divert the actors from the obligatory passage points that had been imposed upon them. New spokesmen are heard that deny the representativity of the previous ones. Translation continues but the equilibrium has been modified.

Translation is the mechanism by which the social and natural worlds progressively take form. The result is a situation in which certain entities control others. Understanding what sociologists generally call power relationships means describing the way in which actors are defined, associated, and simultaneously obliged to remain faithful to their alliances. The repertoire of translation is not only designed to give a symmetrical and tolerant description of a complex process which constantly mixes together a variety of social and natural entities. It also permits an explanation of how a few obtain the right to express and to represent the many silent actors of the social and natural worlds they have mobilized.

Notes

1 The notion of "stock" is widely used in population demography. In the present case the stock designates the population of scallops living and reproducing in St. Brieuc Bay. A given stock is designated by a series of parameters that vary over time: overall number, cohorts, size, natural mortality rate, rate of reproduction, and so on. Knowledge of the stock thus requires systematic measures which make it possible to forecast changes. In population dynamics mathematical models define the influence of a range of variables (e.g., intensity of fishing and the division of catch between cohorts) upon the development of the stock. Population dynamics is thus one of the essential tools for what specialists in the study of maritime fishing call the rational management of stocks.

2 For this study we had available all the articles, reports and accounts of meetings that related to the experiments at St. Brieuc and the domestication of scallops. About twenty interviews with leading protagonists were also undertaken.

3 Centre National d'Exploitation des Océans (CNEXO) is a public body that was created in the early 1970s to undertake research designed to increase knowledge and means of exploiting marine resources.

4 The term *actor* is used in the way that semioticians use the notion of the *actant* (Greimas and Courtes 1979). For the implication of external actors in the construction of scientific knowledge or artifacts see the way in which Pinch and Bijker (1984) make use of the notion of a social group. The approach proposed here differs from this in various ways: first, as will be suggested below, the list of actors is not restricted to social entities; but second, and most important, because the definition of groups, their identities and their wishes are all constantly negotiated during the process of translation. Therefore, these are not pregiven data but take the form of an hypothesis (a problematization) that is introduced by certain actors and is subsequently weakened, confirmed, or transformed.

5 The reader should not impute anthropomorphism to these phrases! The reasons for the conduct of scallops – whether these lie in their genes, in divinely ordained schemes, or anything else – matter little! The only thing that counts is the definition of their conduct by the various actors identified. The scallops are deemed to attach themselves just as fishermen are deemed to follow their short-term economic interests. They therefore act.

6 On the negotiable character of interests and identities of the actors see Callon (1980).

7 As can be discerned from its etymology, the word *problem* designates obstacles that are thrown across the path of an actor and which hinder his movement. This term is thus used in a manner which differs entirely from that current in the philosophy of science and epistemology. Problems are not spontaneously generated by the state of knowledge or by the dynamics of progress in research. Rather they result from the definition and interrelation of actors that were not previously linked to one another. To problematize is simultaneoulsy to define a series of actors and the obstacles which prevent them from attaining the goals or objectives that have been imputed to them. Problems, and the postulated equivalences between them, result from the interaction between a given actor and all the social and natural entities which it defines and for which it seems to become indispensable.

8 When the shell is formed it constitutes an effective shield against certain predators such as starfish.

9 Numerous analyses have made it clear that a scientific argument may be seen as a device for *interessement*. See, among others, Michel Callon, John Law, and Arie Rip (1986). Since

the point is well established, details of the rhetorical mechanisms by which academics and fishermen were interested are not described in the present article.

10 D. Buestel, J-C. Dao, A. Muller-Fuega (1974). Resultats préliminaires de l'expérience de collecte de naissains de coquilles Saint-Jacques en rade de Brest et en baie de Sainte-Brieuc' in Colloque sur l'aquaculture, Brest, October 1973. *Actes de Colloque* I, CNEXO.

11 Ibid.

12 The description adopted here is not deliberately anthropomorphic in character. Just because currents intervene to thwart the experiments of researchers does not mean that we endow them with particular motives. Researchers sometimes use a vocabulary which suggests that starfish, climatic changes, and currents have motives and intentions of their own. But it is precisely here that one sees the distance that separates the observer from the actor and the neutrality of the former with respect to the point of view of the latter. The vocabulary adopted, that of *interessement* and enrollment, makes it possible to follow the researchers in their struggles with those forces that oppose them without taking any view about the nature of the latter.

13 Buestal et al. Resultats préliminaires.

14 Ibid.

15 The discussions were recorded in reports which were made available.

16 One participant in the discussion, commenting on the report of Buestel et. al., noted: "At a theoretical level we must not minimise what we know already about scallops … It is important to remember that the biology of *Pecten* was somewhat better known than you suggested."

17 Buestel et al. Resultats préliminaires.

18 Furthermore, right at the beginning of the experiments, the three researchers gathered the St. Brieuc collectors together and transported them to their laboratory at Brest. Only after their arrival in Brest and in the presence of attentive colleagues were the larvae extracted from the collectors, arrayed on a pallet somewhere near the Spanish Bridge, and counted. There is no difference between this and what happens after the polling stations close and the ballot boxes are sealed. These are only reopened under the vigilant gaze of the scrutineers gathered round the tables upon which they are to be counted.

19 In the course of discussion the researcher whose opinions were constantly sought by the participants made this judgment: "Let me underline the fact that this very remarkable communication marks an important date in our knowledge of the growth of *Pecten maximus*."

20 This does not imply that all fishermen actively subscribe to the position adopted by their delegates. Rather it simply signifies that they do not interrupt the negotiations that those delegates undertake with the scientists and the larvae. As what subsequently happened reveals, interruption can occur without the fishermen explaining themselves publicly.

21 It is no surprise that the controversy of dispute was not explicitly voiced. Even electors sometimes "vote with their feet."

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Susan Leigh Star

Power, Technology and the Phenomenology of Conventions

On Being Allergic to Onions*

Introduction

> Today I was reading about Marie Curie:
> she must have known she suffered from radiation sickness
> her body bombarded for years by the element
> she had purified
> It seems she denied to the end
> the source of the cataracts on her eyes…
> She died a famous woman denying
> her wounds
> denying
> her wounds came from the same source as her power
> (Rich, "Power", 1978)

> I guess what I am saying is that in the university and in science the boundary between insider and outsider for me is permeable. In most respects, I am not one or the other. Almost always I am both and can use both to develop material, intellectual, and political resources and construct insider enclaves in which I can live, love, work, and be as responsible as I know how to be. So, once more I am back to the dynamic between insider and outsider and the strengths that we can gain from their simoultaneous coexistence and that surprises and interests me a lot. (Hubbard, in Hubbard and Randall 1988: 127)

* From John Law (ed.) *A Sociology of Monsters. Essays on Power, Technology and Domination* © *Sociological Review Monograph* 38, 1991. Reproduced with the kind permission of *Sociological Review Monograph*.

> It is not peculiar that the very thing being deconstructed – creation – does not in its intact form have a moral claim on us that is as high as the others' [war, torture] is low, that the action of creating is not, for example, held to be bound up with justice in the way those other events are bound up with injustice, that it (the mental, verbal, or material process of making the world) is not held to be centrally entailed in the elimination of pain as the unmaking of the world is held to be entailed in pain's infliction? (Scarry 1985: 22)

This is an essay about power.

Contrast the following three images of multiple selves or "split personalities":

1. *An executive of a major company presents different faces*. The executive is a middle-aged man, personable, educated, successful. To tour the manufacturing division of the plant, he dons a hard hat and walks the floor, speaking the lingo of the people who work there. In a board meeting he employs metaphors and statistics, projects a vision of the future of the company. On weekends he rolls up his sleeves and strips old furniture, plays lovingly with his children that he has not seen all week.
2. *A self splits under torture*. The adolescent girl sits on the therapist's couch, dressed as a prostitute would dress, acting coyly. Last week she wore the clothes of a matronly, rather sombre secretary, and called herself by a different name. Her diagnosis is multiple personality disorder. Most cases of this once-thought-rare disorder arise from severe abuse, sexual or physical torture.
3. *A Chicana lesbian writes of her white father*. The words are painful, halting, since they are written for an audience finding its identities in being brown, or lesbian, or feminist. As in all political movements, it is easier to seek purity than impurity. Cher'rie Moraga (1983) writes of the betrayal that paradoxically leads to integration of the self, La Chingara, the Mexican Indian woman who sleeps with the white man, betrays her people, mothers her people. Which self is the "real" self here?

Bruno Latour's powerful aphorism, "science is politics by other means", coined in the context of his discussion of Pasteur's empire-building and fact-creating enterprises has been taken up by most of the research in the new sociology of science, in one form or another (1987). The sentral image of Pasteur is that of the executive with many faces: to farmers, he brings healing, to statisticians, a way of accounting for data, to public health workers, a theory of disease and pollution that joins them with medical research. He is stage-manager, public relations person, behind-the-scenes planner. It is through a series of translations that Pasteur is able to link very heterogeneous interests into a mini-empire, thus, in Latour's words, "raising the world" (1983).

The multiplicity of selves which Pasteur is able to unite is an exercise of power of great importance. And from Latour's work, and that exploring related themes, we also understand that the enrolment does not just involve armies of people, but also of nature and technologies. Explanations and explorations, *intéressement*, extends to the non-human world of microbes, cows, and machines. A new frontier of sociological explanation is found through links between traditional interests and politics, and those usually ignored by such analysis, of nature and technique.

The multiplicity of Pasteur's identities or selves is critical to the kind of power of the network of which he is so central a part. Yet this is only one kind of multiplicity, and one kind of power, and one kind of network. Its power rests, as Latour, Callon and others who have written about this sort of power in networks themselves attest, upon processes of delegation and discipline (Callon 1986). This may be delegation to machines, or to other allies – often humans from allied worlds who will join forces with the actor and attribute the fruits of their action back to him, her or them. And the discipline means convincing or forcing those delegated to confirm to patterns of action and representation. This has important political consequences; as Fujimura has written:

> While Callon and Latour might be philosophically correct about the constructed nature of the science-society dichotomy (who represents nonhumans versus who represents humans), the consequences of that construction are important… I want to examine the practices, activities, concerns and trajectories of *all the different paricipants* – including nonhumans – in scientific work. In contrast to Latour, I am still sociologically interested in understanding why and how some human perspectives win over others in the construction of technologies and truths, why and how some human actors will go along with the will of other actors, and why and how some human actors resist being enrolled… I want to take sides, to take stands. (1991a)

The two other kinds of multiplicity I mention above – multiple personality and marginality – are the point of departure for feminist and interactionist analyses of power and technology. We become multiple for many reasons. These include the multiple personalities that arise as a respons to extreme violence and torture and extend to the multiplicity of participating in many social worlds – the experience of being marginal. By experience and by affinity, some of us begin not with Pasteur, but with the monster, the outcast.[1] Our multiplicity has not been the multiple personality of the executive, but that of the abused child, the half-breed. We are the ones who have done the invisible work of creating a unity of action in the face of a multiplicity of selves, *as well as*, and at the same time, the *invisible work* of lending unity to the face

of the torturer or of the executive. We have usually been the delegated *to*, the disciplin*ed*.[2] Our selves are thus in two senses monstrous selves, cyborgs, impure, first in the sense of uniting split selves and secondly in the sense of being that which goes unrepresented in encounters with technology. This experience is about multivocality or heterogeneity, but not only that. We are at once heterogeneous, split apart, multiple – and through living in multiple worlds *without* delegation, we have experience of a self unfied only through action, work and the patchwork of collective biography (see Fujimura 1991a and Strauss 1969 for discussions of this latter point).

We gain access to these selves in several ways:

1. by refusing those images of the executive in the network which screen out the work that is delegated. That is, in the case of Pasteur or any executive, much of the work is attributed back to the central figure, erasing the work of secretaries, wives, laboratory technicians, and all sorts of associates. When this invisible work (Star 1991; Shapin 1989; Daniels 1988) is recovered, a very different network is discovered as well;
2. by refusing to discard any of our selves in an ontological sense – refusing to "pass" or to become pure, and this means in turn,
3. acknowledging the primacy of *multiple membership* in many worlds at once for each actor in a network. This *multiple marginality* is a source not only of monstrosity and impurity, but of a power that once resist violence and encompasses heterogeneity. This is at its most powerful a collective resistance, based on the premise that the personal is political.

All of these ways of gaining access imply listening, rather than talking on behalf of. This often means *refusing* translation – resting uncomfortably but content with that which is wild to us.

The background in science studies

A number of recent conversations in the sociology of technology concern the nature of this relationship between people and machines, human and non-human (see e.g. Latour 1988; Callon 1986). Some focus on the divide between them: where should it be placed? There is a fierce battle, for instance, between several British and French sociologists of science on precisely this question. The British sociologists involved argue that there is, and should be, a moral divide between people and machines, and attempts to subvert it are dehumanizing ones. They return us to a primitive realism of the sort we had before science studies. The French, on the other hand, focus against "great divides", and seek a heuristic flattening

of the differences between people and machines in order to understand the way things work together. These often break conventional boundaries. A third strand, which I shall loosely call American feminist, argues that people and machines are coextensive, but in a densely stratified space, and that the voices of those suffering from abuses of technological power are among the most powerful analytically. A fourth strand, European and American phenomenology or ethnomethodology, argues that technology is an occasion to understand the way understanding itself – social order, meaning, routines – is constituted and reconstituted dynamically and that reflexive analysis of technology is thus paramount. (Several of these essays appear in Pickering 1992)

In the midst of these conversations, I have found myself asking, "what *is* technology?" or sometimes, "what *is* a human being?". As a result of the discussion I mentioned above, we walk in a very interesting landscape these days in science and technology studies. There are cyborgs, near-animate doors, bicycles and computers, "conversations" with animals and objects, talk that sounds quite ecological and Green, if not downright pagan, about the continuum of life and knowledge; talk that opens doors on topics like subjectivity, reflexivity, multivocality, nonrational ways of knowing. In the policy field, things are scarcely less lively. On the one hand, critics of technology (Kling, Dreyfus) are labelled Luddities and scathingly attacked by those developing state-of-the art technology. On the other, utopian advocates of new systems envision global peace through information technology, genetic maps, or cyberspace simulations. A third side invokes visions of techno-ecological disaster, accidents out of control, a world of increasingly alienated work where computers are servants of a management class. At the same time, people from all sides of the fray are blurring genres (fiction and science, for example), disciplines, or familiar boundaries.

Sociologists of science have helped[3] create this landscape through a heretical challenging of the biggest sacred cow of our times: the truthfulness of science as given from nature, the inevitability of scientific findings, their monolithic voices. Even in severely criticizing science for biases of gender, race or militarism, science critics had not previously ventured far into this territory. Although often implicit, an early message from science criticism had been that science done right would not be biased. The message from sociology of science has consistently been: the "doing right" part *is* the contested territory. There are a few people asking the question about whether doing science at *all* can constitute doing right, or whether the entire enterprice is not necessarily flawed, but these are relatively rare: Restivo (1988) and Merchant (1980) are among them.

There is much disagreement in science studies about the nature of the politics by other means in science, both descriptively and prescriptively. We are recognizing

that in talking of the central modern institutions of science and technology, we are talking of moral and political order (see Clarke 1990a). But do we have a fundamentally *new* analysis of that order (or those orders)? Are science and technology different? Or are they just new, interesting targets for social science?

Since few of us are interested in merely adding a variable to an extant analysis, most sociologists of science would hold that there *is* something unique about science and technology (but see Woolgar 1991 for a critique of this notion in the recent "turn to technology" in science studies). These include the ideas that:

- science is the most naturalized of phenomena, helping form our deepest assumptions about the taken-for-granted;
- technology freezes inscriptions, knowledge, information, alliances and actions inside black boxes, where they become invisible, transportable, and powerful in hitherto unknown ways as part of socio-technical networks;
- most previous social science has focused exclusively on humans, thus ignoring the powerful presence, effects and heuristic value of technologies in problem-solving and the moral order;
- science as an ideology legitimates many other activities in a meta sense, thus becoming a complex, embedded authority for rationalization, sexism, racism, economic competitiveness, classification and quantification;
- technology is a kind of social glue, a repository for memory, communication, inscription, actants and thus has a special position in the net of actions constituting social order.

There is as well a persistent sense in science studies that technology in particular is *terra incognita* for social scientists, perhaps because of the myth of "two cultures" of those who work on machines vs. those who study or work with people.

Power in the current problems of sociology of technology

This sense of a new territory, and a unique set of problems has prompted a number of historical reconstructions, where the participation of scientists, technologies, various devices and instruments are included in the narrative. Many sociologists of science claim that taking these new actors into account gives a new, more complete analysis of action. "Politics by other means" is underscored by looking at how traditional power tactics, such as entrepreneurship or recruitment, are supported by new activities, such as building black boxes, or translating the terms of a problem from scientific language to some other language or set of concerns.

In the terms of Latour and Callon, this latter is the power of *intéressement* – the process of translating the images and concerns of one world into that of another, and then disciplining or maintaining that translation in order to stabilize a powerful network. The networks include people, the built environment, animals and plants, signs and symbols, inscriptions, and all manner of other things. They purposely eschew divides such as human/nonhuman and technology/society.

Another discourse about "politics by other means" concerns groups traditionally dispossessed or oppressed in some fashion: ethnic minorities, women of all colours, the old, the physically disabled, the poor. Here the discourse has traditionally been about access to the technology, or the effects of technology (often differential) upon a particular group. Some examples include the sexist design and impact of reproductive technologies; the lack of access to advanced information technologies by the poor, further deepening class differences: the racist and sexist employment practices of computer chip manufacturers; and issues of deskilling and automation to labour.

Some writers in the science studies area have begun to bring these two concerns together, although others have begun to drive them apart in acrimonious battle (see e.g. Scott 1991). From one point of view, discussions of racism and sexism use reified concepts to manipulate tired old social theory to no good ends except guilt and boredom. From another, the political order described in actor network theory, or in descriptions of the creation of scientific facts, they describe an order which is warlike, competitive, and biased toward the point of view of the victors (or the management). Yet both agree that there are important joint issues in opening the black boxes of science and technology, in examining previously invisible work, and, especially, in attempting to represent more than one point of view within a network. We know how to discuss the process of translation from the point of view of the scientist, but much less from that of the laboratory technician, still less from that of the lab's janitor, much as we agree in principle that all points of view are important. There is a suspicion from one side that such omissions are not accidental; from the other, that they reflect the adequacy of the available material, but are not in principle analytic barriers.

The purpose of this essay is to attempt to provide some tools hopefully useful for several of the discourses, and perhaps as well as show some ways in which technology re-illuminates some of the oldest problems in social sciece. I can see two leverage points for doing this. These are 1) the problem of standards, and their relationship with invisible work; and 2) the problem of identity, and its relationship to marginality.

There are many challenges associated with adopting the stance that each perspective is important in a network analysis. One is simply to find the resources to

do more work on traditionally underrepresented perspectives (see e.g. Shapin 1989; Star 1991; Clarke and Fujimura, 1992). Another is using multiplicity as the point of departure for *all* analysis, instead of adding perspectives to an essentially monolithic model. Yet another is methodological: how to model (never mind translate or try to find a universal language for) the deep heterogeneities that occur in any juxtaposition, any network? (Star and Griesemer 1989; Star 1988; Callon 1986, 1990) This methodological issue is a state-of-the-art one in many disciplines, including science studies, but also including organization studies, computer science (especially distributed artificial intelligence and federated databases), and literary theory.

This essay speaks to the second point: how to make multiplicity primary for some of the concerns about power appearing now in science studies. The following example illustrates some common aspects of the problems of standards and invisible work.

On being allergic to onions

I am allergic to onions that are raw or partially cooked. When I eat even a small amount, I suffer stomach pain and nausea that can last for several hours. In the grand scheme of things this is a very minor disability. However, precisely because it is so minor and yet so pervasive in my life, it is a good vehicle for understanding some of the small, distributed costs and overheads associated with the ways in which individuals, organizations and standarized technologies meet.

The case of McDonald's

> Participation in McDonald's rituals involves temporary subordination of individual differences in a social and cultural collectivity. By eating at McDonald's, not only do we communicate that we are hungry, enjoy hamburgers, and have inexpensive tastes but also that we are willing to adhere to a value system and a series of behaviours dictated by an exterior entity. In a land of tremendous ethnic, social, economic, and religious diversity, we proclaim that we share something with millions of other Americans. (Kottak 1978: 82)

One afternoon several years ago I was very late to a meeting. Spying a McDonald's hamburger stand near the meeting, I dashed in an ordered a hamburger, remembering at the last minute to add "with no onions". (I hadn't eaten at McDonald's since developing the onion allergy.) Forty-five minutes lates I walked out with my

meal, while all around me people were being served at lightning speed. Desperately late now and fuming, I didn't think about the situation, but merely felt annoyed. Some months later, I was again with a group, and we decided to stop to get some hamburgers at another McDonald's. I had forgotten about my former experience there. They all ordered their various combinations of things, and when it came to my turn, I repeated my usual, "hamburger with no onions". Again, half an hour later, my companions had finished their lunches, and mine was being delivered up by a very apologetic counter server. This time the situation became clear to me.

"Oh", I said to myself, "I get it. They simply can't deal with anything out of the ordinary." And indeed, that was the case. The next time I went to a fast-food restaurant I ordered along with everyone else, omitted the codicil about onions, took an extra plastic knife from the counter, and scraped off the offending onions. This greatly expedited the whole process.

The curious robustness of disbelief on the part of waiters

I travel a lot. I also eat out at restaurants a lot. I can state with some certainty that one of the more robust cross-cultural, indeed cross-class, cross-national phenomena I have ever encountered is a curious reluctance by waiters to believe that I am allergic to onions. Unless I go to the extreme of stating firmly that "I don't want an onion on the plate, near the plate in the plate or even hovering *around* the food", I will get an onion where I have requested none (approximately 4 times out of 5), at restaurants of all types, and all levels of quality, all over the world.

The cost of surveillance

In my case, the cost of surveillance about onions is borne entirely by me (or occasionally by an understanding dinner partner or host). Unlike people on salt-free, kosher or vegetarian regimes, there exists no recognizable consumer demand for people allergic to onions. So I often spend half my meal picking little slives out of the food or closely examining the plate – a state of affairs that would probably be embarassing if I were not so used to doing it by now.

Anyone with an invisible, uncommon or stigmatized disorder requiring special attention will hopefully recognize themselves in these anecdotes. If half the population were allergic to onions, no doubt some institutionalized processes would have developed to signal, make optional, or eliminate them from public eating places. As things stand, of course, such measures would be silly. But the visible presence of coronary patients, elders, vegetarians, orthodox Jews, and so on, has led

many restaurants, airlines, and institutional food suppliers to label, regulate and serve food based on the needs of these important constituencies.

When an artifact or event moves from being presumed neutral to being a marked object – whether in the form of a gradual market shift or a stronger one such as barrier-free architecture for those in wheelchairs or deaf-signing for the evening news – the nature of human encounters with the technologies embedded in them may be changed. This is one form where politics arise in connection with technology and technological networks. These are politics which come to bear a label: "handicapped access", "reproductive technologies", "special education", even "participant-centered design".

But the signs which bear labels are deceptive. They make it seem as if the matter of technology were a matter of expanding the exhaustive search for "special needs" until they are all tailored or customized; the chimera of infinite flexibility, especially in knowledge-based technologies, is a powerful one.

There are two ways in which this illusion can be dangerous. The first is in the case of things like onions: there are always misfits between *standardized* or *conventional* technological systems and the needs of individuals (Star 1990 discusses this with the respect to high technology development). In the case of McDonald's, a highly standardized and franchised firm, changes can be made only when market niches or consumer groups arise that are large enough to affect the vast economies of scale practised by the firm. Thus, when dieters and Californians appear to command sufficient market share to make a difference, salad bars appear in McDonald's; non-onion entrees are far less likely. Even where there are no highly standardized production technologies (in most restaurants, for instance), a similar phenomenon may appear in the case of highly conventionalized activities – thus chefs and waiters automatically add onions to the plate, because most people eat them. It is easier to negotiate individually with non-standardized producers, but not guarantreed. The lure of flexibility becomes dangerous when claims of universality are made about any phenomenon. McDonald's appears to be an ordinary, universal, ubiquitous restaurant chain. *Unless* you are: vegetarian, on a saltfree diet, keep kosher, eat organic foods, have diverticulosis (where the sesame seeds on the buns may be dangerous for your digestion), housebound, too poor to eat out at all – or allergic to onions.

The second illusion about perfect flexibility is a bit more abstract, and concerns not so much exclusion from a standardized form, but the ways in which membership in multiple social worlds can interact with standard forms. Let's say for the sake of argument that McDonald's develops a technology which includes vegetarian offerings, makes salt optional, has a kosher kitchen attached to every franchise, runs their own organic farms for supplies, includes a meals-on-wheels programme

and free lunches for the poor, and all sorts of modular choices about what condiments to add or substract. But that morning I have joined the League to Protect Small Family-Owned Businesses, and, immune to their blandishments, walk down the street and bypass all their efforts. I have added a self to which they are blind, but which affects my interaction with them.

We have some choices in the sociology of technology about how to conceptualize these phenomena, which are obviously exemplary of many forms of techological change. First is a choice about what is to be explained. It is true that McDonald's appear in an astonishing number of places; they are even more successful than Pasteur at politics by other means, if extension and visible presence are good measures. Is that the phenomenon to be explained – the enrolment and *intéressement* of eating patterns, franchise marketing, labour pool politics, standardization and its economics? It is also true that McDonald's screens out a number of clients in the act of standardizing its empire, as we have just discussed. Should *that* be the phenomenon we examine – the experience of being a McDonald's non-user, a McDonald's resister or even castaway? In the words of John Law, sociologist of thechnology and of McDonald's:

> In particular, the McDonald's marketing operation surveys its customers in order to obtain their reaction to the adequacy of their experience in the restaurant on a number of criteria: convenience, value, quality, cleanliness and service … these criteria are in no way "natural" or inevitable. Rather they must be seen as cultural constructs. The idea that food should be fast, cheap, or convenient would be anathema, for instance, to certain sections of the French middle class ... These reasons for eating at McDonald's micht equally well be reasons for *not* eating there in another culture. (1984: 184)

There are two kinds of phenomena going on here, and both miss another aspect of the transformation of the sort captured very well by semioticians in discussions of rhizomatic methaphors, or that which is outside of both the market and unmarked categories, which resists analysis from inside *or* outside. In this case, this means living with the *fact* of McDonald's no matter where you fall on the scale of participation, since you live in a landscape with its presence, in a city altered by it, or out in the country, where you, at least, drive by it and see the red and the gold against the green of the trees, hear the radio advertising it, or have children who can hum its jingle.

The power of feminist analysis is to move from the experience of being a nonuser, an outcast or a castaway, to the analysis of the fact of McDonald's (and by extension, many other technologies) – and implicity to the fact that "it might have

been otherwise'[4] – there is nothing necessary or inevitable about the presence of such franchises. We can bring a stranger's eye to such experiences. Similarly, the power of actor network theory is to move from the experience of the building of the empire of McDonald's (and by extension, many other technologies) and from the enormous amount of enrolment, translation and *intéressement* involved – to the fact that "it might have been otherwise" – there is nothing necessary or inevitable about any such science or technology, all constructions are historically contingent, no matter how stabilized.

One powerful way these two approaches may be joined is in linking the "non-user" point of departure with the translation model, returning to the point of view of that which cannot be translated: the monstrous, the Other, the wild. Returning again to John Law's observation about the way McDonald's enrols customers:

> It creates classes of customers, theorizes that they have certain interests, and builds upon or slightly diverts these interests in order to enlist members of that group for a few minutes each day or each week. It does this, group by group and interest by interest, in very particular ways … Action is accordingly induced not by the abstract power of words and images in advertising, but rather in the way that these words and images are put into practice by the corporation, and then *interpreted* in the light of the (presumed) interests of the hearer. Advertising and enrolment work if the advertiser's theory of (practical) interests is workable. (1984: 189)

He goes on to discuss the ways in which McDonald's shares sovereignty with other enterprises which seek to order lives, and of coexisting principles of order which in fact stratify human life.

But let our point of departure be not that which McDonald's stratifies, nor even the temporally brief but geographically extensive scope it enjoys and shares with other institutions, nor the market niches which it does not (yet?) occupy. Let it be the work of scraping off the onions, the self which has *just* joined the small business preservation group, the *as-yet unlabelled*. This is not the disenfranchised, which may at some point be "targeted"; not the residual category not covered in present marketing taxonomies. This is that which is permanently escaping, subverting, but nevertheless in relationship with the standardized. It is not nonconfirmity, but heterogeneity. In the words of Donna Haraway, this is the cyborg self:

> The cyborg is resolutely comitted to partiality, irony, intimacy, and perversity. It is oppositional, utopian, and completely without innocence. No longer structured by the polarity of public and private, the cyborg defines a technological

> polis based partly on a revolution of social relations in the *oikos*, the household. Nature and culture are reworked; the one can no longer be the resource for appropriation or incorporation by the other. (1991: 151)

In a sense, a cyborg is the relationship between standardized technologies and local experience; that which is between the categories, yet in relationship to them.

Standards/conventions and their relationship with invisible work: heterogeneous "externalities"

> To speak to others is to first silence those in whose name we speak.
> (Callon 1986: 216)

One problem in network theory is that of trying to understand how networks come to be stabilized over a long period of time. Michel Callon has tackled this problem in his essay, "Techno-Economic Networks and Irreversibility" (1991). There are some changes which occur in large networks which are irreversible, no matter what their ontological status. The initial choice of red as a colour in traffic lights that means, "stop" for example, is now a widespread convention that would be functionally impossible to change, yet it was initially arbitrary. The level of diffuse investment, the links with the other networks and symbol systems, and the sheer degree of interpenetration of "red as stop" renders it irreversible. We are surrounded by these networks: of telephones, computer links, road systems, subways, the post, all sorts of integrated bureaucratic record-keeping devices.

Irreversibility is clearly important for an analysis of power and of robustness in networks in science studies. A fact is born in a laboratory, becomes stripped of its contingency and the process of its production to appear in its facticity as Truth. Some Truths and technologies, joined in networks of translation, become enormously stable features of our landscape, shaping action and inhibiting certain kinds of change. Economically, those who invest with the winners in this stabilization process may themselves win big as standard setters. Later, others sign on to the standardized technologies in order to gain from the already-established structures, and benefit from these *network externalities*. Just as city-dwellers benefit from the ongoing positive externalities of theatres, transportation systems, and a density of retail stores, network-dwellers benefit from externalities of structure, density of communications populations, and already-established maintenance. Any growing network evidences this, such as the community of electronic mail users in academia.

One can now sign on and (more or less) reliably communicate with friends, benefiting from a network externality that didn't exist just a few years ago.

Understanding how, and when, and whether one can benefit from network externalities is an essentially sociological art: how does the individual join with the aggregate, and to whose benefit? Once arrangements become standard in a community, creating alternative standards may be expensive or impossible, unless an alternative community develops for some reason. Sometimes the expense is possible and warranted, and may in fact lead to the development of another community, as in Becker's analysis of maverick artists (1982).

Becker raises the question of the connection between work, communities and conventions in creating aesthetics and schools of thought. He begins with a series of simple, pragmatic questions: why are concerts two hours long? Why are paintings the size that they are (in general)? By examining the worlds which intersect to create a piece of art, *and valuing each one in his analysis*, he restores some of the normally hidden aspects of network externalities. There are contingencies for musicians' unions in prescribing hours of work, but also for those parking the cars of symphony-goers, those cleaning the buildings after hours, and these contingencies, as much as considerations of more publicly-acknowledged traditions, are equally important in forming aesthetic traditions.

So most composers write for concerts that are about two hours long, most playwrights plays of similar length; most sculptures fit in museums and the backs of transport vans, and so forth. Those artists who are mavericks play with these conventions, opposing one or more. Occasionally, a naïve artist – with little knowledge of any of the conventions – will be picked up an accepted into the art world – and for that reason is especially sociologically interesting for illuminating the usually taken-for-granted.

The phenomenon Becker is pointing to in art is equally true in science and technology, if not more so, because there are so few instances of solitary or naïve scientists (inventors are possibly a counterexample). Scientists and technologists move in communities of practice (Wenger 1990; Lave and Wenger, 1991) or social worlds (Clarke 1990b) which have conventions of use about materials, goods, standards, measurements, and so forth. It is expensive to work within a world and practise outside this set of standards; for many disciplines (high energy physics, advanced electronics research, nuclear medicine), nearly impossible.

Yet these sets of conventions are not always stable. At the beginning of a technological regime; when two or more worlds first come together; when a regime is crumbling – these are all periods of change and upheaval in worlds of science. As well, *the sets of conventions are never stable for non-members*. McDonald's may provide sameness and stability for many people – in John Law's words, it may order

five minutes of their world each day – but for me and for others excluded from their world, it is distinctly not ordered. Rather, it is a source of chaos and trouble.

Network or networks; that is the question

There is thus a critical difference between stabilization within a network or community of pratice, and stabilization between networks, and again critical differences between those for whom networks are stable and those for whom they are not, where those are putatively the "same" network. Again we have a choice for a point of departure: does McDonald's represent a stable network, a source of chaos, or a third thing altogether?

Politics by other means or by the same old means?

Bruno Latour explicates some of the features of actor network theory, and the mix between humans and nonhumans involved in socio-technical systems, in his article on "The Sociology of a Door-Closer". He advocates an ecological analysis of people-and-objects, looking at the links between them, the shifts with respect to action, and the ways that duties, morality and actions are shifted between humans and nonhumans: "The label 'inhuman' applied to techniques simply overlooks translation mechanisms and the many choices that exist for figuring or de-figuring, personifying or abstracting, embodying or disembodying actors"(1988: 303).

The analytic freedom accorded by this heuristic is considerable; in fact Latour and Callon's work has opened up a whole new way of analysing technology. However, the problem remians with respect to humans and the question of power that such mixes may seem to sidestep traditional questions of distribution and access: "As a technologist, I could claim that, provided you put aside maintenance and the few sectors of population that are discriminated against, the groom does its job well, closing the door behind you constantly firmly and slowly" (p. 302).

There is no analytic reason to put aside maintenance and the few sectors of population that are discriminated against, in fact, every reason not to. As Latour himself notes in respons to criticism of the actor network theory for the political implications of its "levelling" of human/nonhuman differences, heuristic flattening does not mean the same thing as empirical ignoring of differences in access or experience. Rather, it is a way of breaking down reified boundaries that prevent us from seeing the ways in which humans and machines are intermingled.

However, one of the features of the intermingling that occurs may be that of exclusion (technology as barrier) or violence, as well as of extension and empowerment. I think it is both more analytically interesting and more politically just to

begin with the question, *cui bono?* than to begin with a celebration of the fact of human/nonhuman mingling.

Network externalities and barriers to entry: physical and cultural

One of the interesting analytic features of such networks is the question of the *distribution of the conventional*. How many people can get in and out of doors, and how many cannot? What is the phenomenology of encounters with conventions and standardized forms, as well as with new technologies? And here an opportunity for new ground in science studies arises: given that we are multiply marginal, given that we may interweave several selves with our technologies, both in design and use, where and what is the meeting place between "externalities" and "internalities"? I say this not to invoke another "great divide", but to close one. A stabilized network is only stable for some, and that is for those who are members of the community of practice who form/use/maintain it. And part of the public stability of a standardized network often involves the private suffering of those who are not standard – who must use the standard network, but who are also non-members of the community of practice.

One example of this is the standardized use of the pseudo-generic "he" and "him" in English to refer to all human beings, a practice now changing in many places due to feminist influence. Social psychologists found that women who heard this language form understood its meaning, but were unable to project a concrete example, and unable to place themselves within the example, whereas men could hear themselves in the example (Martyna 1978). Women thus both used and did not use the technology of this expression, and, with the advent of feminist analysis of language, were able to bring that experience to public scrutiny.

When standards change, it is easier to see the invisible work and the invisible memberships that have anchored them in place. But until then it may be difficult, at least from the managerial perspective. A recent article by Paul David, an economist of standards, looks at a familiar problem for economists of information technology, called "the productivity paradox" (1989). For many firms, and even at the level of national economies, the introduction of (often very expensive) information technology has resulted in a decline in productivity, contrary to the perceived productivity benefits promised by the technology. David makes a comparison with the introduction of the general purpose electric dynamo engine at the beginning of the century, which saw a similar decline in productivity. He refers to the work of several economists on the "transition regime hypothesis" – basically, that large scale

technological change means a change in economic regime, which carries its own – often invisible to standard analysis – costs.

The transition regime hypothesis: whose regime? whose transition?

From the viewpoint of the analysis put forth here, the productivity paradox is no paradox at all. If much work, practice, and membership goes unrepresented in analysis of technology and socio-technical networks, then the invisible work that keeps many of them stabilized will go unaccounted for, but appear as a decline in productivity. Just as feminist theory has tried to valorize housework and domestic labour as intrinsic to large scale economics, the invisible work of practice, balancing membership and the politics of identity is critical for the economics of networks.

Who carries the cost of distribution, and what is the nature of the personal in network theory? I believe that the answers to these questions begin with a sense of the multiplicity of human beings and of objects, and of a commitment to understanding all the work which keeps a network standardized for some. No networks are stabilized or standardized for everyone. Not even McDonald's.

Cyborgs and multiple marginalities: power and the zero point

> In torture, it is in part the obsessive display of agency that permits one person's body to be translated into another person's voice, that allows real human pain to be converted into a regime's fiction of power. (Scarry 1985: 18)

> It is through the use of standardized packages that scientists constrain work practices and define, describe and contain representations of nature and reality. The same tool that constrains representations of nature can simultaneously be a flexible dynamic construction with different faces in other research and clinical/applied worlds. Standardized packages are used as a dynamic interface to translate interests between social worlds. (Fujimura 1992)

> To translate is to displace … But to translate is also to express in one's own language what others say and want, why they act in the way they do and how they associate with each other; it is to establish oneself as a spokesman. At

> the end of the process, if it is successful, only voices speaking in unison will be heard. (Callon 1986: 223)

Several years ago I taught a graduate class in feminist theory at a large university in California. The first day of class eight women and one other person showed up. I couldn't tell whether the ninth person was male or female. S/he gave his/her name as "Jan", an ambiguous name. In the course of our class discussions, it turned out that Jan was considering transsexual surgery. S/he'd taken some hormone shots, and thus begun to grow breasts, and was dressing in a gender-neutral way, in plain slacks and short-sleeved shirt. S/he said that s/he wasn't sure if s/he wanted to go ahead with the surgery: that s/he was enjoying the experience of being ambiguous gender-wise. "It's like being in a very high tension zone, as if something's about to explode", she said one day. "People can't handle me this way – they want me to be one thing or another. But it's also really great, I'm learning so much about what it means to be neither one nor the other. When I pass a woman, I begin to understand what feminism is all about. But this is different somehow."

I was deeply moved by Jan's description of the "high tension zone", though I didn't really know what to make of it at the time. A few weeks into the class we became friends, and she told me more about the process she was going through. She worked for one of the high technology firms in Silicon Valley, one which offered very good health insurance. But the health insurance company, Blue Cross, was unsure about paying for the extremely expensive process of transsexual surgery. Furthermore, the "gender identity clinic" where Jan was receiving psychotherapy and the hormone shots was demanding that s/he dress more like a conventionally feminine woman to "prove" that s/he was serious in her desire for the surgery. She told me that they required you to live for 2 years passing as a woman.

Around the Christmas holidays we fell out of touch. I was amazed to receive a phone call from Jan in February. "Well, congratulate me. I've done it", she exclaimed into the phone. "What?" I said, puzzeled. "I've had the surgery, I'm at home right this minute", she said. I asked her how she was feeling, and also how it had happened. "Did (the company) decide to pay for it?" I questioned. "No", she replied. "Blue Cross decided to pay for the whole thing. And then the doctor just said 'better do it now before they change their minds.' So I did!"

In the years that followed I saw Jan's (now Janice) name once in a while in local feminist club announcements; she became an active leader in the women in business groups in the area. I never saw her again after that February, but continued to be haunted by the juxtaposition of the delicate "high tension zone", the greed and hypocrisy of the insurance companies and physicians involved, and her own desperation.

Another friend has told me of a similar phenomenon within the gender clinics which require candidates for transsexual surgery to dress and act *as stereotyped females*, and deny them surgery if they do not: "They go from beeing unambiguous men, albeit unhappy men, to unambiguous women" (Stone 1989: 5 of MS). She goes on to recommend that the transsexual experience become an icon for the twin experiences of the high tension zone and the gender stereotype/violence:

> Here on the gender borders at the close of the twentieth century … we find the epistemologies of white male medical practice, the rage of radical feminist theories and the chaos of lived gendered experience meeting on the battlefield of cultural inscription that is the transsexual body: a meaning machine for the production of ideal type … Given this circumstance a counterdiscourse is critical, but it is difficult to generate a discourse if one is programmed to disappear. The highest purpose of the transsexual is to erase his/herself, to fade into the "normal" population as soon as possible. What is lost is the ability to authentically represent personal experience. (Stone 1989)

Here is a socio-technical network, an exercise of power – and a certain kind of loss. What would it have taken to preserve the "high tension" of Jan's non-membership, the impurity of being neither male nor female? This high tension zone is a kind of zero point between dichotomies (see Latour 1987; in *Irreductions*, in Pickering 1991) or between great divides: male/female, society/technology, either/or.

Elaine Scarry's extraordinary *The Body in Pain: The Making and Unmaking of the World* (1985) is a book about torture and war. Her argument is that during torture (and in similar ways during war) the world is created and uncreated. The torturer shrinks the world of the tortured, by taking the uncertainty of experienced pain and focussing it on material objects and on the verbal interchange between them. Old identities are erased, made immaterial.[5] We never really know about the pain someone else experiences, argues Scarry, and this uncertainty has certain political attributes that are explored during torture and war as the private becomes made public and monovocal. The visible signs of violence are transported to the public, and through a series of testaments, modifications, and translations become belief.

There are striking similarities between the making of the world Scarry decribes and the making of the world by Pasteur described by Latour, or the successful process of translation Callon analyses, although there seems to be no violence in these latter. A set of uncertainties are translated into certainties: old identities discarded, and the focus of the world narrowed into a set of facts.

The unity and closedness of the world of the torturer/tortured are seen as aberrant and outside the normal world by most people – far outside our normal realm.

But Scarry argues that it is precisely this distancing that is one of the factors that makes torture possible, *because* it makes invisible to us what are in fact the pedestrian ingredients of making the world outside the extreme of torture. Simone de Beauvoir (1948) and Hannah Arendt (1977) have made similar arguments about anaesthetization to violence and the banality of evil. We always have elements of uncertainty about the personal world of another, especially about pain and suffering; we often leave one world for another, or narrow our experience without betrayal or permanent change – for example, in the dentist's chair, when we can think only of the immanent pain.

If we shift our gaze from the extremes: torture, or the enormous success of Pasteur, to something as simple and almost silly as an allergy to onions, it becomes clear that similarly quotidian events form part of a pattern. Stabilized networks seem to insist on annihilating our personal experience, and there is suffering. One source of the suffering is denial of the co-causality of multiple selves and standards, when claims are made that the standardized network is the only reality that there is. The uncertainties of our selves and our biographies fall to the monovocal exercise of power, of making the world. My small pains with onions are on a continuum with the much more serious and total suffering of someone in a wheelchair barred from activity, or those whose bodies in other ways are "non-standard". And the work I do: of surveillance, of scraping off the onions, if not of organizing non-onion-eaters, is all prior to giving voice to the experience of the encounters. How much more difficult for those encounters which carry heavier moral freight?

Networks which encompass both standards and multiple selves are difficult to see or understand except in terms of deviance or "other" as long as they are seen in terms of the executive mode of power relations. Then we will have doors that let in some people, and not others, and our analysis of the "not others" can't be very important, certainly not central. The torture elicited by technology, especially, because it is distributed over time and space, because it is often very small in scope (five minutes of each day), or because it is out of sight, is difficult to see as world making. Instead it is the executive functions, having enrolled others, which are said to raise the world.

The vision of the cyborg, who has membership in multiple worlds, is a different way of viewing the relationship between standards and multiple selves. And this involves weaving in a conception of multiple membership, of a cyborg vision of nature, along with the radical epistemological democracy between humans and nonhumans. In the words of Donna Haraway:

> There's also the problem, of course, of having inherited a particular set of descriptive technologies as a Eurocentric and Euro-American person. How do

> I then act the bricoleur that we've all learned to be in various ways, without being a colonizer… How do you keep foregrounded the ironic and iffy things you're doing and still do them seriously. Folks get mad because you can't be pinned down, folks get mad at me for not finally saying what the bottom line is on these things: they say, well do you or don't you believe that non-human actors are in some sense social agents? One reply that makes sense to me is, the subjects are cyborg, nature is coyote, and the geography is elsewhere. (in Penley and Ross 1990/91: 10)

But there is a problem with this conception, and that has to do with the simultaneous poverty of our analyses of human/nonhuman, and of multiple membership for humans between human groups:

> You can't work without a conception of splitting and deferring and substituting. But I'm suspicious of the fact that in our account of both race and sex, each has to proceed one at a time… there is no compelling account of race and sex *at the same time*. There is no account of any set of differences that work other than by twos simultaneously. Our images of splitting are too impoverished … we don't actually have the analytical technologies for making the connections. (In Penley and Ross 1990/91: 15-16)

What would a richer theory of splitting involve, bringing together the following elements:

- multiple membership
- maintaining the "high tension" zone while acknowledging the cost of maintaining it
- the cost of membership in multiple arenas
- multivocality and translation?

Multiple memberships, multiple marginalities

Every enrolment entails both a failure to enrol and a destruction of the world of the non-enrolled. Pasteur's success meant simultaneously failure for those working in similar areas, and a loss and world-destruction for those outside the germ theory altogether. We are only now beginning to recover the elements of that knowledge: immunology, herbal wisdom, acupuncture, the relationship between ecology and health. This had not to do with Pasteur vs. Pochet, but the ecological effects of Pasteurism and its enrolment.

One of Haraway's suggestions is that the destruction of the world of the non-enrolled is rarely total. While torture, or the total institution, is one end of a continuum, the responses to enrolment are far more varied along a much richer continuum. The basic responses, outside of signing on, have to do with a multiplicity of selves, partial signings-on, partial commitments. Rut Linden's courageous and moving study of survivors of the Nazi holocaust, interwoven with her own biography as as American Jew, testifies to this rich complexity (1989). Adele Clarke's study of the different communities of practice which joined together in creating modern reproductive science shows how multiple memberships, partial commitments, and meetings across concerns in fact constitute science (1990a, 1991).

Becker's analysis of commitments and "side bets" is apposite here. In his decoupling of commitment from consistency, there is a metaphor for decoupling translation and enrolment. How can we explain consistent human behaviour? he asks. Ruling out mentalist explanations, functionalist explanations of social control, or purely behaviourist explanations, he instead offers that commitments are a complex of *side-bets* woven by the individual, ways of involving his or her action in a stream of "valuable actions" taken up by others. Following Dewey's theory of action, he notes that we involve ourselves in many potential actions; these become meaningful in light of collective consequences, jointly negotiated (Becker 1960).

Similarly, our experiences of enrolment and our encounters with standards are complexly woven and indeterminate. We grow and negotiate new selves, some labelled and some not. Some are unproblematic in their multiplicity; some cause great anguish and the felt need for unification, especially those that claim sovereignty over the entire self.

One of the great lessons of feminism has been about the power of collective multiplicity. We began with the experience of being *simultaneously* outsiders and insiders (Hubbard and Randall 1990). In the end, it is the simultaneity that has emerged as the most powerful aspect of feminism, rather than the outsiderness. The civil liberties/equal rights part of feminism would not have fundamentally extended political theory; but the double vision, and its combination of intimacy, ubiquity and collectivity has done so (Smith 1987). It's not so much that women have been left out, but that we were both in and out at the same time.

Sociology and anthropology have long traditions of studying the marginal person – the one who both belongs and does not belong, either by being a stranger (this is especially strong in the work of Simmel and Schutz) or by being simultaneously a member of more than one community. The person who is half black and half white, androgynous, of unknown parentage, the clairvoyant (who has access to another, unknown world) – all are either venerated or reviled in many cultures. The concept of the stranger, or strangeness to our own culture, as a window into

understanding culture, is fundamental to many branches of anthropology and to ethnomethodology and its fruitful investigations into the taken-for-granted (see e.g. Garfinkel 1967 and its many references to Schutz).

Sociologist Everett Hughes extended Simmel's concern with the stranger, drawing on the work of his teacher Robert Park. He considered the anthropological strangeness of encounters between members of different ethnic groups who worked and lived together and developed an analysis of some of the ways in which multiple membership plays itself out in the ecology of human relations. In "Dilemma and Contradictions of Status" for example, he explores what happens when a person working in an organization belongs to two worlds simultaneously, and the prescriptions for action and membership are different (1970: 141-50 [1945]). He used the example of a female physician, or a Black chemist. Later sociologists used a related concept, "role strain", but that is one which fails to convey the sense of "high tension zone" or the complexity of the relationships involved in simultaneous multiple membership.

Another student of Park's, Everett Stonequist, reviewed various forms of marginality in his monograph, *The Marginal Man: A Study in Personality and Culture Conflict* (1961 [1937]). He discussed the stories of various racial and cultural hybrids: in Hawaii, in Brazil, in the United States and South Africa, as well as the phenomenon of cultural hybridism, as among immigrants and denationalized peoples, and the Jews. What is interesting about his work is that he places marginality at the centre of *all* sociology:

> It is the fact of cultural duality which is the determining influence in the life of the marginal man. His is not a clash between inborn temperament and social expectation, between congenital personality tendency and the patterns of a given culture. His is not a problem of adjusting a single looking-glass self, but two or more such selves. And his adjustment pattern seldom secures complete cultural guidance and support, for his problem arises out of the shifting social order itself. (p. 217)

But we are all implicated in this changing social order, Stonequist goes on to say – through technology, through shifts in the meaning of race and nationality, and through the diffusion of peoples across lands.

Because, in analysing power and technology, we are involved in understanding precisely such shifts and precisely such shifting social orders, we could take a similar mandate. We know that the objects we are now including in the sociology of science and technology belong to many worlds at once. One person's scrap paper can be another's priceless formula; one person's career-building technological

breakthrough can be another's means of destruction. Elsewhere I have analysed the ways different social worlds construe the objects which inhabit more than on shared domain between scientists and others involved in the science-making enterprice, such as amateur collectors (Star and Griesemer 1989; Star 1988). People inhabit many different domains at once, as well, and the negotiation of identities, within and across groups, is an extraordinarily complex and delicate task. It's important not to presume either unity or single membership, either in the mingling of humans and nonhumans or amongst humans. Marginality is a powerful experience. And we are all marginal in some regard, as members of more than one community of practice (social world).

Conclusion: metaphors and heterogeneity

Because we are all members of more than one community of practice and thus of many networks, at the moment of action we draw together repertoires mixed from different worlds. Among other things, we create metaphors – bridges between those different worlds.

Power is about *whose* metaphor brings worlds together, and holds them there. It may be a power of the zero-point or a power of discipline; of enrolment or affinity; it may be the collective power of non-splitting. Metaphors may heal or create, erase or violate, impose a voice or embody more than one voice. Figure 1 sketches some of the possible configurations of this sort of power:

This essay is about a point of departure for the analysis of power. I do not recommend enfranchising or creating a market niche for those suffering from onion-allergy; nor a special needs assessment that would try to find infinitely flexible technologies for all such cases. Nor am I trying to say that conventions or standards are useless, or can be done without. But there is a question about where to begin and where to be based in out analyses of standards and technologies. If we begin with the zero point, like my friend Jan, we enter a high tension zone which may illuminate the properties of the more conventionalized, standardized aspects of those networks which are stabilized for many. Those who have no doors, or who resist delegation – those in wheelchairs, as well as door-makers and keepers, are good points of departure for our analysis, because they remind us that, indeed, it might have been otherwise.[6]

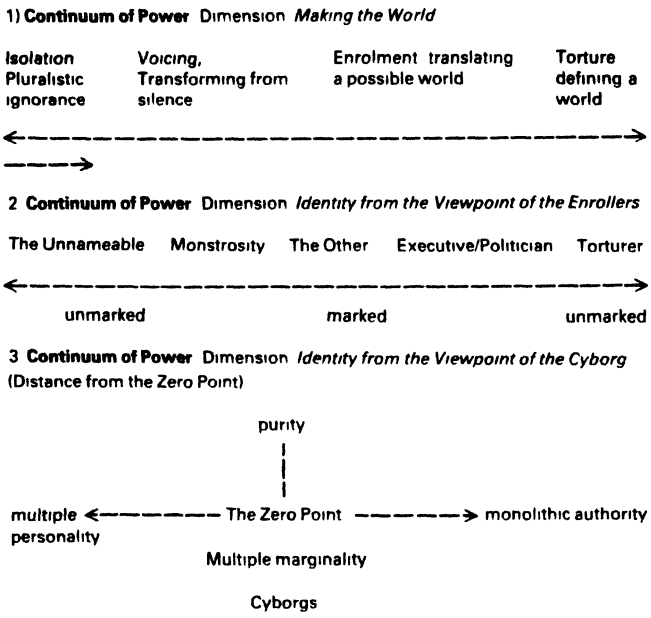

Figure 1. Dimensions of power

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Notes

1 Monsters are the embodiment of that which is exiled from the self. Some feminist writers have argued that monsters often represent the wildness which is exiled from women under patriarchial domination, perhaps the lesbian self, and that apparently dichotomous pairs such as Beauty and the Beast, Godzilla and Fay Wray are actually intuitions of a healthy female self.

2 There are many courses for managers whose speciality is teaching executives how to delegate things to their secretaries and others below them in the formal hierarchy. Traditionally, of course, and still for the most part, this is male-to-female delegation.
3 Along with antiracist theorists, Third World writers on de-centring, deconstructionists, literary theorists, feminist activists and theorists, and critical anthropologists, among others.
4 A methodological dictum of Everett Hughes (1970).
5 This has striking resonances with the creation of the world in the "total institution" described by Goffman in his classic book Asylums (1961). Fagerhaugh and Strauss (1979) as well describe a similar shrinkage of identity and of the world in their Politics of Pain Management.
6 This is one place where ethnomethodology and symbolic interactionism richly complement each other in exploring the taken-for-granted. See Becker 1967.

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Donna Haraway

Situated Knowledges*

The Science Question in Feminism and The Privilege of Partial Perspective[1]

Academic and activist feminist enquiry has repeatedly tried to come to terms with the question of what *we* might mean by the curious and inescapeable term "objectivity". We have used a lot of toxic ink and trees processed into paper decrying what *they* have meant and how it hurts *us*. The imagined "they" constitute a kind of invisible conspiracy of masculinist scientists and philosophers replete with grants and laboratories; and the imagined "we" are the embodied others, who are not allowed *not* to have a body, a finite point of view, and so an inevitably disqualifying and polluting bias in any discussion of consequence outside our own little circles, where a "mass"-subscription journal might reach a few thousand readers composed mostly of science-haters. At least, I confess to these paranoid fantasies and academic resentments lurking underneath some convoluted reflections in print under my name in the feminist literature in the history and philosophy of science. We, the feminists in the debates about science and technology, are the Reagan era´s "special-interest groups" in the rarified realm of epistemology, where traditionally what can count as knowledge is policed by philosophers codifying cognitive canon law. Of course, a special interest group is, by Reaganoid definition, any collective historical subject which dares to resist the stripped-down atomism of Star Wars, hypermarket, postmodern, media-simulated citizenship. Max Headroom doesn´t have a body; therefore, he alone *sees* everything in the great communicator´s empire of the Global Network. No wonder Max gets to have a naïve sense of humor and a kind of happily regressive, pre-oedipal sexuality, a sexuality which we ambivalently – and dangerously incorrectly – had imagined was reserved for lifelong inmates

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of female and colonized bodies, and maybe also white male computer hackers in solitary electronic confinement.

It has seemed to me that feminists have both selectively and flexibly used and been trapped by two poles of a tempting dichotomy on the question of objectivity. Certainly I speak for myself here, and I offer the speculation that there is a collective discourse on these matters. On the other hand, recent social studies of science and technology have made available a very strong social constructionist argument for *all* forms of knowledge claims, most certainly and especially scientific ones.[2] In these tempting views, no insider´s perspective is privileged, because all drawings of inside-outside boundaries in knowledge are theorized as power moves, not moves towards truth. So, from the strong social constructionist perspective, why should we be cowed by scientists´ descriptions of their activity and accomplishments; they and their patrons have stakes in throwing sand in our eyes. They tell parables about objectivity and scientific method to students in the first years of their initiation, but no practitioner of the high scientific arts would be caught dead *acting on* the textbook versions. Social contructionists make clear that official ideologies about objectivity and scientific method are particularly bad guides to how scientific knowledge is actually *made*. Just as for the rest of us, what scientists believe or say they do and what they really do have a very loose fit.

The only people who end up actually *believing* and, goddess forbid, acting on the ideological doctrines of disembodied scientific objectivity enshrined in elementary textbooks and technoscience booster literature are nonscientists, including a few very trusting philosophers. Of course, my designation of this last group is probably just a reflection of residual disciplinary chauvinism from identifying with historians of science and too much time spent with a microscope in early adulthood in a kind of disciplinary pre-oedipal and modernist poetic moment when cells seemed to be cells and organisms, organisms. *Pace*, Gertrude Stein. But then came the law of the father and its resolution of the problem of objectivity, solved by always already absent referents, deferred signifieds, split subjects, and the endless play of signifiers. Who wouldn´t grow up warped? Gender, race, the world itself – all seem just effects of warp speeds in the play of signifiers in a cosmic force field. All truths become warp speed effects in a hyper-real space of simulations. But we cannot afford these particular plays on words – the projects of crafting reliable knowledge about the "natural" world cannot be given over to the genre of paranoid or cynical science fiction. For political people, social constructionism cannot be allowed to decay into the radiant emanations of cynicism.

In any case, social constructionists could maintain that the ideological doctrine of scientific method and all the philosophical verbiage about epistemology were cooked up to distract our attention from getting to know the world *effectively* by

practising the sciences. From this point of view, science – the real game in town, the one we must play – is rhetoric, persuasion of the relevant social actors that one´s manufactured knowledge is a route to a desired form of very objective power. Such persuasions must take account of the structure of facts and artefacts, as well as of language-mediated actors in the knowledge game. Here, artefacts and facts are parts of the powerful art of rhetoric. Practice is persuasion, and the focus is very much on practice. All knowledge is a condensed node in an agonistic power field. The strong programme in the sociology of knowledge joins with the lovely and nasty tools of semiology and deconstruction to insist on the rhetorical nature of truth, including scientific truth. History is a story Western culture buffs tell each other; science is a contestable text and a power field; the content is the form.[3] Period. The form in science is the artefactual-social rhetoric of crafting the world into effective objects. This is a practice of world-changing persuasions that take the shape of amazing new objects – like microbes, quarks, and genes.

But whether or not they have the structure and properties of rhetorical objects, late twentieth-century scientific entities – infective vectors (microbes), elementary particles (quarks), and biomolecular codes (genes) – are not Romantic or modernist objects with internal laws of coherence.[4] They are momentary traces focused by force fields, or they are information vectors in a barely embodied and highly mutable semiosis ordered by acts of recognition and misrecognition. Human nature, encoded in its genome and its other writing practices, is a vast library worthy of Umberto Eco's imagined secret labyrinth in *The Name of the Rose* (1980). The stabilization and storage of this text of human nature promise to cost more than its writing. This is a terrifying view of the relationship of body and language for those of us who would still like to talk about *reality* with more confidence than we allow the Christian right's discussion of the Second Coming and their being raptured out of the final destruction of the world. We would like to think our appeals to real worlds are more than a desperate lurch away from cynicism and an act of faith like any other cult´s, no matter how much space we generously give to all the rich and always historically specific mediations through which we and everybody else must know the world.

So, the further I get with the description of the radical social constructionist programme and a particular version of postmodernism, coupled to the acid tools of critical discourse in the human sciences, the more nervous I get. Like all neuroses, mine is rooted in the problem of metaphor, that is, the problem of the relation of bodies and language. For example, the force field imagery of moves in the fully textualized and coded world is the matrix for many arguments about socially negotiated reality for the postmodern subject. This world-as-code is, just for starters, a high-tech military field, a kind of automated academic battlefield, where

blips of light called players disintegrate (what a metaphor!) each other in order to stay in the knowledge and power game. Technoscience and science fiction collapse into the sun of their radiant (ir)reality-war.[5] It shouldn´t take decades of feminist theory to sense the enemy here. Nancy Hartsock (1983b) got all this crystal clear in her concept of abstract masculinity.

I, and others, started out wanting a strong tool for deconstructing the truth claims of hostile science by showing the radical historical specificity, and so contestability, of *every* layer of the onion of scientific and technological constructions, and we end up with a kind of epistemological electro-shock therapy, which far from ushering us into the high stakes tables of the game of contesting public truths, lays us out on the table with self-induced multiple personality disorder. We wanted a way to go beyond showing bias in science (that proved too easy anyhow) and beyond separating the good scientific sheep from the bad goats of bias and misuse. It seemed promising to do this by the strongest possible constructionist argument that left no cracks for reducing the issues to bias versus objectivity, use versus misuse, science versus pseudo-science. We unmasked the doctrines of objectivity because they threatened our budding sense of collective historical subjectivity and agency and our "embodied" accounts of the truth, and we ended up with one more excuse for not learning any post-Newtonian physics and one more reason to drop the old feminist self-help practices of repairing our own cars. They´re just texts anyway, so let the boys have them back. Besides these textualized postmodern worlds are scary, and we prefer our science fiction to be a bit more utopic, maybe like *Woman on the Edge of Time* or even *Wanderground*.

Some of us tried to stay sane in these disassembled and dissembling times by holding out for a feminist version of objectivity. Here, motivated by many of the same political desires, is the other seductive end of the duplicitous objectivity problem. Humanistic Marxism was polluted at the source by its structuring ontological theory of the domination of nature in the self-construction of man and by its closely related impotence to historicize anything women did that didn´t qualify for a wage. But Marxism was still a promising resource in the form of epistemological feminist mental hygiene that sought our own doctrines of objective vision. Marxist starting points offered tools to get to our versions of standpoint theories, insistent embodiment, a rich tradition of critiques of hegemony without disempowering positivisms and relativisms and nuanced theories of meditaion. Some versions of psychoanalysis aided this approach immensely, especially anglophone object relations theory, which maybe did more for U.S. socialist feminism for a time than anything from the pen of Marx or Engels, much less Althusser or any of the late pretenders to sonship treating the subject of ideology and science.[6]

Another approach, "feminist empiricism", also converges with feminist uses of Marxian resources to get a theory of science which continues to insist on legitimate meanings of objectivity and which remains leery of a radical constructivism conjugated with semiology and narratology (Harding, 1986, pp. 24-6, 161-2). Feminists have to insist on a better account of the world; it is not enough to show radical historical contingency and modes of construction for everything. Here, we, as feminists, find ourselves perversely conjoined with the discourse of many practising scientists, who, when all is said and done, mostly believe they are describing and discovering things *by means of* all their constructing and arguing. Evelyn Keller has been particularly insistent on this fundamental matter, and Harding calls the goal of these approaches a "successor science". Feminists have stakes in a successor science project that offers a more adequate, richer, better account of a world, in order to live in it well and in critical, reflexive relation to our own as well as others´ practices of domination and the unequal parts of privilege and oppression that make up all positions. In traditional philosophical categories, the issue is ethics and politics perhaps more than epistemology.

So I think my problem, and "our" problem, is how to have *simultaneously* an account of radical historical contingency for all knowledge claims and knowing subjects, a critical practice for recognizing our own "semiotic technologies" for making meanings, *and* a no-nonsense commitment to faithful accounts of a "real" world, one that can be partially shared and friendly to earthwide projects of finite freedom, adequate material abundance, modest meaning in suffering, and limited happiness. Harding calls this necessary multiple desire a need for a successor science project and a postmodern insistence on irreducible difference and radical multiplicity of local knowledges. *All* components of the desire are paradoxical and dangerous, and their combination is both contradictory and necessary. Feminists don´t need a doctrine of objectivity that promises transcendence, a story that loses track of its mediations just where someone might be held responsible for something, and unlimited instrumental power. We don´t want a theory of innocent powers to represent the world, where language and bodies both fall into the bliss of organic symbiosis. We also don´t want to theorize the world, much less act within it, in terms of Global Systems, but we do need an earthwide network of connections, including the ability partially to translate knowledges among very different – and power-differentiated – communities. We need the power of modern critical theories of how meanings and bodies get made, not in order to deny meanings and bodies, but in order to live in meanings and bodies that have a chance for a future.

Natural, social, and human sciences have always been implicated in hopes like these. Science has been about a search for translation, convertibility, mobility of meanings, and universality – which I call reductionism, when one language (guess

whose) must be enforced as the standard for all the translations and conversions. What money does in the exchange orders of capitalism, reductionism does in the powerful mental orders of global sciences: there is finally only one equation. That is the deadly fantasy that feminists and others have identified is some versions of objectivity doctrines in the service of hierarchical and positivist orderings of what can count as knowledge. That is one of the reasons the debates about objectivity matter, metaphorically and otherwise. Immortality and omnipotence are not our goals. But we could use some enforceable, reliable accounts of things not reducible to power moves and agonistic, high-status games of rhetoric or to scientistic, positivist arrogance. This point applies whether we are talking about genes, social classes, elementary particles, genders, races, or texts; the point applies to the exact, natural, social, and human sciences, despite the slippery ambiguities of the words *objectivity* and *science* as we slide around the discursive terrain. In our efforts to climb the greased pole leading to a usable doctrine of objectivity, I and most other feminists in the objectivity debates have alternatively, or even simultaneously, held on to both ends of the dichotomy, which Harding describes in terms of successor science projects versus postmodernist accounts of difference and I have sketched in this article as radical constructivism versus feminist critical empiricism. It is, of course, hard to climb when you are holding on to both ends of a pole, simultaneously or alternatively. It is, therefore, time to switch metaphors.

The persistence of vision[7]

I would like to proceed by placing metaphorical reliance on a much maligned sensory system in feminist discourse: vision. Vision can be good for avoiding binary oppositions. I would like to insist on the embodied nature of all vision, and so reclaim the sensory system that has been used to signify a leap out of the marked body and into a conquering gaze from nowhere. This is the gaze that mythically inscribes all the marked bodies, that makes the unmarked category claim the power to see and not be seen, to represent while escaping representation. This gaze signifies the unmarked positions of Man and White, one of the many nasty tones of the word *objectivity* to feminist ears in scientific and technological, late industrial, militarized, racist and male dominant societies, that is, here, in the belly of the monster, in the United States in the late 1980s. I would like a doctrine of embodied objectivity that accommodates paradoxical and critical feminist science projects: Feminist objectivity means quite simply *situated knowledges*.

The eyes have been used to signify a perverse capacity – honed to perfection in the history of science tied to militarism, capitalism, colonialism, and male supremacy

– to distance the knowing subject from everybody and everything in the interest of unfettered power. The instruments of visulization in multinationalist, postmodernist culture have compounded these meanings of dis-embodiment. The visualizing technologies are without apparent limit; the eye of any ordinary primate like us can be endlessly enhanced by sonography systems, magnetic reasonance imaging, artificial intelligence-linked graphic manipulation systems, scanning electron microscopes, computer-aided tomography scanners, color enhancement techniques, satellite surveillance systems, home and office VDT's, cameras for every purpose from filming the mucous membrane lining the gut cavity of a marine worm living in the vent gases on a fault between continental plates to mapping a planetary hemisphere elsewhere in the solar system. Vision in this technological feast becomes unregulated gluttony; all perspective gives way to infinitely mobile vision, which no longer seems just mythically about the god-trick of seeing everything from nowhere, but to have put the myth into ordinary practice. And like the god-trick, this eye fucks the world to make techno-monsters. Zoe Sofoulis (1988) calls this the cannibal-eye of masculinist extra-terrestrial projects for excremental second birthing.

A tribute to this ideology of direct, devouring, generative, and unrestricted vision, whose technological mediations are simultaneously celebrated and presented as utterly transparent, the volume celebrating the 100th anniversary of the National Geographic Society closes its survey of the magazine´s quest literature, effected through its amazing photography, with two juxtaposed chapters. The first is on "Space", introduced by the epigraph, "The choice is the universe – or nothing" (Bryan, 1987, p. 352). Indeed. This chapter recounts the exploits of the space race and displays the color-enhanced "snapshots" of the outer planets reassembled from digitalized signals transmitted across vast space to let the viewer "experience" the moment of discovery in immediate vision of the "object".[8] These fabulous objects come to us simultaneously as indubitable recordings of what is simply there and as heroic feats of techno-scientific production. The next chapter, is the twin of outer space: "Inner Space", introduced by the epigraph, "The stuff of stars has come alive" (Bryan, 1987, p. 454). Here, the reader is brought into the realm of the infinitesimal, objectified by means of radiation outside the wave lengths that "normally" are perceived by hominid primates, i.e., the beams of lasers and scanning electron microscopes, whose signals are processed into the wonderful full-color snapshots of defending T cells and invading viruses.

But, of course, that view of infinite vision is an illusion, a god-trick. I would like to suggest how our insisting metaphorically on the paricularity and embodiment of all vision (although not necessarily organic embodiment and including technological mediation), and not giving in to the tempting myths of vision as a route to disembodiment and second-birthing, allows us to construct a usable, but

not an innocent, doctrine of objectivity. I want a feminist writing of the body that methaphorically emphasizes vision again, because we need to reclaim that sense to find our way through all the visualizing tricks and powers of modern sciences and technologies that have transformed the objectivity debates. We need to learn in our bodies, endowed with primate color and stereoscopic vision, how to attach the objective to our theoretical and political scanners in order to name where we are and are not, in dimensions of mental and physical space we hardly know how to name. So, not so perversely, objectivity turns out to be about particular and specific embodiment, and definitely not about the false vision promising transcendence of all limits and responsibility. The moral is simple: only partial perspective promises objective vision. This is an objective vision that initiates, rather than closes off, the problem of responsibility for the generativity of all visual practices. Partial perspective can be held accountable for both its promising and its destructive monsters. All Western cultural narratives about objectivity are allegories of the ideologies of the relations of what we call mind and body, of distance and responsibility, embedded in the science question in feminism. Feminist objectivity is about limited location and situated knowledge, not about transcendence and splitting of subject and object. In this way we might become answerable for what we learn how to see.

These are lessons which I learned in part walking with my dogs and wondering how the world looks without a fovea and very few retinal cells for color vision, but with a huge neural processing and sensory area for smells. It is a lesson available from photographs of how the world looks to the compund eyes of an insect or even from the camera eye of a spy satellite or the digitally transmitted signals of space probe-perceived differences "near" Jupiter that have been transformed into coffee table color photographs. The "eyes" made available in modern technological sciences shatter any idea of passive vision; these prosthetic devices show us that all eyes, including our own organic ones, are active perceptual systems, building on translations and specific *ways* of seeing, that is, ways of life. There is no unmediated photograph or passive camera obscura in scientific accounts of bodies and machines; there are only highly specific visual possibilities, each with a wonderfully detailed, active, partial way of organizing worlds. All these pictures of the world should not be allegories of infinite mobility and interchangeability, but of elaborate specificity and difference and the loving care people might take to learn how to see faithfully from another´s point of view, even when the other is our own machine. That´s not alienating distance; that´s a *possible* allegory for feminist versions of objectivity. Understanding how these visual systems work, technically, socially, and psychically, ought to be a way of embodying feminist objectivity.

Many currents in feminism attempt to theorize grounds for trusting especially the vantage points of the subjugated; there is good reason to believe vision is

better from below the brilliant space platforms of the powerful. (Hartsock, 1983a; Sandoyal, n.d.; Harding, 1986; Anzaldua, 1987). Linked to this suspicion, this chapter is an argument for situated and embodied knowledges and against various forms of unlocatable, and so irresponsible, knowledge claims. Irresponsible means unable to be called into account. There is a premium on establishing the capacity to see from the peripheries and the depths. But here lies a serious danger of romanticizing and/or appropriating the vision of the less powerful while claiming to see from their positions. To see from below is neither easily learned nor unproblematic, even if "we" "naturally" inhabit the great underground terrain of subjugated knowledges. The positionings of the subjugated are not exempt from critical re-examination, decoding, deconstruction, and interpretation; that is, from both semiological and hermeneutic modes of critical enquiry. The standpoints of the subjugated are not "innocent" positions. On the contrary, they are preferred because in principle they are least likely to allow denial of the critical and interpretative core of all knowledge. They are savvy to modes of denial through repression, forgetting, and disappearing acts – ways of being nowhere while claiming to see comprehensively. The subjugated have a decent chance to be on to the god-trick and all its dazzling – and, therefore, blinding – illuminations. "Subjugated" standpoints are preferred because they seem to promise more adequate, sustained, objective, transforming accounts of the world. But *how* to see from below is a problem requiring at least as much skill with bodies and language, with the mediations of vision, as the "highest" technoscientific visualizations.

Such preferred positioning is as hostile to various forms of relativism as to the most explicitly totalizing versions of claims to scientific authority. But the alternative to relativism is not totalization and single vision, which is always finally the unmarked category whose power depends on systematic narrowing and obscuring. The alternative to relativism is partial, locatable, critical knowledges sustaining the possibility of webs of connections called solidarity in politics and shared conversations in epistemology. Relativism is a way of being nowhere while claiming to be everywhere equally. The "equality" of positioning is a denial of responsibility and critical enquiry. Relativism is the perfect mirror twin of totalization in the ideologies of objectivity; both deny the stakes in location, embodiment and partial perspective; both make it impossible to see well. Relativism and totalization are both "god-tricks" promising vision from everywhere and nowhere equally and fully, common myths in rhetorics surrounding Science. But it is precisely in the politics and epistemology of partial perspectives that the possibility of sustained, rational, objective enquiry rests.

So with many other feminists, I want to argue for a doctrine and practice of objectivity that privileges contestation, deconstruction, passionate construction,

webbed connections, and hope for transformation of systems of knowledge and ways of seeing. But not just any partial perspective will do; we must be hostile to easy relativisms and holisms built out of summing and subsuming parts. "Passionate detachment" (Kuhn, 1982) requires more than acknowledged and self-critical partiality. We are also bound to seek perspective from those points of view, which can never be known in advance, which promise something quite extraordinary, that is, knowledge potent for constructing worlds less organized by axes of domination. In such a viewpoint, the unmarked category would *really* disappear – quite a difference from simply repeating a disappearing act. The imaginary and the rational – the visionary and objective vision – hover close together. I think Harding´s plea for a successor science and for postmodern sensibilities must be read to argue that this close touch of the fantastic element of hope for transformative knowledge and the severe check and stimulus of sustained critical enquiry are jointly the ground of any believable claim to objectivity or rationality not riddled with breath-taking denials and repressions. It is even possible to read the record of scientific revolutions in terms of this feminist doctrine of rationality and objectivity. Science has been utopian and visionary from the start; that is one reason "we" need it.

A commitment to mobile positioning and to passionate detachment is dependent on the impossibility of innocent "identity" politics and epistemologies as strategies for seeing from the standpoints of the subjugated in order to see well. One cannot "be" either a cell or molecule – or a woman, colonized person, laborer, and so on – if one intends to see and see from these positions critically. "Being" is much more problematic and contingent. Also, one cannot relocate in any possible vantage point without being accountable for that movement. Vision is *always* a question of the power to see – and perhaps of the violence implicit in our visualizing practices. With whose blood were my eyes crafted? These points also apply to testimony from the position of "oneself". We are not immediately present to ourselves. Self-knowledge requires a semiotic-material technology linking meanings and bodies. Self-identity is a bad visual system. Fusion is a bad strategy of positioning. The boys in the human sciences have called this doubt about self-presence the "death of the subject" that single ordering point of will and consciousness. That judgment seems bizarre to me. I prefer to call this generative doubt the opening of non-isomorphic subjects, agents, and territories of stories unimaginable from the vantage point of the cyclopian, self-satiated eye of the master subject. The Western eye has fundamentally been a wandering eye, a travelling lens. These peregrinations have often been violent and insistent on mirrors for a conquering self – but not always. Western feminists also *inherit* some skill in learning to participate in revisualizing worlds turned upside down in earth-transforming challenges to the views of the masters. All is not to be done from scratch.

The split and contradictory self is the one who can interrogate positionings and be accountable, the one who can construct and join rational conversations and fantastic imaginings that change history.[9] Splitting, not being, is the privileged image for feminist epistemologies of scientific knowledge. "Splitting" in this context should be about heterogeneous multiplicities that are simultaneously necessary and incapable of being squashed into isomorphic slots or cumulative lists. This geometry pertains within and among subjects. The topography of subjectivity is multidimensional; so therefore, is vision. The knowing self is partial in all its guises, never finished, whole, simply there and original; it is always constructed and stitched together imperfectly, and *therefore* able to join with another, to see together without claiming to be another. Here is the promise of objectivity: a scientific knower seeks the subject position, not of identity, but of objectivity, that is, partial connection. There is no way to "be" simultaneously in all, or wholly in any, of the privileged (subjugated) positions structured by gender, race, nation, and class. And that is a short list of critical positions. The search for such a "full" and total position is the search for the fetishized perfect subject of oppositional history, sometimes appearing in feminist theory as the essentialized Third World Woman (Mohanty, 1984). Subjugation is not grounds for an ontology; it might be a visual clue. Vision requires instruments of vision; an optics is a politics of positioning. Instruments of vision mediate standpoints; there is no immediate vision from the standpoints of the subjugated. Identity, including, self-identity, does not produce science; critical positioning does, that is, objectivity. Only those occupying the positions of the dominators are self-identical, unmarked, disembodied, unmediated, transcendent, born again. It is unfortunately possible for the subjugated to lust for and even scramble into that subject position – and then disappear from view. Knowledge from the point of view of the unmarked is truly fantastic, distorted, and irrational. The only position from which objectivity could not possibly be practiced and honored is the standpoint of the master, the Man, the One God, whose Eye produces, appropriates, and orders all difference. No one ever accused the God of monotheism of objectivity, only of indifference. The god-trick is self-identical, and we have mistaken that for creativity and knowledge, omniscience even.

Positioning is, therefore, the key practice in grounding knowledge organized around the imagery of vision, and much Western scientific and philosophic discourse is organized. Positioning implies responsibility for our enabling practices. It follows that politics and ethics ground struggles for and contests over what may count as rational knowledge. That is, admitted or not, politics and ethics ground struggles over knowledge projects in the exact, natural, social, and human sciences. Otherwise, rationality is simply impossible, an optical illusion projected from nowhere comprehensively. Histories of science may be powerfully told as histories

of the technologies. These technologies are ways of life, social orders, practices of visualization. Technologies are skilled practices. How to see? Where to see from? What limits to vision? What to see for? Whom to see with? Who gets to have more than one point of view? Who gets blinkered? Who wears blinkers? Who interprets the visual field? What other sensory powers do we wish to cultivate besides vision? Moral and political discourse should be the paradigm of rational discourse in the imagery and technologies of vision. Sandra Harding´s claim, or observation, that movements of social revolution have most contributed to improvements in science might be read as a claim about the knowledge consequences of new technologies of positioning. But I wish Harding had spent more time remembering that social and scientific revolutions have not always been liberatory, even if they have always been visionary. Perhaps this point could be captured in another phrase: the science question in the military. Struggles over what will count as rational accounts of the world are struggles over *how* to see. The terms of vision: the science question in colonialism, the science question in exterminism (Sofoulis 1988); the science question in feminism.

The issue in politically engaged attacks on various empiricisms, reductionisms, or other versions of scientific authority should not be relativism – but location. A dichotomous chart expressing this point might look like this:

universal rationality	ethnophilosophies
common language	heteroglossia
new organon	decontruction
unified field theory	oppositional positioning
world system	local knowledges
master theory	webbed accounts

But a dichotomous chart misrepresents in a critical way the positions of embodied objectivity which I am trying to sketch. The primary distortion is the illusion of symmetry in the chart´s dichotomy, making any position appear, first, simply alternative and, second, mutually exclusive. A map of tensions and resonances between the fixed ends of a charged dichotomy better represents the potent politics and epistemologies of embodied, therefore accountable, objectivity. For example, local knowledges have also to be in tension with the productive structurings that force unequal translations and exchanges – material and semiotic – within the webs of knowledge and power. Webs *can* have the property of systematicity, even of centrally structured global systems with deep filaments and tenacious tendrils into time, space, and consciousness, which are the dimensions of world history. Feminist accountability requires a knowledge tuned to reasonance, not to dichotomy. Gender is a field of structured

and structuring difference, where the tones of extreme localization, of the intimately personal and individualized body, vibrate in the same field with global high-tension emissions. Feminist embodiment, then, is not about fixed location in a reified body, female or otherwise, but about nodes in fields, inflections in orientations, and responsibility for difference in material-semiotic fields of meaning. Embodiment is significant prosthesis; objectivity cannot be about fixed vision when what counts as an object is precisely what world history turns out to be about.

How should one be positioned in order to see, in this situation of tensions, reasonances, transformations, resistances, and complicities? Here, primate vision is not immediately a very powerful metaphor or technology for feminist political-epistemological clarification, because it seems to present to consciousness already processed and objectified fields; things seem already fixed and distanced. But the visual metaphor allows one to go beyond fixed appearances, which are only the end products. The metaphor invites us to investigate the varied apparatuses of visual production, including the prosthetic technologies interfaced with our biological eyes and brains. And here we find highly particular machineries for processing regions of the electro-magnetic spectrum into our pictures of the world. It is in the intricacies of these visualization technologies in which we are embedded that we will find metaphors and means for understanding and intervening in the patterns of objectification in the world – that is, the patterns of reality for which we must be accountable. In these metaphors, we find means for appreciating simultaneously *both* the concrete, "real" aspect and the aspect of semiosis and production in what we call scientific knowledge.

I am arguing for politics and epistemologies of location, positioning, and situating, where partiality and not universality is the condition of being heard to make rational knowledge claims. These are claims on people´s lives. I am arguing for the view from a body, always a complex, contradictory, structuring, and structured body, versus the view from above, from nowhere, from simplicity. Only the god-trick is forbidden. Here is a criterion for deciding the science question in militarism, that dream science/technology of perfect language, perfect communication, final order.

Feminism loves another science: the sciences and politics of interpretation, translation, stuttering, and the partly understood. Feminism is about the sciences of the multiple subject with (at least) double vision. Feminism is about a critical vision consequent upon a critical positioning in inhomogenous gendered social space.[10] Translation is always interpretive, critical, and partial. Here is a ground for conversation, rationality, and objectivity – which is power-sensitive, not pluralist, "conversation." It is not even the mythic cartoons of physics and mathematics – incorrectly caricatured in anti-science ideology as exact, hyper-simple knowledges – that have come to represent the hostile other to feminist paradigmatic models of

scientific knowledge, but the dreams of the perfectly known in high-technology, permanently militarized scientific productions and positionings, the god-trick of a Star Wars paradigm of rational knowledge. So location is about vulnerability; location resists the politics of closure, finality, or to borrow from Althusser, feminist objectivity resists "simplification in the last instance". That is because feminist embodiment resists fixation and is insatiably curious about the webs of differential positioning. There is no single feminist standpoint because our maps require too many dimensions for that metaphor to ground our visions. But the feminist standpoint theorists´ goal of an epistemology and politics of engaged, accountable positioning remains eminently potent. The goal is better accounts of the world, that is, "science".

Above all, rational knowledge does not pretend to disengagement: to be from everywhere and so nowhere, to be free from interpretation, from being represented, to by fully self-contained or fully formalizable. Rational knowledge is a process of ongoing critical interpretation among "fields" of interpreters and decoders. Rational knowledge is power-sensitive conversation (King, 1987a):

knowledge:community::knowledge:power
hermeneutics:semiology::critical interpretation:codes.

Decoding and transcoding plus translation and criticism; all are necessary. So science becomes the paradigmatic model, not of closure, but of that which is contestable and contested. Science becomes the myth, not of what escapes human agency and responsibility in a realm above the fray, but, rather, of accountability and responsibility for translations and solidarities linking the cacophonous visions and visionary voices that characterize the knowledges of the subjugated. A splitting of senses, a confusion of voice and sight, rather than clear and distinct ideas, becomes the metaphor for the ground of the rational. We seek not the knowledges ruled by phallogocentrism (nostalgia for the presence of the one true Word) and disembodied vision, but those ruled by partial sight and limited voice. We do not seek partiality for its own sake but for the sake of the connections and unexpected openings situated knowledges make possible. Situated knowledges are about communities, not about isolated individuals. The only way to find a larger vision is to be somewhere in particular. The science question in feminism is about objectivity as positioned rationality. Its images are not the products of escape and transcendence of limits, i.e., the view from above, but the joining of partial views and halting voices into a collective subject position that promises a vision of the means of ongoing finite embodiment, of living within limits and contradictions – of views from somewhere.

Objects as actors: The apparatus of bodily production

Throughout this reflection on "objectivity", I have refused to resolve the ambiguities built into referring to science without differentiating its extraordinary range of contexts. Through the insistent ambiguity, I have foregrounded a field of commonalities binding exact, physical, natural, social, political, biological, and human sciences; and I have tied this whole heterogeneous field of academically (and industrially, for example, in publishing, the weapons trade, and pharmaceuticals) institutionalized knowledge production to a meaning of science that insist on its potency in ideological struggles. But, partly in order to give play to both the specificities and the highly permeable boundaries of meanings in discourse on science, I would like to suggest a resolution to one ambiguity. Throughout the field of meanings constituting science, one of the commonalitites concerns the status of any object of knowledge and of related claims about the faithfulness of our accounts to a "real world", no matter how mediated for us and no matter how complex and contradictory these worlds may be. Feminists, and others who have been most active as critics of the sciences and their claims or associated ideologies, have shied away from doctrines of scientific objectivity in part because of the suspicion that an "object" of knowledge is a passive and inert thing. Accounts of such objects can seem to be either appropriations of a fixed and determined world reduced to resource for instrumentalist projects of destructive Western societies, or they can be seen as masks for interests, usually dominating interests.

For example, "sex" as an object of biological knowledge appears regularly in the guise of biological determinism, threatening the fragile space for social contructionism and critical theory, with their attendant possibilities for active and transformative intervention, called into being by feminist concepts of gender as socially, historically, and semiotically positioned difference. And yet, to lose authoritative biological accounts of sex, which set up productive tensions with its binary pair, gender, seems to be to lose too much; it seems to be to lose not just analytic power within a particular Western tradition, but the body itself as anything but a blank page for social inscriptions, including those of biological discourse. The same problem of loss attends the radical "reduction" of the objects of physics or of any other sciences to the ephemera of discursive production and social construction.[11]

But the difficulty and loss are not necessary. They derive partly from the analytic tradition, deeply indebted to Aristotle and to the transformative history of "White Capitalist Partriarchy" (how may we name this scandalous Thing?) that turns everything into a resource for appropriation, in which an object of knowledge is finally itself only matter for the seminal power, the act, of the knower. Here, the

object both guarantees and refreshes the power of the knower, but any status as *agent* in the productions of knowledge must be denied the object. It – the world – must, in short, be objectified as a thing, not as an agent, it must be matter for the self-formation of the only social being in the productions of knowledge, the human knower. Zoe Sofoulis (1988) identified the structure of this mode of knowing in technoscience as "resourcing" – as the second birthing of Man through the homogenizing of all the world´s body into resource for his perverse projects. Nature is only the raw material of culture, appropriated, preserved, enslaved, exalted, or otherwise made flexible for disposal by culture in the logic of capitalist colonialism. Similarly, sex is only the matter to the act of gender; the productionist logic seems inescapable in traditions of Western binarisms. This analytical and historical narrative logic accounts for my nervousness about the sex/gender distinction in the recent history of feminist theory. Sex is "resourced" for its re-presentation as gender, which "we" can control. It has seemed all but impossible to avoid the trap of an appropriationist logic of domination built into the nature/culture binarism and its generative lineage, including the sex/gender distinction.

It seems clear that feminist accounts of objectivity and embodiment – that is, of a world – of the kind sketched in this chapter require a deceptively simple maneuver within inherited Western analytical traditions, a maneuver begun in dialectics, but stopping short of the needed revisions. Situated knowledges require that the object of knowledge be pictured as an actor and agent, not a screen or a ground or a resource, never finally as slave to the master that closes off the dialectic in his unique agency and authorship of "objective" knowledge. The point is paradigmatically clear in critical approaches to the social and human sciences, where the agency of people studied itself transforms the entire project of producing social theory. Indeed, coming to terms with the agency of the "objects" studied is the only way to avoid gross error and false knowledge of many kinds in these sciences. But the same point must apply to the other knowledge projects called sciences. A corollary of the instence that ethics and politics covertly or overtly provide the bases for objectivity in the sciences as a heterogeneous whole, and not just in the social sciences, is granting the status of agent/actor to the "objects" of the world. Actors come in many and wonderful forms. Accounts of a "real" world do not, then, depend on a logic of "discovery" but on a power-charged social relation of "conversation". The world neither speaks itself nor disappears in favour of a master decoder. The codes of the world are not still, waiting only to be read. The world is not raw material for humanization; the thorough attacks on humanism, another branch of "death of the subject" discourse, have made this point quite clear. In some critical sense that is crudely hinted at by the clumsy category of the social or of agency, the world encountered in knowledge projects is an active entity. In so far as

a scientific account has been able to engage this dimension of the world as object of knowledge, faithful knowledge can be imagined and can make claims on us. But no particular doctrine of representation or decoding or discovery guarantees anything. The approach I am recommending is not a version of "realism", which has proved a rather poor way of engaging with the world´s active agency.

My simple, perhaps simple-minded, maneuver is obviously not new in Western philosophy, but it has a special feminist edge to it in relation to the science question in feminism and to the linked question of gender as situated difference and of female embodiment. Ecofeminists have perhaps been most insistent on some version of the world as active subject, not as resource to be mapped and appropriated in burgeois, Marxist, or masculinist projects. Acknowledging the agency of the world in knowledge makes room for some unsettling possibilities, including a sense of the world´s independent sense of humor. Such a sense of humor is not comfortable for humanists and others committed to the world as resouce. Richly evocative figures exists for feminist visulizations of the world as witty agent. We need not lapse into an appeal to a primal mother resisting becoming resource. The Coyote or Trickster, embodied in American Southwest Indian accounts, suggests our situation when we give up mastery but keep searching for fidelity, knowing all the while that we will be hoodwinked. I think these are useful myths for scientists who might be our allies. Feminist objectivity makes room for surprises and ironies at the heart of all knowledge production; we are not in charge of the world. We just live here and try to strike up non-innocent conversations by means of our prosthetic devices, including our visulization technologies. No wonder science fiction has been such a rich writing practice in recent feminist theory. I like to see feminist theory as a reinvented coyote discourse obligated to its enabling sources in many heterogeneous accounts of the world.

Another rich feminist practice in science in the last couple of decades illustrates particularly well the "activation" of the previously passive categories of objects of knowledge. The activation permanently problematizes binary distinctions like sex and gender, without however eliminating their strategic utility. I refer to the reconstructions in primatology, especially, but not only women´s practice as primatologists, evolutionary biologists, and behavioral ecologists, of what may count as sex, especially as female sex, in scientific accounts (Haraway, 1989b). The *body*, the object of biological discourse, itself becomes a most engaging being. Claims of biological determinism can never be the same again. When female "sex" has been so thoroughly re-theorized and revisualized that it emerges as practically indistinguishable from "mind", something basic has happened to the categories of biology. The biological female peopling current biological behavioral accounts has almost no passive properties left. She is structuring and active in every respect; the "body"

is an agent, not a resource. Difference is theorized *biologically* as situational, not intrinsic, at every level from gene to foraging pattern, thereby fundamentally changing the biological politics of the body. The relations between sex and gender have to be categorically reworked within these frames of knowledge. I would like to suggest this trend in explanatory strategies in biology as an allegory for interventions faithful to projects of feminist objectivity. The point is not that these new pictures of the biological female are simply true or not open to contestation and conversation. Quite the opposite. But these pictures foreground knowledge as situated conversation at every level of its articulation. The boundary between animal and human is one of the stakes in this allegory, as well as that between machine and organism.

So I will close with a final category useful to a feminist theory of situated knowledges: the apparatus of bodily production. In her analysis of the production of the poem as an object of literary value, Katie King offers tools that clearify matters in the objectivity debates among feminists. King suggests the term "apparatus of literary production" to highlight the emergence of what is embodied as literature at the intersection of art, business, and technology. The apparatus of literary production is a matrix from which "literature" is born. Focusing on the potent object of value called the "poem", King applies her analytic framework to the relation of women and writing technologies (King, 1987b). I would like to adapt her work to understanding the generation – the actual production and reproduction – of bodies and other objects of value in scientific knowledge projects. At first glance, there is a limitation to using King´s scheme inherent in the "facticity" of biological discourse that is absent from literary discourse and its knowledge claims. Are biological bodies "produced" or "generated" in the same strong sense as poems? From the early stirrings of Romanticism in the late eighteenth century, many poets and biologists have believed that poetry and organisms are siblings. *Frankenstein* may be read as a meditation on this proposition. I continue to believe in this potent proposition, but in a postmodern and not a Romantic manner. I wish to translate the ideological dimensions of "facticity" and "the organic" into a cumbersome entity called a "material-semiotic actor". This unwieldy term is intended to portray the object of knowledge as an active, meaning-generating axis of the apparatus of bodily production, without *ever* implying the immediate presence of such objects or, what is the same thing, their final or unique determination of what can count as objective knowledge at a particular historical juncture. Like King's objects called "poems", which are sites of literary production where language also is an actor independent of intentions and authors, bodies as objects of knowledge are material-semiotic generative nodes. Their *boundaries* materialize in social interaction. Boundaries are drawn by mapping practices; "objects" do not pre-exist as such. Objects are boundary projects. But boundaries shift from within; boundaries are

very tricky. What boundaries provisionally contain remains generative, productive of meanings and bodies. Siting (sighting) boundaries is a risky practice.

Objectivity is not about dis-engagement but about mutual *and* usually unequal structuring, about taking risks in a world where "we" are permanently mortal, that is, not in "final" control. We have, finally, no clear and distinct ideas. The various contending biological bodies emerge at the intersection of biological research and writing, medical and other business practices, and technology, such as the visualization technologies enlisted as metaphores in this chapter. But also invited into that node of intersection is the analogue to the lively languages that actively intertwine in the production of literary value: the coyote and the protean embodiments of the world as witty agent and actor. Perhaps the world resists being reduced to mere resource because it is – not mother/matter/mutter – but coyote, a figure for the always problematic, always potent tie between meaning and bodies. Feminist embodiment, feminist hopes for partiality, objectivity, and situated knowledges, turn on conversations and codes at this potent node in fields of possible bodies and meanings. Here is where science, science fantasy and science fiction converge in the objectivity question in feminism. Perhaps our hopes for accountability, for politics, for ecofeminism, turn on revisioning the world as coding trickster with whom we must learn to converse.

Notes

1 This chapter originated as a commentary on Harding (1986), at the Western Division meetings of the American Philosophical Association, San Francisco, March 1987. Support during the writing of this paper was generously provided by the Alpha Fund of the Institute for Advanced Study, Princeton, New Jersey. Thanks especially to Joan Scott, Rayna Rapp, Judy Newton, Judy Butler, Lila Abu-Lughod, and Dorinne Kondo.

2 For example, see Karin Knorr-Cetina and Michael Mulkay (1983); Bijker *et al*. (1987); and especially, Latour (1984, 1988). Borrowing from Michael Tournier´s *Vendredi* (1967), Latour´s brilliant and maddening aphoristic polemic against all forms of reductionism, makes the essential point for feminists: "Méfiez-vous de la pureté, c'est le vitriol de l'ame" (Latour, 1984, p. 171). Latour is not otherwise a notable feminist theorist, but he might be made into one by readings as perverse as those he makes of the laboratory, that great machine for making significant mistakes faster than anyone else can, and so gaining world-changing power. The laboratory for Latour is the railroad industry of epistemology, where facts can only be made to run on the tracks laid down from the laboratory out. Those who control the railroads control the surrounding territory. How could we have forgotten? But now it´s not so much the bankrupt railroads we need as the satellite network. Facts run on light beams these days.

3 For an elegant and very helpful elucidation of a non-cartoon version of this argument, see White (1987), I still want more; and unfulfilled desire can be a powerful seed for changing the stories.

4 In her analysis exploring the fault line between modernism and postmodernism in ethnography and anthropology – in which the high stakes are the authorization or prohibition to craft *comparative* knowledge across "cultures", from some epistemologically grounded vantage point *either* inside, outside, or in dialogical relation with any unit of analysis – Marilyn Strathern (1987a) made the crucial observation that it is not the written ethnography that is parallel to the work of art as object-of-knowledge, but the *culture*. The Romantic and modernist natural-technical objects of knowledge, in science and in other cultural practice, stand on one side of this divide. The postmodernist formation stands on the other side, with its "anti-aesthetic" of permanently split, problematized, always receding and deferred "objects" of knowledge and practice, including signs, organisms, systems, selves, and cultures. "Objectivity" in a postmodern frame cannot be about unproblematic objects; it must be about specific prosthesis and translation. Objectivity, which at root has been about crafting *comparative* knowledge (how to name things to be stable and to be like each other), becomes a question of the politics of redrawing of boundaries in order to have non-innocent conversations and connections. What is at stake in the debates about modernism and postmodernism is the pattern of relationships between and within bodies and language.

5 Zoe Sofoulis (1988) has produced a dazzlingly (she will forgive me the metaphor) theoretical treatment of technosience, the psychoanalysis of science fiction culture, and the metaphorics of extra-terrestrialism, including a wonderful focus on the ideologies and philosophies of light, illumination, and discovery in Western mythics of science and technology. My essay was revised in dialogue with Sofoulis´s arguments and metaphors in her PhD dissertation.

6 Crucial to this discussion are Sandra Harding (1986), Keller (1985), Hartsock (1983a, 1983b), Flax (1983, 1987), Keller and Grontkowski (1983), H. Rose, (1986) Haraway (1991), Petchesky (1987).

7 John Varley´s science fiction short story, "The Persistence of Vision", is part of the inspiration for this section. In the story, Varley constructs a utopian community designed and built by the deaf-blind. He then explores these people´s technologies and other mediations of communication and their relations to sighted children and visitors (Varley, 1978). In the story, "Blue Champagne", Varley (1986), transmutes the theme to interrogate the politics of intimacy and technology for a paraplegic young woman whose prosthetic device, the golden gypsy, allows her full mobility. But since the infinitely costly device is owned by an intergalactic communications and entertainment empire for which she works as a media star making "feelies", she may keep her technological, intimate, enabling, other self only in exchange for her complicity in the commodification of all experience. What are her limits to the reinvention of experience for sale? Is the personal political under the sign of simulation? One way to read Varley´s repeated investigations of finally always limited embodiments, differently abled beings, prosthetic technologies, and cyborgian encounters with their finitude, despite their extraordinary transcendence of "organic" orders is to find an allegory for the personal and political in the historical mythic time of the late twentieth century, the era of techno-biopolitics. Prosthesis becomes a fundamental category for understanding our most intimate selves. Prosthesis is semiosis, the making of meanings and bodies, not for transcendence, but for power-charged communication.

8 I owe my understanding of the experience of these photographs to Jim Clifford, University of California at Santa Cruz, who identified their "land ho!" effect on the reader.

9 Joan Scott reminded me that Teresa de Lauretis (1986a, pp. 14-15) put it like this:

> Differences among women may be better understood as differences within women... But once understood in their constitutive power – once it is understood, that is, that these differences not only constitute each woman´s consciousness and sucjective limits but all together define the *female subject of feminism* in its very specificity, is inherent and at least for now irreconcilable contradiction – these differences, then, cannot be again collapsed into a fixed identity, a sameness of all women as Woman, or a representation of Feminism as a coherent and available image.

10 Harding (1986, p. 18) suggested that gender has three dimensions, each historically specific: gender symbolism, the social-sexual division of labor, and processes of constructing individual gendered identity. I would enlarge her point to note that there is no reason to expect the three dimensions to co-vary or co-determine each other, at least not directly. That is, extremely steep gradients between contrasting terms in gender symbolism may very well not correlate with sharp social-sexual divisions of labour or social power, but may be closely related to sharp racial stratification or something else. Similarly, the processes of gendered subject formation may not be directly illuminated by knowledge of the sexual division of labour or the gender symbolism in the particular historical situation under examination. On the other hand, we should expect mediated relations among the dimensions. The mediations might move through quite different social axes of organization of both symbols, practice, and identity, such as race. And vice versa. I would suggest also that science, as well as gender or race, might usefully be broken up into such a multi-part scheme of symbolism, social practice, and subject position. More than three dimensions suggest themselves when the parallels are drawn. The different dimensions of, for example, gender, race and science might mediate relations among dimensions on a parallel chart. That is, racial divisions of labour might mediate the patterns of connection between symbolic connections and formation of individual subject positions on the science or gender chart. Or formations of gendered or racial subjectivity might mediate the relations between scientific social division of labour and scientific symbolic patterns.

The chart below begins an analysis by parallel dissections. In the chart (and in reality?), both gender and science are analytically asymmetrical; i.e., each term contains and obscures a structuring hierachicalized binarism, sex/gender and nature/science. Each binarism orders the silent term by a logic of appropriation, as resource to product, nature to culture, potential to actual. Both poles of the binarism are contructed and structure each other dialectically. Within each voiced or explicit term, further asymmetrical splittings can be excavated, as from gender, masculine to feminine, and from science, hard sciences to soft sciences. This is a point about remembering how a particular analytical tool works, willy nilly, intended or not. The chart reflects common ideological aspects of discourse on science and gender and may help as an analytical tool to crack open mystified units like Science or Woman.

GENDER	SCIENCE
symbolic system	symbolic system
social division of labor	social division of labor
(by sex, by race, etc.)	(e.g. by craft, industrial, or post-industrial logics)
individual identity/subject position	individual identity/subject position
(desiring/desired; autonomous/relational)	(knower/known; scientist/other)
material culture	material culture
(gender paraphernalia and daily	(laboratories, the narrow tracks on

gender technologies, the narrow tracks on which sexual difference runs)	which facts run)
dialectic of construction and discovery	dialectic of construction and discovery

11 Evelyn Keller (1987) insists on the important possibilities opened up by the construction of the intersection of the distinction between sex and gender, on the one hand, and nature and science, on the other. She also insists on the need to hold to some non-discursive grounding in "sex" and "nature", perhaps what I am calling the "body" and "world".

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Part 2: Modest Interventions

Deborah Heath

Bodies, Antibodies, and Modest Interventions*

Since 1992 I have been doing fieldwork on the cultural practices surrounding contemporary genetics, spending extended periods in two US research laboratories and following the networks that link laboratory life to wider worlds. My interest is both in comparing particular variants of local, embodied technoscientific practice and in what emerges from translocal encounters. One of the labs is in a molecular biotechnology department, where I found my participant niche working as a DNA sequencing technician. Preparing DNA samples for automated computerized sequencing, I worked with an array of tools ranging from bacteria and enzymes to robotic workstations – a cyborgian network of organisms and machines.

The second lab, the focus of much of this paper, is part of a research unit located in a children's orthopedic hospital. Working as an apprentice cell culture technician, my tasks included learning to collaborate with mice, lymphocytes, and tumor cells and to harvest and purify the monoclonal antibodies that they/we produced. The unit's overall focus is research on connective tissue. The principal focus of my lab group has been on the characterization of a connective-tissue protein called fibrillin, discovered by Dr. Lynn Y. Sakai, the head of the lab (Sakai, Keene, and Engvall 1986). Mutations in the fibrillin gene have been shown to be the key factor in a heritable condition known as Marfan syndrome.

In November 1992 I followed members of the lab to the Second International Symposium on the Marfan Syndrome, a gathering held primarily for scientists and clinicians. In August 1993 the National Marfan Foundation, the US lay organization for affected individuals and their advocates, held its ninth annual meeting in the city where the lab is located, in conjunction with a scientific workshop on the

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Marfan syndrome. The scientific meeting was chaired by Lynn Sakai and organized with support from members of her lab, including its resident ethnographer. Like the marketplace, the fair, the pilgrimage site, or the E-mail conference, meetings such as these are terrains where boundaries of identity and difference are mapped and contested, streching the limits of local cultural practices.

This essay joins a conversation weaving together the interpretive and critical threads of cultural studies, feminist theory, and social studies of technoscientific knowledge and power (cf. Haraway 1994, 1997; Rouse 1993, 1996a; Traweek 1993). The paper explores the heterogeneous networks of association (*pace* Latour 1987) that infuse everyday laboratory practice and link it to other cultural-material domains, including the annual conventions that bring together those affected by Marfan syndrome with researchers, clinicians, their patrons, and others, including filmmakers, public relations officers, and ethnographers. Tracing the traffic in and out of the lab underscores the heterogeneity of technoscience and the permeability of its borders. At the same time, it draws attention to asymmetries, differences, and contestation among producers and consumers of technoscientific knowledge.[1]

The main characters of this essay comprice a spliced community, a multiplex alignment of human and nonhuman players linked through medical, molecular, and personal embodiments of Marfan syndrome. The stories presented here are neither the master narratives of disembodied subjects nor transparently descriptive anecdotes. Instead, these tales are devices in what I'm calling *modest interventions* – translocal engagements that reveal, perturb, and perhaps transform the constructed boundaries between local, situated knowledges.

In their account of Robert Boyle and the emergent culture of modern science in seventeenth-century England, Shapin and Schaffer (1985) describe the figure of the modest witness, the self-invisible gentleman-scientist who aimed to mirror nature while revealing not a trace of his own history.[2] The originary practices of the Early Modern modest witness, as Elizabeth Potter (2001) and Donna Haraway (1997) have compellingly shown, undergird canonical gendered notions of objectivity. The accounts in this essay speak to an alternative mode of witnessing, based on modest interventions and achieved not through holding objects at a distance but through partial connections and intermittent engagements among different constituencies. Unlike the "view from nowhere" (Bordo 1990; Nagel 1986) that has been the legacy of the modest witness, modest interventions recognize – and make use of – both the local, contingent character of scientific practice and the traffic that connects different locales.

Appropriating Latourian actor-networks (cf. Latour 1987; Callon 1986) for use in the poststructuralist toolkit, my approach is to chart the networks of association that link laboratory practices to other domains, while at the same time attending

to the engagements, disjunctures, and constructed boundaries that disrupt what might otherwise appear to be a seamless web of linkages. Taking ethnographic liberties, some of the interventions that I will describe are my own; others are made by those with prior claim to native status in these technoscientific milieux. In both cases the effect of these border incidents is to make connections visible, at best transforming contradiction into a resource, a field of possibility.

The mindful body at the bench

Lynn Y. Sakai is a protein biochemist, well regarded in her field. She is sansei, a third-generation Japanese American. Before beginning her scientific career she did graduate work in political philosophy. I had worked briefly in the lab where she is PI (principal investigator) before beginning my research in the DNA sequencing group. She had invited me back in part, she said, so that I would have a broader understanding of contemporary biology. "It's more than just what the DNA gene jockeys do", she said. "You should learn something about what DNA expresses: the proteins." Sakai and I also share an interest in critical theory, though apparently from opposite sides of a modernist divide: she regards me, usually with a kind of gracious scientific curiousity, as a "nonlinear thinker." Since beginning of our work together we have maintained a running dialogue about power and technoscience. In the following exchange I asked her to explain why she had left philosophy for science.

> LYS: It was because I came to think that philosophy, theory, had no place in the modern world. It used to be that philosophy was related to political activism, to what went on in the world. These days, my old mentor used to say, theory has gone mad. There's no unified theory to account for the complexities of the modern world. In science you work with your hands; this activity is what Marx said makes us uniquely human. You have a direct impact on things in the world in science, with less chance of being alienated from your work.
> DH: Unless you're a technician.
> LYS: [laughs] Yes, that's right. Most of the time technicians don't get credit for the work that they do. I think that's wrong. Often what happens is that the post-doc is handed a project that a technician had started. The post-doc just puts the icing on the cake and then gets credit for the work, usually as first author on an article. Of course, the PI is last author; they still own the work.
> DH: So really, the scientific labor process works much the way the industrial labor process does.
> LYS: Yes, that's why scientists cling to the distinction between mind and

> hands; it has to do with how credit for work is allocated. The PI is the mind; the technicians are the hands.
> DH: So what would make the hierarchical order of things in science change?
> LYS: I don't know. I try to do things differently in my own lab. My technicians get credit for the work that they do; they're listed as authors on my papers, and I have them give presentations. I can run my lab the way I choose to.[She laughs.] Of course, I'm still the last author. Labs are like independent fiefdoms; they're really premodern.

On one level, the bench laboratory is the territorial domain of a paritcular PI. Still, no lab is wholly independent or self-contained. Its autonomy is mitigated by dependence on patrons for funding, space, and equipment, as well as by interdependence with collaborators and reliance on an infrastructure of technical, administrative, and maintenance personnel shared with other laboratories.

Lynn Sakai's laboratory is located in the research unit that occupies the fifth floor of a children's orthopedic hospital in Portland, Oregon. Both hospital and research unit are supported by the Ancient Arabic Order Nobles of the Mystic Shrine, the Masonic fraternal organization known as the Shriners that was founded in the US in the 1870s. On my way to the lab I pass a display case in the first-floor lobby of the hospital that houses a collection of red fezzes with black tassels, part of the orientalist ceremonial garb of the organization. Patient care is free at all Shriners Hospitals for Crippled Children, and the funding for researchers is comparable to that available through US government sources. On clinic day the lobby is filled with children, many of them in wheelchairs of moving down the hallway using walkers or crutches. Ignoring the elevator, I pass a room marked "Prosthetics and Orthotics" before I enter the stairway to the fifth floor.

The perceived boundary between the world of the research unit and the activities of the rest of the hospital is monitored and reinforced by the unit's spatial segregation. As I enter from the stairway, I am met by large signs on the exterior doors that read "Warning: No Unauthorized Personnel." The floor of the research unit is divided into individual laboratories, each one allocated to a particular principal investigator and his or her staff of technicians, graduate students, and post-docs. In the hallways adjoining the labs hang a series of framed photographs, enlargements of pictures captured by an electron microscope. Several are images of the protein called fibrillin.

It is one of my first days in the lab where I will be working as a cell culture technician. I have successfully passed the initial induction requirements, drug-screening and TB tests, and have been given a photo ID card that identifies me as a "research tech". I am now in the cell culture room in Lab Three with the head

of the lab, who is showing me how to make the medium that is used to feed cells. I am wondering if the skills I acquired working as a DNA sequencing technician in another lab will help me out. I am concentrating, holding an electric pipetter fitted with a long disposable plastic pipette tube, trying carefully to measure one of the ingredients for the medium. It feels awkward in comparison to the smaller plastic-tipped pipetter that I had grown accustomed to using for DNA work. "No, no, not like that." The head of the lab shakes her head, laughing. "You don't have to be that careful. It's not like molecular biology!"

This encounter, among many others, taught me something about how technoscience is grounded in everyday practice and how specific, often mundane, practices help to distinguish one field of endeavor from another. It reveals both the local, embodied materiality of technoscientific knowledge and its translocal heterogeneity. The body-knowledge that I had brought with me from my other field site served in this new setting as a cultural boundary marker, revealing my time spent with a different disciplinary clan.

Recent studies in the sociology of science have pointed to the importance of local or tacit knowledge in technoscientific practice and knowledge production (cf. Collins 1987; Knorr-Cetina 1981, 1992; Lynch 1985). As Cambrosio and Keating (1988:249) put it, "Much of what is important to the understanding of an experimental protocol is not contained in the instructions but is incorporated in the various visual and corporal movements that make up the actual practice." Yet this work has often erred, in my opinion, in describing tacit, experiental, or nonverbal knowledge as inarticulable or unconscious. For example, Knorr-Cetina (1992:121) insightfully portrays the local, holistic approach that benchworkers in a molecular genetics lab use to optimize laboratory procedures, drawing on knowledge that is "implicit, embodied, and encapsulated within the person." However, her discussion takes for granted the mind/body dichotomy that grounds Western notions of objectivity, as well as the cultural-ideological distinctions between technology and science and between technicians and other laboratory workers:

> It is a knowledge which draws upon scientist's bodies rather than their minds. Consciousness and even intentionality are left out of the picture. And there is no native theory as to what this body without mind is doing, or should be doing, when it develops sense. (Knorr-Cetina 1992:121)

As I understand her argument, Knorr-Cetina (1992:119) relates what she sees as the unconscious aspect of embodied knowledge to her claim (which I find otherwise persuasive) that scientists and technicians are "methods", that they are part of a field's apparatus of knowledge production.

As in Knorr-Cetina's account, discussions with my laboratory colleagues, along with my own hands-on experiences in the lab, reveal the persistent division between mind and body in technoscientific practice. Yet the same interlocutors also present critiques of the dominant paradigm. These counterdiscourses (might we call them a "native theory"?) accord significance to an intuitive, corporeal knowledge that, while imbedded in practice, is nonetheless conscious and socially transmissible. Terms like "body-knowledge", "art", "magic", and "good hands" are frequently used to describe this alternative way of knowing.[3]

In the course of one of our conversations I asked Lynn Sakai to comment on the assertion that embodied knowledge is unconscious. She said,

> Boy, is *that* a Cartesian argument!… It [the work you do at the bench] is about body-knowledge, not cerebral knowledge. But, no, it's not unconscious. It's like having good hands. There are scientists who have cerebral knowledge without the body-knowledge, and they're no good. Those who have good hands know it, the way a gardener know he has a green thumb.

Sally Hacker's (1989) term "techno-eroticism" aptly describes the deeply pleasurable sensation of being in sync with certain technological extensions of our mental-physical selves. As my proficiency as a cell culture technician increased, I came to find a kind of kinetic pleasure in the steady cadence of carrying out a repeated task, handling the once-foreign accoutrements of the laboratory with growing dexterity. The comments of native members of the lab confirmed my perceptions about knowledge that is embodied in material practice, not held at a distance by a disembodied mind.

One of the researchers was showing me how to do a procedure for the first time. Doing what ethnographers are inclined to do, I interjected questions at each step in the procedure. She seemed to grow increasingly impatient with my queries and finally said "Just watch. You don't have to understand, because there's a lot that you don't understand. You have to be mindless hands before you can be mind and hands." The ethnographer snorted skeptically. "You do", the researcher insisted. "You have to be hands first".

I initially read the exhortation to be "mindless hands" as a move to reinforce my low status as a neophyte technician, and this may have been partly true. However, subsequent conversations and my own experiences at the bench led me to see that my guide, in urging me to stop asking questions and learn by doing, was also attempting to initiate me into the body-knowledge of the craft of cell culture. I began to have a sense that being "mindless hands" was, on a phenomenological level, about being a "mindful body", entering into the flow of a series of interconnected activities.[4]

Contradictory ideologies – both of which are present in the cultural practices of contemporary biology – inform these contrasting readings of my colleagues's words. The first describes the dichotomous cultural-material world of the modest witness, with a line clearly separating mind from body and mental (scientific) from manual (technical) labor. The division of technoscientific labor is characterized by an apprenticeship system in which individuals are expected to work their way up from the "manual" labour of benchwork through graduate training and post-doctoral fellowships, eventually attaining the credentials necessary to do the "mental" labor of the PI (and to be the "mind" that controls the "hands" of others). This privileges the role of rationality, while claiming to limit its distribution. It also relegates the career technician permanently to the status of nonmind.

Although the legacy of the modest witness – including the hierarchies that it supports – predominates, it coexists with an alternative epistemology that recognizes the corporeality of technoscientific knowledge and the ways that the mindful body engages the world. The latter perspective supports the possibility of modest interventions like those of Lynn Sakai, whose understanding of the importance of "body-knowledge" in the technoscientific enterprise is linked to her critique of the alienation of technicians' labor shapes her laboratory practices.

Monoclonal antibody technology: works of art in the age of cyborgian reproduction

> Hybridomas are permanent cell lines with the potential for unlimited proliferative capacity… The hybridoma technique makes it possible to obtain virtually unlimited quantities of homogeneous antibodies with specificity for any desired antigen. (Hood et al. 1984:20)

At the heart of the circulation of materials and information both within and between labs is an experimental technology that "treats natural objects as processing materials, as transitory object states … decomposable entities from which effects can be extracted" (Knorr-Cetina 1992: 126). Organisms – singly and in combination with one another – and the products or reagents derived from them become part of the experimental apparatus of the lab. This includes the human benchworkers, with the day-to-day work of the lab resulting in an ongoing reconfiguration of the network of associations that we might call cyborg (Haraway 1991a), actant (Latour 1987), or "self-others-things" (Knorr-Cetina 1992; Merleau-Ponty 1945).

In the language of the immunologists, an antigen is identified as "self" and its antibody is known as "other". Monoclonal antibody technology is a collaborative

self-other recognition system joining the capacities of mice, tumor cells, antibodies, and the benchworkers who set the process in motion.[5] Immunized mice produce antibodies to a chosen antigen. The mice are "sacrified" and then "immortalized" as the lymphocytes from their spleens are "fused" with myeloma tumor cells. The result, a chimeric organism called a hybridoma, can produce countless copies of the same antibody indefinitely. The organisms become machines – or supernatural entities.

Developed in 1975 by Georges Köhler and Cesar Milstein, who later won the Nobel prize for their discovery, the technology's discovery is regarded as a watershed event in the new era of genetic engineering and biotechnology. In 1977, working in an immunology lab in her first job as a technician, Lynn Sakai taught herself the technique, using the original article by Köhler and Milstein (1975). At the time no one else in her lab knew how to do the procedure. She says the deep satisfaction of figuring out how to successfully execute this new technology helped give her a sense that science was a creative, empowering endeavor.

My interlocutors' accounts of the work involved in monoclonal antibody technology convey the sense of what might be seen as *shared embodiment*, a coperformance that involves having "a feeling for the organism" (Keller 1983). As one of the researchers in the lab put it, describing the process of caring for hybridoma cells,

> It's about rhythm. You have to be *in sync with your cells*; you have to be able to feel the flow of the experiment. It's not just a matter of mechanically feeding your cells every so many days. You have to really look at them, and have a feeling for when they need to be fed, or they'll poop out on you.

Sakai describes monoclonal antibody technology in animated tones as "the industrial revolution come to biology", with hybridoma cells harnessed to create "factories" for the continuous production of a particular antibody. She laughs and says, "It really is cyborgian, isn't it?" She contrasts the technology with the polyclonal antibody technique that preceded it, in which a particular rabbit produced antiserum: "This was like preindustrial craft. The antiserum was the distinctive creation of that rabbit; when it died, there was no other source". As the process has become routinized, Sakai says, the situation of the typical technician has changed. There are now graduate programs that train students specifically in monoclonal antibody technology; the skill is now acquired as received knowledge to a much greater extent than before. Still, Sakai says, a technician gets the thrill of discovery when she sees a newly produced antibody for the first time, "something that no one else has seen before in the history of the world". She continues:

> It's wrong for that sort of creative work to be alienated from those who produce it, which is what typically happens for technicians when they are denied credit for what they do. When I said that monoclonal antibodies were like the industrial revolution in biology, the workers I was referring to were the hybridomas. Now, what's happening, with largescale automated operations coming to biology, is that technicians are being turned into industrial workers.

Sakai says she doesn't mind harnessing cells in order to effect mechanical reproduction, but she doesn't want people to be treated the same way. "But, I'm a Buddhist", she says. "I still think we should live in harmony with Nature, at the same time that we harness it. [She laughs.] I feel attached to my hybridomas; I created them, they work for me. They're kind of like my pets."

The benchwork laboratory of contemporary biology is, as Karin Knorr-Cetina (1992:129) says, "*a link between internal and external environments*, a *border* in a *wider* traffic of objects and observations" (original emphases).[6] Following the initial discovery of fibrillin, Sakai's lab began a collaboration with two groups of medical researchers who had been conducting research on Marfan patients, collecting blood and skin samples and the kinship charts that geneticists call pedigrees. As a result of these collaborations, mutations in the fibrillin gene have been identified as the cause of Marfan syndrome. The association between fibrillin and Marfan syndrome was established through and has continued to expand, an international network of collaborations and exchanges.

Among the most highly valued trade goods in this circuit are Ab 201 and Ab 69, two of the antibodies that Sakai originally used to identify fibrillin. The electronic and postal conduits between her lab and the worlds beyond it bring in a steady stream of requests for the antibodies, as well as DNA probes and clones, from clinicians, graduate students, and other basic researchers. When she travels to professional meetings, Sakai will often carry centrifuge tubes in her pocket containing allotments of her reagents, the fibrillin antibodies, to parcel out to selected colleagues.

The term *reagent* is generally applied to the materials used in experiments. A reagent is not, however, simply an element that occurs naturally. It is something that has been produced, purified; it is the product of someone's labor. Reading the agency back into our understanding of reagents raises questions of ownership and of control over circuits of exchange. The traffic in Lynn Sakai's antibodies reflects her ownership of them; she controls the network of relations that her exchanges engender. A technician's labor, along with the surplus value that it produces, may be one of the "decomposable entities" from which such ownership claims are extracted. The

fruits of intellectual-manual labor in the laboratory are also subject to claims from patrons. For instance, monoclonal antibodies have been determined to be patentable, which means potentially profitable (cf. MacKenzie, Keating, and Cambrosio 1990). The terms of most scientific funding specify the funding agency's right to profits from any patentable discoveries. Monoclonals are among the myriad commercial reagents available, sold as proprietary ingredients. The fibrillin antibodies are not patented, although Sakai says, "I'd be a fool not to patent any future discoveries". She is clear, though, about their value in creating and expanding alliances.

> LYS: Science is moved along by the individual trades that go on. When a reagent is first developed, it's passed around. If it yields good results, it leads to collaborations.
> DH: So it's about networks of reciprocity.
> LYS: That's *exactly* what it is. It's about meaningful exchanges. Buying a commercial reagent isn't meaningful. It's just a purchase.

As anthropologists working in many other settings have observed, trade goods such as the fibrillin antibodies lose social value when they enter the cash nexus. With commercialization, the scientist whose lab has produced a particular reagent is no longer able to use the reagent directly to initiate or sustain trading relations that extend her networks of association.

The professional meetings discussed below are one of the arenas where trade occurs, not just between individual scientists but also across disciplinary and occupational divides and between scientific researchers and nonscientists. The goods exchanged are symbolic as well as the material and, as with most trading relationships, some exchanges are asymmetrical.

Marfan embodiments

> Feminist embodiment … is not about fixed location in a reified body, female or otherwise, but about nodes in fields, inflections in orientations, and responsibility for difference in material-semiotic fields of meaning. Embodiment is significant prosthesis; objectivity cannot be about fixed vision when what counts as an object is precisely what world history turns out to be about. (Haraway 1991b:195)

Three women, one in a white lab coat, stand in the hallway outside Lab Three looking at the electron micrographs of fibrillin that are hanging on the wall. One

of the two women who have come to tour the lab is over six feet tall. She is a bus driver and founder of the local support group for people with Marfan syndrome. Her height is one of the signs that she is affected. The two visitors are on the planning committee for the annual convention of the National Marfan Foundation (NMF), which will begin later in the week. Lynn Sakai, the woman in the lab coat (a uniform generally reserved for encounters such as this with outsiders), points to the images of the protein that she discovered. One of the visitors asks if they can see mutations in the images of the fibrillin molecule. Sakai explaines that the resolution isn't great enough to see the genetic components where mutations occur.

It is these mutations in the gene that codes for fibrillin that cause Marfan syndrome, which affects the connective tissue in different parts of the body, characteristically the eyes, the bones and ligaments, and the heart and blood vessels. The results include acute nearsightedness, lens dislocation, and scoliosis, as well as above-average height. The most life-threatening manifestations are cardiovascular, in particular the stretching of dilation of the wall around the valve of the aorta, which can result in unexpected rupture and death. In the past this condition was considered untreatable, but developments in pharmaceutical treatment from the 1970s onward, and in open-heart surgery since the 1980s, have substantially improved the prognosis of affected individuals. Most notable is the creation of the composite aortic valve-graft, a prosthetic heart valve sutured onto one end of a composite graft, a woven cloth tube (usually made of Dacron®) that replaces a section of the aorta.[7] Playing a supporting role are the imaging technologies echocardiography and MRI (magnetic resonance imaging), which permit monitoring of the size and function of the aorta both before and after surgery.

If advances in cardiovascular interventions have the highest profile in ongoing treatment of those affected with Marfan, hopes for the future are focused at the body's molecular level, on the fibrillin gene and the as yet unrealized possibilities for gene therapy. These two therapeutic approaches to the Marfan body correspond roughly to two professional communities, clinicians and scientists. There is a perceived division between the two domains that is borne out in practice, despite the traffic between them. The articulation of this boundary in terms of a tension between "applied" and "basic" research can be traced historically to shifts in the post – World War II political economy of research funding, with attendant effects on the relative autonomy of academic science vis-à-vis the biomedical establishment (cf. Wright 1994).[8]

The Second International Symposium on the Marfan Syndrome was held in San Francisco in 1992. Intended primarily for scientists and health care professionals, the conference was divided into moieties, with sessions of interest to clinicians and basic researchers held on separate days. Like the oral presentations, the

posters that visually summarize late-breaking research results were also segregated by being displayed in two rooms, one for each group. A full day was devoted to cardiovascular concerns. A second day and a half emphasized research on fibrillin, billed as the "Marfan gene". Although some of the key figures in the research community – physicians acitively pursuing research programs – span the divide, clinicians not involved in research seemed reticent to participate fully in the scientific portions of the symposium. For instance, during the question period following one of the sessions, the chair asked, "Are there any orthopedists left?" A tentative hand went up at the back of the room, and a physician said, "I don't really have anything scientific to contribute".

The main sessions were bracketed by an opening speech and a final panel discussion that adressed links between biomedical research and the wider concerns of affected people. The theme of the keynote address, entitled "The Joining Circles", was the integration of "the four frontiers" of Marfan syndrome: research, clinical medicine, social support, and life experience (Gasner 1993). It was delivered by Cheryll Gasner, a nurse-practitioner in her mid-30s who heads a university clinic for Marfan patients. One of the founding members of the NMF, Gasner has Marfan syndrome herself and has had five open-heart surgeries. In addition to her clinical work, she participates in the laboratory research program of a medical geneticist who specializes in Marfan syndrome. She embodies the connections she described in her talk and is a commited advocate for strengthening them in ways that make a difference for those who are affected, as she made evident in a subsequent interview:

> I have to keep clear which hat I'm wearing. There's my position as a nurse-practitioner, my work with the Northern California chapter of the National Marfan Foundation, my position as a patient. It's hard sometimes … I try hard to work with the physicians; it's my job. But I also know that they're human, that they're fallible. Many patients think that they're infallible. I try to pass on the sense that patients need to develop self-sufficiency. I teach people from Day One to take personal responsibility, to press for what they want done. I work to get people empowered. We've got a saying, "Either change your doctor, or change doctors".

Although those affected with Marfan were not the principal participants in the conference, members of the NMF attended an evening reception along with representatives of an organization called Tall Clubs International (TCI), a federation of social clubs for "unusually tall" people (defined in their bylaws, as a minimum of five feet, ten inches for women and six feet, two inches for men). TCI has selected

the NMF as its chosen charity; during the reception one of its members, a woman who had been elected Miss Tall San Francisco, presented a check to the head of the NMF. TCI's literature reveals that 60 percent of its membership is female, which may speak to the stigmatization of tall women in US culture. Negative stereotypes about women of above-average height appear to carry over into the mediacal treatment of Marfan patients, with some clinicians recommending that girls in particular be given hormones to speed the onset of puberty and thus limit adult height.

At the opening session of the Ninth Annual National NMF Conference one of the first speakers was a woman on the organizing committee, the six-foot two-inch bus driver who had visited the lab earlier in the week. Her remarks, which were about using humor as a defensive strategy, drew attention to gender about height. The focus was a mean-spirited co-worker who had started a rumor that the speaker had had a sex change; why else would she be so tall? Her response was to join with a male colleague in starting a counterrumor. Their story was that the two of them had previously been married, and had separated when they both decided to have sex change operations. They had since reunited, the story continued, and he was now carrying their child. The audience, composed mostly of people with Marfan, met her account with hearty laughter. When she had finished her narrative, she joked about having to lower the microphone for the next speaker, Lynn Sakai, who is more than a foot shorter than she.

Sakai spoke both as the organizer of the scientific meeting running concurrently with the NMF conference and as a representative of the Shriners Hospitals, one of the sponsors of both meetings. The centerpiece of her brief presentation was a slide that showed an electron micrograph of the fibrillin molecule, much like the one hanging on the wall outside her lab. Addressing the question that one of her visitors had asked earlier in this week, she noted that mutations were not visible. When the slide first appeared, someone in the audience hissed at the villain molecule responsible for Marfan syndrome. Sakai told me later that even though she was sure it had been done in jest, she still felt somewhat hurt that the protein that she had discovered would elicit such a response.

Other opportunities for contact with NMF members gave scientists and clinicians at the conference a human dimension to their understanding of genetic variability. One scientist said that, although she has collaborated on all but one of the articles describing different Marfan mutations, it was only when she visited the clinic on the day before the NMF meeting that she understood what diversity in the expression of the syndrome actually meant. She said that one of the attending physicians at the clinic, a medical geneticist who had seen individual Marfan patients for years, reported having a similar reaction. As she put it, "Seeing a whole collection of people with Marfan syndrome in the same place, and seeing how they

all look really different, gave a new meaning to the diversity of phenotype. It was striking relating the mutations to these whole people".

For those affected with Marfan syndrome, the physical and cultural signs of the condition and the medical crises and interventions that they endure are part of the shared life experiences that foster a sense of identity at gatherings such as local meetings and the annual national NMF conferences. In a playful performance in the closing session of the NMF meeting, a group of several women calling themselves "The Melodic Marfettes" sang their own rendition of Woody Guthrie's song "So Long, It's Been Good to Know You". It captured some of the feeling of solidarity that I had heard expressed in many other ways throughout the meeting, both during workshops and in the hallways between sessions, much of which focused on markers of difference in the world dominated by those who are unaffected. Here are two of the verses, which contain references to both the significance of storytelling and the shared bodily experiences of people with Marfan syndrome:

> The day I arrived I felt lonely and shy.
> I said to myself, "Let's give it a try".
> I heard people's stories and people heard mine
> About shoe size and lenses, aorta and spine.
> Chorus: Singing so long, it's been good to know you, etc.
>
> I came here this week with a lot on my mind,
> I came here not knowing what I might find.
> I looked at these Marfans and what did I see?
> A whole brand-new family that looked just like me.

Hillary Rose (1983, 1994) has written that a feminist epistemology for the natural sciences would resolve the mind/body dichotomy by insisting that heart be linked to head and hands. This is a lesson that the Marfan activists who inhabit the borderlands of technocience already know. Given the consequences of untreated cardiovascular problems and the extent to which medical intervention has extended the lives of many people with Marfan, it is not surprising that the heart has become a focal point for the efforts of both lay advocacy groups and clinicians. The National Marfan Foundation uses the heart as a symbol in its fundraising campaigns and has designated February, when the annual campaign takes place, as Have-a-Heart Month because of Valentine's Day and the birthday of Abraham Lincoln, who is thought to have had Marfan syndrome. Items distributed by the NMF include heart-shaped Post-it notes and T-shirts that read, "The Progress Is Heartening". At the Ninth Annual National NMF Conference, one

of the fundraising events was the raffling of a quilt covered with hearts. Beneath the trappings of public relations schemes and consumer capitalism, the heart is an icon for a politics of truth and caring grounded in a kinship of affiction and a sense of shared embodiment.

Partial connections and modest interventions

> The knowing self is partial in all its guises, never finished, whole, simply there and original; it is always constructed and stitched together imperfectly, and therefore able to join with another, to see together without claiming to be another. Here is the promise of objectivity: a scientific knower seeks the subject position not of identity, but of objectivity; that is, partial connection. (Haraway 1991b: 193)

Operating in an experimentalist mode, I organized two roundtable discussions during the NMF meeting, inviting researchers, clinicians, and advocates to engage one another in open-ended discussion. I was curious to see how representatives of these different constituencies – whose domains are interdependent yet largely distinct from one another – would interact, and how both commonalities and discontinuities might become apparent.

In the course of one of these conversations, a patient-advocate pointedly conveyed the frustration that many people with Marfan feel about the pace of research results and an apparent lack of focus on concerns of immediate importance to those who are affected. She capped her remarks to the clinicians and researchers at the table by saying "It's been two years [since the partial sequence of fibrillin was published]. What the patients want to know is: 'Where's the beef?'".

After the discussions I asked Lynn Sakai, who had attended both sessions, for her reactions. She said that she appreciated such contacts with patientadvocates for giving a human dimension to her approach. At the same time, she said some of the advocates' comments, such as their focus on therapeutic concerns, had been disturbing. "I'm a basic researcher", she said, "not a clinician". The tension she felt between the power of the patients' perspective and the high value she places on her professional autonomy seems indicative of the contradictory connections and divisions that describe the networks linking this laboratory researcher to wider worlds.

In the 1992 annual report of the Shriners Hospitals medical research programs, Lynn Sakai extols the virtues of "pure" research, expressing her conviction that it provides the firmest foundation for clinically significant discoveries:

> I believe that the story of fibrillin and the Marfan syndrome is instructive. In the Portland Unit, scientists were performing research on the connective tissue, without any prior idea that their work would lead them to a specific result. In Balitmore, clinicians were actively studying the Marfan syndrome and collecting patient samples. The cause of the malady was unknown for almost one hundred years. In 1991, the time was right; the groups in Portland and Baltimore got together to collaborate, and the cause of the Marfan syndrome was discovered. Research is like that: it is difficult to predict the outcome of research, which needs only a free and open, and well-funded environment, but our belief is that, since there is so much about what makes our bodies work that is unknown, clinical progress can only be made through basic research. (Shriners Hospitals for Crippled Children 1992)

Working within a hospital system in which the research units are generally headed by MDs, Sakai is well aware that the notion of "pure science" is an ideal type – though a compelling one – and that scientific knowledge production is dependent on shifting power relations within wider networks of patrons and allies. "Twenty years ago", she says, "scientists were seen as the handmaidens of the MDs. That's begun to change". I ask with a smile, "Is that because now you're the handmaidens of industry?" She laughs and nods. "Yes, the rise of the biotech industry has had something to do with it. Scientists are much more powerful now. But we still have to compete with MDs for funding". Although Sakai's words in the Shriners annual report can be read as the rhetorical appeal of a research scientist addressing her patrons, they also convey her deeply held beliefs about the importance of scientific autonomy to the successful pursuit of new knowledge. This is linked to her concern about the targeting of federal funding for the life sciences toward particular clinical problems, constraining the resources available for basic research.

A week or so after the NMF Conference, Sakai and I watched a viodeotape of local television coverage of the event, which the head of public relations for the Shriners Hospital had put together. The clips, from two local stations, each contained a short interview with Sakai concerning the scientific aspects of the disease. There were also interviews with people affected with Marfan syndrome, including the head of the local chapter. Other shots included the clinic day, workshops, a speaker at the scientific sessions, panelists at the medical presentations, and stock footage of one of the technicians in Sakai's lab "doing science", that is, pipetting while wearing a white lab coat. The latter footage was taken in 1991, when Sakai received national coverage following the publication of articles in *Nature* (Dietz et al. 1991; Maslen et al. 1991) about the fibrillin sequence and the characterization of mutations in the fibrillin gene in Marfan patients.

I complimented her on how she had done in both interviews, kidding her a little at the same time. I told her that she always did a good job communicating with lay people when she actually did it, that it was only before the fact that she groused about having to do it. "In practice, your're a populist; it's only in principle that you're an elitist", I joked. "I'm always an elitist", Sakai snarled, and then laughed. Then she said, "The patients really don't know very much about what the research is really all about". "Well", I countered, "are there many opportunities for patients and researchers to come into contact with one another?" Sakai conceded that there weren't, and then praised Priscilla Ciccariello, head of the NMF, for pushing researchers to make a commitment to Marfan syndrome and those affected with it. As she had said during her introductory remarks at the NMF meeting, Ciccariello's efforts had given her own research "a human face". At the same time, some of the contact Sakai had had with members of the affected community had been "unsettling". "The patients really think that I'm responsible to them", she said.

She stopped, thought for a moment, and then said that with a just a little reorientation, a little tinkering here and there, she could push parts of her own research agenda in directions that could provide diagnostic or therapeutic insights. We discussed what some of those possibilities might be. Soon thereafter, however, she said, "But science is supposed to be pure. The data are supposed to follow their own course". "But science is a human product", I replied. "The data don't just invent themselves". "No, of course not", she retorted, "but it's not good when research is dictated by these applied concerns; it's misguided". At this point she seemed quite irritated, and said, "I don't want to talk about this anymore". We stood in silence for a moment, and then I said, with a tentative smile, "You're mad at the Marfan patients, aren't you?" She paused, then laughed and nodded. "You're right; I am. They've made a difference in how I think about my work".

Throughout this conversation it struck me that Sakai alternately advanced and retreated across the boundary between an insular science and its larger context. This is precisely the site of her practice; it is both circumscribed by its local boundaries and pulled to reach beyond them. Having left philosophy because it divorced mind from action, in search of a world of activity where head and hands are joined, she still lives with contradictions, as, of course, we all do. Some she engages directly, doing her best, for instance, to mitigate the effects of laboratory hierarchies that minimize contributions of technical labor. Others are more problematic; the privilege of pursuing "pure" science is closely linked to the relative structural autonomy that permits her both to run her lab largely as she chooses, and to pursue, and sometimes achieve, profoundly satisfying mental-corporeal pleasures.

If cultural studies of science are "politically and epistemically engaged" (Rouse 1993:20) in ways that implicate its practitioners in the practice of technoscience,

the boundaries of anthropology are no less permeable. As an ethnographer of technoscience, I have found my own interpretive and epistemic practices shaped by the encounters with my interlocutors "in the field" as we participate in, observe, and critique one another's practices. Lynn Sakai's work and my own are both anchored in the privileged pursuit of curiosity. My curiosity about the local knowledge of laboratory practice has taught me both about the embodied pleasures of participant performance and about body-knowledge as a locus of critical discourse on the nature of technoscientific knowledge. My encounters with Marfan advocates gave me a different sense of shared embodiment at the intersection between engagement and the kinship of affliction.

Like my interlocutors, I am committed to an "itinerant territoriality". (Deleuze and Guattari 1987) that traverses and perhaps destabilizes the institutionalized boundaries between Science and Not Science, aiming to make the partial connections between them matter more. We share the interstitial spaces of what Donna Haraway (1997) calls the *mutated* modest witness, where received boundaries between the knower and the known are critically contested. The modest interventions that bring together scientists and clinicians with border denizens like Marfan activists and ethnographers combine local knowledges in order to build a differently situated – but never disembodied – translocal knowledge and practice.

Notes

1 Within the laboratory setting I want to highlight the viewpoint of the technicians and of certain non-human benchworkers. Beyond the lab I want to draw attention to the experiences of people affected by Marfan syndrome. I am also concerned with conveying a sense of alternative hegemonies as well as counterhegemonies, a sense of the heterogeneity within the "view from above", with the rivalries and interdependencies marking distinctive yet mutually constitutive cultural domains. The recent history of research on the Marfan syndrome, for example, has been contingent on developments in biotechnology, influenced by the lobbying efforts of lay advocates, dependent on the support of public- and private-sector patrons, and carried out by both basic researchers and clinicians from a range of disciplines and subfields, each with its own constituencies and characteristic practices.

2 The masculinist asceticism of the modest witness can bee seen as originating earlier, as David Noble (1992) argues, in the emergence of an ascetic culture among Christian clerics in the late Middle Ages, which excluded women from science and institutions of higher learning.

3 See Heath (1992) for a discussion of the notion of good hands in a DNA sequencing lab.

4 See Scheper-Hughes and Lock (1987) for an insightful account of the notion of the mindful body.

5 For a social history of the art and science of hybridoma technology, see Cambrosio and Keating (1992).

6 While Knorr-Cetina limits this wider landscape to connections among other laboratories, I want to extend the terrain of the present discussion to include the traffic that links the lab to (among others) the worlds of clinicians, organ donors, people with Marfan syndrome and the advocates, and the patron institutions that fund biomedical and basic research.

7 Depending on where or how severely the aorta is weakened or torn, larger sections may be replaced. As a pamphlet on the Marfan syndrome published by the NMF puts it, "[I]ndeed, a few people with the Marfan syndrome have had their entire aorta converted to Dacron®!" (Pyeritz and Conant 1989:15).

8 Susan Wright's (1994) study of genetic engineering policy provides a detailed and revealing comparasive account of the political economy of research funding in both the US and the UK since World War II. She examines the consequences of the shift from the postwar boom in relatively unrestricted science funding toward increasing demands for "targeted" research and "accountability" among researchers to produce results with demonstrable applications. This pressure to articulate basic research agendas in terms of biomedical concerns originates in dependence for funding from both public and private sources. At the same time, the direct involvement of some basic researchers in, for example, biotech firms has provided them with a new measure of partial autonomy from public and academic biomedical institutions.

9 E. Potter (2001), *Gender and Boyle's Law of Gases* (Bloomington: Indiana University Press, 2001)

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Ingunn Moser and John Law

Good Passages, Bad Passages*

First story

Ingunn rings the front door bell of Liv's flat, and there is nobody at home.[1] Indeed she has been ringing for some time. It's getting monotonous. Then she hears the sound. It's the sound of an electric wheelchair. She turns round. There's a woman coming towards her. The woman is driving the wheelchair. And she's looking at Ingunn. She's wondering who Ingunn is and what she's doing there. The wheelchair rolls to a halt. Later it will become clear how it works, the wheelchair. And how this woman – it turns out that she is Liv – lives, spends much of her day, in the wheelchair.

Apart from the fact that she is confined to a wheelchair, Ingunn knows almost nothing about Liv. She knows that she can't answer the phone, but that's about all. For instance, she doesn't even know how Liv controls the wheelchair. Liv is going to explain that she steers her wheelchair with a switch. She doesn't work the switch with her fingers: she does not have the use of her arms and her hands. Instead she works it with her chin. It takes the form of a long stick – perhaps we should say a joystick – which is attached to the back of her chair. It goes from the back, over her right hand shoulder and arm, and ends just beneath her chin. If she leans her head forward a little then she can move it, move it forwards and backwards, to the left and the right. If she holds it to the left, then the chair turns left. And if she holds it to the right, then, well, it turns to the right. To start it she uses a key, which takes the form of another switch, attached to the same stick that goes over her shoulder to the back of the chair. The key has a green button on top. Having unlocked the

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chair, she can start it by moving the first - black - switch in the direction she wishes to go. To stop, she simply releases the switch. To make it go faster, she knocks the switch to the right. This moves the three-level speed regulator one step upwards. But she says that she doesn't do this very often.

Extension

The story is prosaic - though vital, of course, for Liv. The joystick and her wheelchair give her mobility. But, at the same time, it's prosaic because Liv has been living with it since 1983. But at the time, well, it was an extraordinary event, the arrival of this wheelchair and its joystick. It was, she remembers it well, "the greatest day of her life". Until that moment she'd only had a manual wheelchair. Well, actually, for much of her life she'd not had a wheelchair at all. At first there was nothing, then her parents laid her out, flat, in a home-made carriage. Later there was an equally home-made wheelchair, a series of such wheelchairs, homemade wheelchairs, followed finally by one that was manufactured.

The 1983 wheelchair spelled a revolution for Liv. At an age of 44 she could move by herself for the first time in her life. She could control where she went. She could stop and start at will, turn left or right, move faster or slower into the sun or into the shade, indoors and out of doors. She could, as we say, go for a walk.

So by now it is part of the mundane, the everyday, for Liv. And, to be sure, it's a prosaic story in technoscience studies too with its stories about extensions, prostheses and heterogeneous networks. We know about the ways in which different materials interact to produce cyborgs, and the way in which we are more than bodies, bodies alone[2]. But we are, perhaps, less clear in other ways. In this paper we want to focus on the material specificities - corporeal and otherwise - which lead to or affect the character of dis/ability. It is our argument that dis/ability is a matter that is highly specific: that people are dis/abled in endless different and quite specific ways. But we are also interested in the ways in which dis/ability is linked up with identity or subjectivity. Indeed, we take it that the links between dis/ability and subjectivity are close - which means that any study of the materialities of dis/ability is incomplete unless it also attends to the continuities and discontinuities of subjectivity - a topic that has attracted rather little attention both in actor-network theory and, more generally, within the field of science and technology studies.

Second story

So Liv is looking at Ingunn. There's a question written on her face. Ingunn explains who she is and asks her: "are you Liv". Yes, she's Liv, though it turns out she's not expecting Ingunn today. But it's okay to visit anyway. "No, it won't be inconvenient. Yes, you can come in. Yes, we can talk". So now she's opening the door.

Opening the door? Again it isn't clear how she's doing this but Liv is going to explain. She's going to explain about a third joystick, this time with a red button. She can move it, again by shifting her head, her chin. But this time it's different. Because this joystick is working something called an "environmental control". So what happens?

The answer is that once she sets the environmental control running it moves through a series of functions, click, click, click, a different function each time. Liv knows the order in which they come. It turns out later that it is the first sub-option within the fourth main function, after the fourth click, that is going to open her front door. She moves her chin at the right moments, moves the joystick. And finally the door opens. And then Liv is rolling forward. Her wheelchair is taking her through the door. Ingunn is following her, and once they are both through, a few seconds later, the door closes. It closes automatically. They're in the flat and they're ready to talk.

Specificities

Altogether there are five joysticks. That is, five long switches which branch out of a single support. One of these works the environmental control. Click, click, click, this shifts itself through its functions. So what *are* its functions? Well, that depends on the set-up, on how it's been arranged. Liv's environmental control works a series of functions: it answers the telephone; it makes telephone calls; it switches the lights in her flat on and off; it turns the television on and off; and it operates a series of what they call "apparatuses". That's the first level. But there's more than one level. Go down one step and you can control the specificities. For instance, the specificities of the television. What channel does she want to watch? How loud should the sound be? Or, on this level, again under apparatuses, you can turn the radio on and off, you can open or shut the front door and the patio doors, lock or unlock the front door, and call for help if an emergency should occur. The environmental control is a little - or not so little - hierarchy of controls, commands that work this and that in her flat.

Specificities. A command to do this. The capacity to do that. Liv is able, she is *able* to control the television, to open her front door, and all the rest. And, we've seen this, she can move, move around in her wheelchair. Mobility, specificity. She can work parts of her flat. The door, that's a specificity. The television, that's another. But she can't work the blinds, not for the moment. They're not hooked up the environmental control, not yet. They're not hooked up to it because she hasn't got round to it yet. So the blinds don't have the electric motor they'll need if they are to be worked from the wheelchair. She's planning to get this. Does she want anything else? Well, possibly, though she's not bothered about having an alarm. No, she says, she doesn't need that, there's always someone around. "There'd be someone around if something went wrong. And I could ring them anyway." Liv's flat is one of 18 in a new and relatively uninstitutionalised local authority home for people with disabilities. This means that her flat is her private home - her personal territory. Care workers come in - but as visitors - though Liv can get help around the clock.

The environmental control is a set of specificities. It is like the wheelchair, which is another set of specificities. Forwards, backwards, left or right, movement is possible on a surface that is reasonably solid and reasonably smooth. These are specificities about mobility. Dis/ability is a set of specificities – which means, to be sure, that we might imagine ourselves as abled, but abled in a million ways. Just as Liv is dis/abled in million ways. Opening doors. Going up and down stairs. Brushing our teeth. Reading the newspaper. Using the telephone. Writing a letter. Cleaning the kitchen. Making a meal. Eating in a restaurant. Going to the cinema. Doing up our shoelaces. Sitting a granddaughter on our knee. And so on. And so on.

Specificities.

Third story

So Liv has got it worked out – but then again, Liv is a pretty determined person. She's 56 and she's been dis/abled since birth. She was born at a time when there was no formal education for severely dis/abled people in many parts of Norway. It was her mother who taught her to read and to count – her mother and friends of the family. She has battled her way towards relative ability for decades.

Here's another story. Liv is from Trøndelag which is hundreds of kilometers from where she lives now. But she's still got family there, family and friends, and she likes to visit them. Though visiting isn't so easy she's determined about it. She was determined, for instance, to go back and visit the institution she'd lived in for years which was having a celebration. So she and her carers made the arrangements. She bought the train ticket. She told the railway she was dis/abled, confined to a

wheelchair. No problem, they said. The trains are built for people in wheelchairs too. There's a lift, a hoist, at every station. You roll the wheelchair onto the hoist. It lifts the wheelchair up. And then you roll into the train.

The day arrived. Liv was there at the station. She was waiting for her train. The train arrived. But where was the hoist? Answer: it was missing. They tried hard and found a kind of a ramp with rails. Then they tried to haul the wheelchair up the ramp, but it didn't work because the wheelchair was too heavy, and the ramp was too steep. The train left without Liv.

Passages

Movement between specificities. Between, for example, the platform of the station and the train itself. Or her home town and her destination. We need to say that the movement between specificities is also a specificity in its own right. Here it takes the form of a hoist and a taxi - for though the railway had got it wrong and failed to make the specificity needed to bridge the gap between the platform and the train, they did do the next best thing. They ordered a taxi and paid for it too, though the story doesn't have an entirely happy ending, because, on the way back, there *was* a hoist. So they lifted Liv and her wheelchair into the train, but then they parked her in the only place where there was room for a wheelchair: in the baggage compartment. Liv found herself travelling with the baggage.

So the argument has to do with specificities and the relations between specificities. Once we start to attend carefully to specificities, the passages between those specificities also come into focus. We find that we need to pay attention to them too. We need to look into how they are done, done, or not done, these passages which are also specificities in their own right. And talking with, talking of, Liv, already tells us quite a bit about the character of some of those passages. It tells us, for instance, that some are easy and some are difficult. It tells us, for instance, that for Liv the passage between opening her front door and switching on the lights is pretty straightforward, as is the passage between controlling the front door and moving her wheelchair. Whereas, on that day in that railway station, it turned out that the passage between platform and train was insurmountable.

Note that: on *that* day, and in *that* railway station. Because we're dealing with specificities here, specificities, and the equally specific passages between specificities. Specificities – let's remind ourselves – that are specific because they come in the form of networks of heterogeneous materials. To repeat the standard lesson from STS: if the networks are in place, if the prostheses are working, then there is ability. If they are not, well then, as is obvious, there is dis/ability. So here's the

proposition. Dis/ability is about specific passages between equally specific arrays of heterogeneous materials. It is about the character of the materials which dis/able those passages. And it is about the arrays which secure or don't secure them - like absent lifts.

Fourth story

We said it earlier: Ingunn knew almost nothing about Liv before she visited her for the first time, except that Liv couldn't answer the telephone. So she knew that Liv couldn't talk so well, and the question was: how would they communicate?

It turned out Liv could talk. Ingunn discovered this in the first five seconds, at the moment when they met outside her front door. But could they have a proper conversation? Could they talk for two or three hours? Would Liv be able to respond to her questions? And in turn, how well would Ingunn understand her answers? None of this was clear as they entered Liv's flat. Ingunn looked around for the aids which she had become familiar with in the course of other interviews. For instance, the portable computer with its little screen or the little box with its menu of chosen sentences – devices which speak the words when words made by voices break down. But she couldn't see any such devices. It seemed that they were going to talk to one another face to face. Voice to voice.

And so it turned out. Liv asked Ingunn to take a seat – and she sat on her sofa. Liv moved her wheelchair to the right of the sofa. Liv started to speak and Ingunn concentrated – and though it wasn't easy Ingunn understood what Liv was saying. She was asking about the study, about the reason for Ingunn's interest in her disability. And so the conversation started. Indeed it started well, though, to be sure, sometimes it came unstuck.

Came unstuck? Well yes. For every so often even with concentration it wasn't possible to make sense of Liv's words. Ingunn was looking at her face, her expression, her mouth, her lips, attending to her voice, to her words, but also to her intonation, to the emotions carried in her voice, the intonations of pleasures and sadnesses. She was listening, for instance, to the moments when her voice trembled or became thick. For Liv had much to tell, and she conveyed it well, yet sometimes, even so, it wasn't possible to make sense of what she was saying.

How much did it matter? Answer: it didn't matter much - but it also mattered a lot. It didn't matter much because Liv was watching Ingunn and could see if she wasn't following. Or Ingunn would repeat what she thought Liv had said, and ask her: "is this what you mean?" And she'd agree, or not. And then, at least sometimes,

it would be turned into a joke and there would be laughter to relieve the tension of failing communication.

Which meant that communication also mattered very much to Liv. Here is a excerpt from the interview notes:

> – I feel myself so handicapped, she says, with a voice that is moved to tears.... She says this to me, and asks me whether I understand her, do I understand her when she speaks?
>
> – Yes, I say, if we sit opposite one another.
>
> – For not everyone understands me when I speak, says Liv, with sorrow and pain in her voice, a lump in her throat. That is so..... Yes. She speaks, and then there is a long pause. It is not easy for her to say this.

Bad passages

So talk is another set of specificities. Each moment in a conversation is a moment that joins together the moment before and the moment after. Artful work, well, yes, there is artful work in holding on to incomplete meanings, in joining them together, in making the necessary passages. Harold Garfinkel showed this thirty years ago[3], all the business of repairing indexicality by means of reflexivity. But then there is breakdown. If you go beyond a particular point and the words no longer make sense. The words that you didn't make out can no longer be retrieved, rebuilt and inserted back into a context, and then sense is lost.

Which is all very well, and no doubt right, but perhaps it also pays insufficient regard to the materialities of words[4]. So what of the materiality of words? If they are spoken then these have to do with air and acoustics. But also with ears and with tongues. With throats and voiceboxes. With stomachs and breaths. With heads and cheeks and tongues and lips. With the way in which the mouth is held. With many muscular abilities. With the coordination and ordering of no less than fifty eight muscles in the tongue alone. There are so many muscular abilities, abilities that are so important, that there is a whole profession called speech therapy which reorders the disciplines of the voice when these are disrupted. But the materialities of words also have to do with the way in which speakers face each other, or don't, with what they are able to see of one another. And with ears and the sense of hearing. So once again we are dealing with specificities, specific material heterogeneities and the

passages between those specificities. Which brings us to Liv's urgency, her desire to be understood. And to her self-evident pain when she is not understood.

The reasoning is so: pleasures and pains, or so we are suggesting, have in part, perhaps in large part, to do with passages. They have to do with difficult passages that are then made easy, or easy passages that are then made difficult. Or they have to do with what we might think of as "necessary passages" – by which we mean passages that are, as it were, set for subjects in the material and discursive conditions which order relations. Which help to constitute normative subjectivity. Which order what will come to count as the passages that are important. Or simply taken-for-granted, at any rate by those who are normatively competent. Or, to put it differently, by those who happen to take the form of relatively standardised technico-bodily packages. Such as, for instance, the business of opening and closing a front door for someone who has voluntary control of their hands. Or not. Going for a walk for someone who can indeed, use their legs. Or not[5]. Or speaking to someone else, having a conversation by using the voice. Or otherwise.

There are passages that are presupposed, normatively prescribed: if these turn out to be bad passages for the subject, then they make lacks. And if such passages are made better then this, perhaps, makes for pleasure[6].

Fifth story

This is Ingunn's second visit to Liv. By now things are different. Liv has acquired a computer which she uses to write. Of course she cannot use a keyboard. So Ingunn is asking how she works the computer. The answer is that it has a special control, a further joystick. This controls a special program called Wivik that replaces the keyboard. The program has its own window on the screen - the bottom half - while the text she's writing is in a second window in the top half of the screen. Liv can't control the cursor in the text window directly - only the way it moves in the special program in the lower window. But how does it work? Here is an excerpt from Ingunn's fieldnotes:

> "How do you start, for instance?" I ask. And she says "I push the blue joystick" till I hear a "click", which means that I am connected to the computer." By pushing the joystick in four directions Liv can move the cursor within the Wivik program. This has four big boxes with four arrows. And each of the big boxes is subdivided. So the whole thing is like a chinese box. And then Liv is demonstrating to me how she uses this system. She says "I'll write my name". She pushes the joystick to the left to get into the upper left square of

> the Wivik window where there are four smaller squares. She pushes the joystick away from her chin to move the cursor into the square for "l".
>
> So that's the "l". Turning this into a capital involves further moves. She has to move the cursor down into the big box at the bottom on the right of the screen. This is subdivided into something like sixteen boxes. One of these is a function called "sp". "sp" means "special functions". Once she is inside this she can open up another menu, or another display in the form of four further boxes where she chooses between special functions such as "capital letters", "save", and "print". Now she chooses "capital letter" and the "l" turns into an "L". This done, she has to get back up again to the boxes with the letters of the alphabet. So she continues to write, first an "i", and then a "v". She's written "Liv". All of which means that there are a lot of operations involved in writing a single symbol or word, not to mention a sentence. And if she wants to correct things it is similarly complicated. She has to find a special sign to get into the equivalent of the backspace function on the keyboard.

However Liv works it all okay. It's almost in her body by now, an embodied skill. It's almost in her chin, the ability to work the system without thinking explicitly about every move. But it takes time. Even writing her name is a very long operation. "It is very slow," she says. "But I can write more now, and I can write alone."

Better passages

So good passages have to do with moving smoothly between different specificities and their materialities. Bad passages are about awkward displacements, movements that are difficult or impossible. So what, then, of this Wivik program? First let's note that it isn't really very easy to use – or, more precisely, it is pretty laborious. It is much easier for someone who has the use of their hands to sit and type at a keyboard. Liv takes several minutes to write the three letters that make up her name. And it takes her two days to write a two-page letter to her friend. So we wouldn't want to say that Wivik is actually a way of making good passages.

But. But. Yet, we can approach the argument the other way round, and then it looks rather different. Before Liv was given the computer and the Wivik program - indeed at the time of Ingunn's first visit - she couldn't write on her own at all. She could dictate what she wanted to write to her teacher or perhaps to her carers. But her writing time was limited. There were two hours with the teacher a week - and however much time she could beg or borrow from her carers. Most of the time, then,

she simply couldn't write at all. Which was, so to speak, the literary equivalent of her inability to get onto the train. A passage so bad that it wasn't really a passage at all.

Now hoists and Wivik programs are not that wonderful. In the case of Wivik she has to chase up and down the hierarchy of commands dictated by the structure of the program. On the other hand, she *can* chase up and down that hierarchy. She *can* write letters and sentences when no-one else is around. She *can* spend a weekend writing a letter to one of her friends. The passages it affords, then are not that wonderful. But they are a great deal better than what there was before. They are a great deal better than nothing.

Sixth story

At that first interview Ingunn is with Liv for three hours. They talk, and near the end Liv sends Ingunn to the canteen where she is given something to eat and drink. She returns to Liv's flat to eat it and drink it. That's it: Ingunn eats and drinks, with her hands and her mouth, but Liv does not join in. Instead, she sits there, and she watches.

And what is the significance of this? Of course, there is a severely practical matter. Liv cannot feed herself. But there is something else going on too. The Norwegian custom runs so: if you visit someone's house then you are offered something to eat and drink. It is a part of the custom, the ritual, a part of playing the role of a good host, a gesture of friendship. Liv cannot play every aspect of that role. She cannot get up and go to the kitchen to make a cup of coffee. But she can send - she does send - Ingunn to the cafeteria to get a sandwich and a cup of coffee. And, note this, it is understood that Ingunn will not pay. She is a guest, Liv's guest.

Orderings

Does Liv want to eat with her guest, or does she prefer to wait, wait until she has gone? Empirically, the question is one that is open. And, no doubt, it is in part a matter of discretion: Liv's discretion. For if she chose to eat with Ingunn then she would need her help, and perhaps she would prefer to avoid that. Perhaps for her this is a personal matter – something that she does not want Ingunn to see. Though what counts as personal is, of course, a tricky matter, one of negotiation and discretion as the story about the role of the host suggests.

Here perhaps, we are all students of Erving Goffman, or Norbert Elias, or Judith Butler, or Leigh Star[7], with their lessons about the division between private

and public, visible and invisible, back stage and front. This is an oblique way of saying that not everything is as it seems, that the public smoothnesses always conceal work, and indeed may also conceal private disruptions. So the good passages which we see are concealing other passages – the hard work, for instance, and all the time that goes into a two page letter. Of course, some of these secret passages are good, but some of them may also be bad. To say it again, the apparently effortless movement from one specificity to the next conceals work. It conceals pain, the effort, of arraying the materials of successive specificities, of ordering them[8] or, perhaps, the shame involved in the materialities of their arrangement[9]. So there are front-stage slickness and back-stage complexities, difficulties, or bad passages.

So Liv? Well, isn't it like this? She is like any person. For any person is, after all, a set of more or less complex and difficult passages. And an economy that distributes those passages between visibility and invisibility. Not all of those distributions have to do with difficulty or ease – or (which is not necessarily the same thing) to do with pain or pleasure[10]. Not all. But some of them do. For instance, what we think of and perform as the "intimate" bodily functions. These passages, passages which are taken to be difficult, are certainly not visible for most of us, most of the time. And if Liv's dis/ability requires that here she needs the help of carers, then they are certainly invisible to Ingunn, a visiting sociologist. They are back stage.

If our lives are the performance of specific passages between specific material arrays, then no doubt we might tell stories about the ways in which they are ordered, about the various ways in which they follow one another, and the degree to which they do so smoothly. There are, to be sure, whole literatures on this. For instance, thanks to Leigh Star, in STS we know something of the difficulties of being allergic to onions: yes, it is usually better to be a standardised bodily package[11], one that is normatively approved, where the norms are embedded in the ramifications of the networks of specificities, and the passages between them. Of course, what it is that counts as "standardised", what it is that is *made* to be standardised, are also matters that deserve inquiry. And then, again as we know well, packages that are standardised also prefer to imagine themselves, perform themselves, as unmarked categories. Or are imagined and performed in this way as the invisible body, the corporeal-technical body that is "naturally able", that has been normalised to the center. The unmarked normativity that is standard, that is standard and invisible – and is therefore invisible[12]. Is made invisible by being made smooth, made standard, or not. For passages are smoother for some than others. Stairs don't mix with wheelchairs. They mix better with legs – but legs, for instance, without the pain that comes with lower limb atherosclerosis. And non-standardised bodies, some of them, don't mix so well with onions. So there is the question of the materialities

of passages – those materialities that are assumed, normative materialities, those which are provided like stairs, and those that are not like ramps or hoists.

Seventh story

Here is another excerpt from the interview notes. Ingunn is asking what Liv is able to do now, that she couldn't do before, without technology?

> – Decide for myself, Liv says with emphasis. I can decide when I want to get up, and when I want to go to bed. What and when I want to eat. I can prepare and cook my own food – with help. I can decide how to decorate and arrange my flat. I couldn't do that before, not where I lived earlier. There I only had a single room. Here I have decided about everything in my flat. Every flat here is different, she adds. And she repeats; I can eat at home by myself here, I can have visitors, prepare the food myself – with help. Those who want to can go to the canteen and buy their food there instead. And I can go out for a walk whenever I would like.

"Where I lived earlier". Liv is making a contrast between her current living conditions and the home where she used to live, which was much more institutionalised. Elsewhere she tells stories about this, about the grey and white, the walls that were painted in interminable tones with different greys and whites. And of the single light in every room, hanging from the center of the ceiling, that cast a harsh glare over everything. Every room was the same. There was no individuality. It was a world of institutional regimes, going to bed and getting up at fixed times, the meals at the same times each day, the menus on a weekly schedule, rigidly fixed – the same, week in and week out.

So life is different now. Liv can decide about time, about when to do things. Though, of course, since she often needs somone to help her, she may have to wait if the carers are already busy. Which, she also adds, is usually no great problem.

Discretion

So there are smooth passages, and then there are passages that are more awkward. And then there are public passages and those that are private. All of this has to do with ordering. But then there is also the matter of order. Literally, we mean that. The questions of what comes before what, and crucially, how it is determined, what

comes before what. Which brings us to the vexed question of discretion, of choice, of centered decision-making, questions that have to do with the final triumph of the modern subject in all his glory.

But before we get completely carried away into irony, let us note that this is what Liv, who is scarcely an unmarked category, is seeking and is talking about. It is what she has been struggling for. Indeed, it is what she has been struggling for, for most of her life which has, as a consequence, dramatically improved in quality with its computers and its intelligent flats and the creation of new forms of care for people like Liv, forms of care that are no longer scheduled like life in a barracks. With huge institutions. With everyone the same, stripped of individuality, stripped of discretion, without the slightest ability to choose, to make decisions.[13]

Eighth story

A further excerpt from the field notes.

> – Is there something you miss or wish you could do?
>
> – Liv instantly replies: – "to write". She says this with some force. She goes on: – "because it has always been so cumbersome. I learned to use a word processor, and got help with it, in the place I lived before. At that time I had pc with a special mouse. I still have it in the school in the old building here". .... Then Liv confides to me: "I am writing my memoirs, my autobiography". She says this in a low voice and with a big smile on her face. I have the sense that if she had been able to lean forward as she said this, then she would have done so. This is obviously very important for her. It turns out that Liv has written over 25 chapters! – "I have so much in my head, she says with another smile. Recently I have been writing about my time here, what happened after I moved here. I have two school hours each week and then I write. That means that what I do is to dictate, since it is so cumbersome to use the writing system that I have got. And the teacher writes down what I say. ... I really think it is important for young people to know how it is to be handicapped, and how it was to be handicapped in the old days.

Indeed, Liv has written twenty five chapters of her memoirs. She's been working on it hard – ever since she moved to her new home. It isn't her only priority, but it is near the top of her list, perhaps even at the top.

Ingunn has looked at the autobiography and discussed it with her. Many Norwegians are interested in their family origins, and Liv is no exception. So the memoirs starts with a family tree, and then describes what it was like to live on a farm in Trøndelag in the 1940s: bringing in the harvest; slaughtering the animals; curing the meat and making sausages; Christmas celebrations. The round of the year. And then woven into this, Liv is telling the story of her own life: her premature birth; the fact that against all the odds she survived; the fact that in celebration of this, she was christened Liv (in Norwegian this means "life"); the virtual impossibility of getting an education for someone as disabled as her; the first primitive technical aids; the purchase of her first manufactured wheelchair. An important moment, of this Liv remembers: "it was shiny, green and beautiful". Then the move from home to an institution at the moment when her father fell ill and her mother could no longer cope, which was a moment of great anxiety, the night she first slept alone – but also, or so it was to turn out, a moment of release and liberation. The moment when it became possible to make new social contacts, to build a new social life. And then the trials and tribulations – we have already touched on these – of living in a large institution with all its interminable routines. But also a whole chapter devoted to her new electric wheelchair, to the freedom and mobility that it brought, and the pleasures that followed.

And the story continues to grow.

Continuities

We want to talk about the *importance* of the act of writing for Liv.

What is happening as she writes is that Liv is building a life. Let us emphasise that: she is *building a life*. She is *building* it. And it is also the narrative of a *singular* life, of a life that holds together, a life that has grown, grown through a series of narrated passages. There are good passages. Her life has grown out of a family context that can be traced back – she has done this – to the sixteenth century. It has grown out of the context of a rural family history and has unfolded, to be sure, through endless struggle and adversity. This means that there are bad passages, her birth in the winter and her survival against all the odds. But then there are better passages, the things that she did, Liv did, on the farm, in her home, in her commune. For there is a strong sense in her autobiography of *agency*. Of Liv as a positive agent. Of someone who is able to act in a way that is independent of others. Move from place to place, metaphorically. Of someone who is able to ignore her physical dependence on her carers and enablers. Who knows perfectly well – to put it in STS language – that she is inserted in a series of heterogeneous networks,

human and non-human. But for whom – how should we say this? – this is not morally important.

"Morally important"? We have some anxieties about the term. We don't want to build a dualism between the moral on the one hand and the pragmatic on the other. Though it is perhaps difficult to avoid some kind of divide: we have seen this already in the difference between back-stage and front, between the somewhat disembodied agent and the difficult passages that she conceals. But in talking this way, we want to follow Goffman and catch something about the interdependent importance of both independence and unity for Liv as a moral agent. For what we might think of as Liv's "moral economy"? Her sense of self. Her sense of herself, to repeat, as an active and autonomous agent. Her sense of herself as a unitary agent. A unitary agent? This takes us into deep waters. But we are tempted to tell a story about activities or narratives of continuity, of good passages, of stories that are "rational". Which means that they are planful and coherently ordered – and no doubt, in fair measure, centrally controlled. Which is the point about discretion, the normatively desirable state of discretion in the modern discourses of Western subjectivity.

Rationalisation: of course the term has a double sense. The act of making rational, of ordering. And the act of pasting coherence on after the event. No doubt storytelling, autobiography and memoirs lie somewhere between the two: retrospective and prospective. What will happen, what the agent will do, these are made in large measure by the narratives of the past; the genres of telling and sensemaking, of which, to be sure, autobiography is only one, all be it one that is important for many – and not least Liv.

So Liv is performing herself as a rational agent. This means that she is also performing herself as a continuity. Liv in 1939 leads to Liv in 1997. The one grows out of the other. It is in some sense a continuous passage, or a continuous set of passages. The earlier and the later Livs are both part of a single chronological narrative, a narrative in which Liv as agent makes herself, struggling against all the difficulties of a dis/abled body. Against or with all the everyday contingencies, there is nevertheless a real coherence in which she has some degree of control.

Autobiography, then, is a prosthesis. It is an extension to the person. Or the person is an extension to the autobiography. Cyborg-like, they are partially connected, internally related, and irreducible to one another.

Ninth story

Towards the end of our first interview, there was a knock on the door, and a care worker came into the flat. She'd expected Liv to be alone, and was a little surprised

to see a visitor. However, she wanted to talk with Liv about two or three things, and went ahead and talked about them anyway. There was the matter of Liv's laundry, but also a question to do with her personal finances. In an earlier correspondence, Liv had said that she wanted to take full responsibility for running her personal finances. Now a letter responding to this had arrived from the administration of the home. The carer read it out to Liv. It turned out to be a question about Liv's earlier letter. How important was it for her to control her own finances? Did Liv really mean what she had said? Did she really understand what was involved?

As the carer did this Liv got very upset. Ingunn's fieldnotes say:

> Afterwards I ask her if she is angry. And what kinds of things make her angry anyway.
>
> – Yes, says Liv, when people want to make decisions for me. When they overstep the boundaries. For instance, when they involve themselves in my financial affairs. I want to manage my money for myself. I have always done so. I will not have them interfering in my private life or in my finances.

Discontinuities

Here Liv is making herself separate. She is insisting on the performance of a discontinuity. Of course we have come across discontinuities already. Liv separates herself from her environment in physical ways. She has her own flat with its environmental controls. As we have seen, she can close the door on the flat. It is her private space.

But separation is not simply a physical matter. Indeed, the physical separations are significant because they point to what we have referred to as "moral" divisions and distinctions: Liv as an autonomous and discretionary agent. Which is of course the point of the last story. Here another agent is invading Liv's space both physically and morally. Physically she has come into the room and started a conversation despite the fact that someone else was already there, and despite the fact that another conversation was already going on. And if this is also a moral intrusion, then it is perhaps doubly so because the intruder wants to talk about Liv's personal finances.

Note that: we write "personal" finances. We scarcely need to create a full-blown narrative of the development of normative rationality and that of the modern Western subject to appreciate that something rather sensitive is going on here. The competent subject is indeed one that can count, can calculate, can plan, can exercise discretion and so take responsibility for the decisions it has taken. And if decisions

about matters of finance are particularly important within this paradigm of subjectivity, this is perhaps not so very surprising given the links between the formation of normative subjectivity and the development of market relations.

All of which is a way of saying that this intrusion performs Liv as an incompetent subject. Which means, in turn, that here the performance of *discontinuity* is the essence of competence.

Tenth story

Well perhaps we don't need to make another story, because what we want to do is to point to some of the complexities of Liv's situation. She is totally dependent on care for many of her daily activities. She is totally dependent on the environmental control in order to work her flat. She is totally dependent on her wheelchair in order to achieve mobility. The list of continuities that are also dependencies is endless, as it is for all of us – though, to be sure, it is the fact of Liv's dis/ability that witnesseses this, that makes her passages, good, bad and indifferent, so much more visible than would be the case for a person with a normatively standardised bodily package.

All this means that at the same time (again like all of us) Liv is indeed independent. She can write. She can go out for a walk when she wants. She can watch the television like anyone else. And, we haven't mentioned this, she can knit - she knits caps and legwarmers. She can paint - her flat is full of her own paintings. She can bake cakes. She makes Christmas decorations with the help of an assistant. Her life is full, she is a busy person. And she is indeed in a real sense, a person who is independent.

Dis/continuities

Here it seems we are faced with a puzzle, or a paradox. Somehow or other, if we are to understand what is going on for Liv, then we have to hold together both continuity and discontinuity. Or, to put it a little differently, it seems that continuity and discontinuity are being performed together.

Paradox? No doubt, the paradox is more apparent than real. Empirically it is obvious enough what is happening. Indeed, perhaps it is obvious at more than one level. For instance, first, it seems that moral continuity also depends on – indeed performs – moral discontinuity. To be a competent agent, is in some sense to be separated from other agents at times. We have just seen that. But, at the same time, it is also to extend the moral continuities of planful action and sustained identity

into both the past and the future. Hence the importance of Liv's autobiography, not to mention her artistic and craft activities mentioned above.

Moral continuity/moral discontinuity, an oscillation or alternation. But then, second, there is a link of a similar kind between the discontinuities of moral agency, and the continuities of material support. We've made the point above, so it scarcely needs labouring. Liv is able to move, able to write, able to act as an autonomous agent, only because she is embodied in and performed by an endless network of heterogeneous materials, human and non human.

Perhaps, then, it is something like this. Liv is a *cyborg*. She's not simply a cyborg in the easy sense that she is part machine, part human. That this is the case is self-evident – though it is self-evident for all of us, inserted into and produced by the specificities of heterogeneous networks. No. She is also a cyborg in another and yet more important sense. She is a cyborg in the sense that she is irreducible, she is irreducible to a unity – *even though "she" is also a unity*.

Perhaps there are various ways of saying this – though no doubt our languages with their preferences for singularities or binarisms strain away from the possibility, make it/them difficult to say[14]. We need to exercise the imagination in order to elbow away at the conditions of im/possibility. And this, or so it seems to us, is what Donna Haraway is trying to do with this metaphor, the cyborg. For a cyborg is a unity but also a composite of parts that cannot be reduced to one another, which are different in kind, and which are not homogeneous. *But which are also internally related to one another*. Which would not be the way that they are, individually, if it were not for that link, that internal relation.

How to press the point? Perhaps this will help. Marilyn Strathern recounts that there are two Stratherns: Strathern the feminist and Strathern the anthropologist. And notes that there are *partial connections* between the two. The anthropologist is not the same as the feminist – but it would not be the way it is if it were not connected to the feminist. And vice versa. Note that: Strathern's argument, which tells of her as a cyborg, does not depend on the material heterogeneity of a woman/machine assemblage. Heterogeneity, partial separation, may come in quite other forms. Prosthesis does not necessarily have to do with artificial limbs.

Except we should end, where we began, with Liv, who more visibly than most of us lives in a place and performs herself through physical prosthesis. She is indeed a cyborg, yes, in an obviously material sense, but is a person, yes, a modern western subject, whose struggles to achieve that normative form of subjectivity make it easier to see what is at stake for all of us. For all of us as we make, are made by, good passages and bad passages. As we make and are made by the desires for continuities and discontinuities. As we weave, are woven, in the partial connections, in the particular oscillations and dis/continuities of normative subjectivities.

In which case Liv is made, created, within an economy of non-coherence, a heterogeneous economy, an economy that cannot be told and performed in one place at one time. Which cannot be drawn together. Absence and presence, yes, these go together. That is the character of subjectivity[15].

Notes

1 This paper draws on interviews of Liv conducted by Ingunn Moser as part of a larger study of dis/ability funded by the Norwegian Ministry of Health and Social Affairs and the University of Oslo in the period 1994 -1998. We are grateful to the Ministry, the University of Oslo, the Research Council of Norway, and the British Council for the financial support which has made this work possible. We are grateful to Brita Brenna, Mark Elam and Annemarie Mol for sustained intellectual support and discussion. But most of all we are grateful to Liv for her interest, support and encouragement, and her willingness to describe and explore important aspects of her life.

2 The relevant STS literatures include publications by Madeleine Akrich, Michel Callon, Charis Cussins, Donna Haraway, Karin Knorr-Cetina, Bruno Latour, John Law, Annemarie Mol, Vicky Singleton, Sandy Stone, Leigh Star, Sharon Traweek and Sherry Turkle. See (Akrich and Pasveer: 1996; Callon and Latour: 1981; Cussins: 1997; Haraway: 1989; Haraway: 1991a; Latour: 1988; Latour: 1990; Latour: 1993; Law and Mol: 1995; Mol: 1995; Mol: 1997; Singleton: 1993; Singleton: 1996; Star: 1991; Stone: 1995; Turkle: 1996)

3 See (Garfinkel: 1967).

4 "Perhaps": for Garfinkel was also deeply interested in the materialities of ordering, at least in many cases. For instance, in the records kept by jurors, or the materialities of Agnes' performance of female gendering.

5 Going for a walk. Here we think also of the people who turn up at hospitals suffering from pain when they go walking, pain which in the textbook stories, is caused by artherosclerosis in the blood vessels of the legs, which means that the blood supply is impaired. How do doctors decide whether or not to operate? There are a thousand and one indicators and contingencies. But one has to do with the style of life of the patient. If she always walked everywhere then this is a specificity to do with an important passage. Or to put it a little differently, she is dis/abled in a way which is not the case if she is happy to sit in a chair in a home all day. For details of this case see (Mol: 1997). A similar logic applies to the passage towards pregnancy: as is obvious, not every women wishes to have a baby. But those who really wish to get pregnant and are unable to do so unaided, are under certain circumstances, now able to secure technological intervention to achieve this passage. See (Cussins: 1997).

6 For further discussion of forms of pleasure and pain, see (Moser and Law: 1997).

7 See: (Butler: 1990; Elias: 1978; Goffman: 1968; Goffman: 1971; Star: 1991; Star: 1992).

8 Perhaps the point is made in a similar manner within the work of the actor-network theorists when they talk about "black boxing". In which case an agent is one who comes to stand for, to speak for, a lashup of heterogeneous bits and pieces, awkward and disruptive passages which are, for the moment, pushed into the background. See (Callon: 1986; Callon and Law: 1995; Callon and Law: 1997; Latour: 1988; Law: 1994).

9 Which is, to be sure, a somewhat different point: the making of back-stage front-stage distinctions is also a "moral" matter in which certain aspects of corporeality and embodiment are taken to be discrediting. There is a large feminist literature on this, and it is also developed in an historical context in the writing of Norbert Elias. We will return to the question of the "moral" below.

10 After all, sexualities, often backstage, are equally often sources of pleasure.

11 The reference is to (Star: 1991).

12 As has been extensively considered in some of the literatures of feminism. See, for instance, Donna Haraway's writing: (Haraway: 1991b; Haraway: 1996), and also in the writing of Annemarie Mol, which explores the normativities that are implicitly performed in devices and organisational arrangements.

13 Ordering. Deciding what comes first. Deciding what comes first? Well, that is the way we have set it up. As a matter of choice. But if we put it this way, then it also implies that matters are drawn together, arrayed and displayed at a single place and a single time. As, for instance, on the screen of a computer, whose material arrays and specificities perform the possibility of centering. But this is only one possibility, and there are others. Perhaps, then, we might imagine subjectivities built in other ways: subjectivities made in alternatives to centred discretion: subjectivities performed in indeterminacy, undecidablility.

14 A binarism is *also* a singularity. That is, the parts of the binarism perform themselves as singularities. The same argument applies to pluralities. Pluralities are made up, in the standard stories of political eocnomy, by primitive and homogenised singularities. Donna Haraway wrestles with these linguishtic difficulties, as do Marilyn Strathern, Annemarie Mol and John Law.

15 The heterogeneities of absence/presence are discussed at some length in: (Law: 1997; Law and Mol: 1997). But the metaphor of partial connection draws on (Haraway: 1991a) and (Strathern: 1991).

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Marianne de Laet and Annemarie Mol

The Zimbabwe Bush Pump

Mechanics of a Fluid Technology*

This is an article about water pumps. More precisely, it is about a *particular* hand water pump: the Zimbabwe Bush Pump "B" type. The article is not critical, but neither is it neutral. For we happen to like, no, even better, to *love* the Zimbabwe Bush Pump in all of its many variants. But even if affection moves our writing, this is not an exercise in praise. Rather, we want to analyse the specific quality that attracts us to the Zimbabwe Bush Pump. This turns out to be its *fluidity*. So in what follows we lay out the various ways in which this piece of technology, so advanced in its simplicity, is fluid in its nature.[1]

The Zimbabwe Bush Pump is solid and mechanical and yet, or so we will argue, its *boundaries* are vague and moving rather than being clear or fixed. Likewise, the question as to whether or not the Bush Pump actually *works*, as technologies are supposed to, can only rarely be answered with a clear-cut "yes" or "no". Instead, there are many grades and shades of "working"; there are adaptations and variants. Thus the fluidity of the pump's working order is not a matter of interpretation. It is built into the technology itself.[2]

This is not an accident. The Bush Pump is made that way. It is made that way by a modest inventor. For to our great pleasure the Bush Pump comes with a non-classical hero who is as active as can be and yet makes no claims to *heroic* actorship. To the extent that we know him, he is (how to say this without getting personal or, even less appropriate, ironic?) an ideal man. For he too is fluid, *dissolving* into his surroundings. The one kind of activity which he firmly stands for is

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attending, being attuned, and adapting to what happens to the Bush Pump in the world-out-there.[3]

In technology studies much has been written about the enormous difficulty of moving technologies, of transferring them from one site to another. For instance, in her case studies Madeleine Akrich has beautifully shown how the element that leads to the collapse of a carefully built network of machines, skills, and social relations may be tiny. A minute bug eating cotton stalks stored in a warehouse is sufficient to harm the transfer of a cooking device from Sweden (where it burned sawmill waste) to Nicaragua. The successful move of a *Gazogene* from its manufacturer in France to Costa Rica where it ought to generate power is stopped in its tracks by attempts to feed it with a type of wood it hadn't met before. While the transport of a photoelectric lighting kit from France where it is made, to Africa where it is intended for use, is impeded by the fact that it depends on a non-standard type of plug – that isn't available in Africa.[4]

Stories like these bring out the striking adaptability of the Zimbabwe Bush Pump. Perhaps in this it is like the clinical diagnosis of anemia in medicine which, unlike its laboratory-based cousin, reveals a flexibility that allows it to travel almost anywhere. As has been argued elsewhere, the adaptability of clinical diagnostic methods suggests that they hold together as a *fluid* rather than as a network.[5] Something similar might be true for other technologies that transport well. Therefore we mobilise the metaphor of the *fluid* here to talk of the Bush Pump. In doing so we hope to contribute to an understanding of technology that may be of help in other contexts where artefacts and procedures are being developed for intractable settings which urgently need working tools. Because in travelling to "unpredictable" places, an object that isn't too rigorously bounded, that doesn't impose itself but tries to serve, that is adaptable, flexible and responsive, in short a fluid object, may well prove to be stronger than one which is firm.[6]

Our contention that technology is likely to travel well when it is *fluid* is not only relevant for the Zimbabwean villages *for*, and – as we argue – *by*, which the Bush Pump was designed. We write about it *here* because the Bush Pump may have something to tell readers of *Social Studies of Science* as well: it may help the current move in science and technology studies, to transform what it means to be an *actor*. For, as has been argued by many, the "actor" that sociology has inherited from philosophy, *Rational Man* – a well-bounded, sane and centered *human* figure – is in urgent need of an update. At first sight it may seem a tall order for the Bush Pump to provide such an update; a pump, after all, is neither human nor rational. But then again: the Bush Pump *does* all kinds of things, and we will explore some of its *activities*. Arguably, it *acts* as an actor. Thus subsuming the pump under the

category of "actor" broadens the category, allowing it to include non-human, non-rational entities.[7]

But there is more. Our new actor, the Bush Pump, is not well-bounded but entangled in terms of both its performance and its nature, in a variety of worlds. These begin to change more or less dramatically as soon as the Bush Pump stops acting. Yet it is not clear *when* exactly the Pump stops acting, when it achieves its aims, and at which point it fails and falters. That is what we also mean to capture when we use the term *fluid*. If the Bush Pump may be called an "actor" despite its fluidity, then "actors" no longer or not always *need* the clear-cut boundaries that come with a stable identity. In short and to summarise: the Bush Pump is not a solid character. Not only can actors be non-rational and non-human; they can also – or so we hope to demonstrate – be fluid without losing their agency.[8]

With this assertion we enter a theoretical debate in Science and Technology Studies, which is to do with the nature, the power, and the intentions of the actor in actor network approaches.[9] And we carry this debate a step further when we talk about the Bush Pump's designer. Obviously, the Bushpump's designer is a human actor. But him, too, we subject to our theoretical purposes, in this text. We draw his image so that it contrasts with the *managerial vision* of the heterogeneous engineer[10]. The latter has been depicted as a network builder, who gains prominence by successfully marshalling credit for the work done by assemblies of people and assemblages of things. Louis Pasteur (in the portrait done by Bruno Latour) is a case in point.[11] Granted the honour of having "conquered" an infectious disease plagueing French cows, Pasteur is present in all French towns – if not as a statue, then at least as a street. Latour's study shifts the attention from the general to the army; from Pasteur to all other elements that worked just as hard in eradicating the disease.

There is, however, a next step to be made. For even if Latour's work shifts Pasteur out of the center by pointing to the network he needs, it also suggests (or has been read as suggesting) that innovation, even if it turns out to be the work of a large army, *does* need a general in order to spread out. This machiavellian reading of Latour says that technologies depend on a power-seeking strategist, who, given a laboratory, plots to change the world. And this is where the Bush Pump and its designer come in. They allow us to frame a different vision. The *success* of a technology does not necessarily depend on an engineer who masters the situation and subtly subdues everyone and everything involved. A serviceable or even submissive inventor may help spread technologies just as well – or even better. Effective actors need not stand out as solid statues but may fluidly dissolve into whatever it is they help achieve.

The scope of the object: The boundaries of the Zimbabwe Bush Pump "B" Type explored

> The designer knows when he has reached perfection, not when there is no longer anything to add, but when there is no longer anything to take away.[12]

So the object we invite you to examine with us is the Zimbabwe Bush Pump.[13] And our first questions are: What does it look like? How big is it? What forms a part of it? Where are its boundaries? How might we best describe it?

The Zimbabwe Bush Pump has existed for more than half a century, but it has not remained the same. It is not an immutable but a changeable object, that has altered over time and is under constant review. The current model results from restyling and improving an older manually operated water pump that was first designed in 1933 by Tommy Murgatroyd in what was then Rhodesia's Matabeleland. The experimenting and changing is still going on.

When new models come into being the old ones do not necessarily disappear. The original pump has proved to be a technology appropriate to the conditions of the African bush: some of Murgatroyd's Bush Pumps installed in the 1930s are still working in Zimbabwe today.[14] Other models succeeded the original, and some of these also survive. And while many different types of manual water pumps are available, it is the newest model Bush Pump – the "B" type – that is spreading most rapidly in Zimbabwe right now.[15]

So the Bush Pump is fluid because it is variable over time. But if we are to describe it we need to pick a version so we focus on this newest model, the "B" type. Even if this is the latest model now, it may already be slightly outdated by the time you read this text – though it won't have disappeared from the Zimbabwean villages where it is installed. For the Bush Pump "B" type may not be made to be immutable, but it *is* made to last.

Pump head: Topping the well

Cheerfully blue, you would want a Zimbabwe Bush Pump "B" type in your own back yard. Originally designed for "simplicity, durability, and ease of maintenance",[16] the current model is attractive and appealing. Its cobalt colour suggests purity, clarity, and freshness, the qualities sought for the water that it delivers. And its clean hard lines and compact shape ask you to "pick me up and install me where-ever you fancy. I am cool and easy to use." This message is not frivolous fantasy on our part. The pump is *meant* to convey messages of this kind. The pump's manufacturer in Harare, V&W Engineering, has found that the tools it makes are most likely to be

used if they are brightly coloured.[17] And together with Dr. Morgan, the developer of the "B" type, the factory has worked hard to enhance the usability of the pump, increasing its durability, while making it cheaper as well.[18]

The Zimbabwe Bush Pump "B" type consists of a pump head or water discharge unit, a base or pump stand, and a lever. The steel pump stand is bolted to the bore hole casing at one end and to the water discharge unit at the other. The lever is a flexibly fixed wooden block, joined with bolts to the upper part of the water discharge unit. When the lever is raised and lowered it works the moving parts of the pump. The wooden block is attached to a U bracket which holds the upper end of the pump rod. Movement of the rod (backwards and forwards, and side to side) is absorbed by two floating washers within the floating washer housing. These parts forms the water discharge unit at the top of the rising main – together they form the stable section of the pump above ground level. Of course, all this is held together by nuts and bolts.

These words don't really describe it properly, do they? Perhaps, then, a drawing will help.

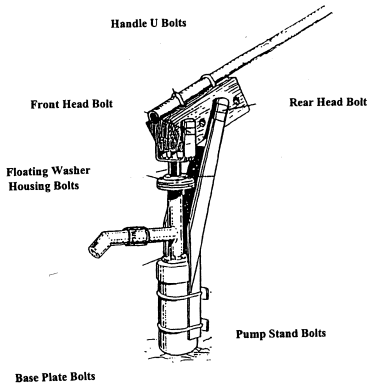

Figure 1: Pump head as pictured in instruction manual
Source: Morgan, op. cit. note 12, 1.

Hydraulics: Down the well

Together with the words, the drawings offer a reasonable description of the device. But even so, the pump isn't quite *there* yet, for it has other *invisible* parts beneath the ground, moving and static parts. In his wonderfully rich text on rural water supplies and sanitation in Zimbabwe, Dr. Peter Morgan begins his description – another description – of the pump as follows.

> The Bush Pump operates on a lift pump principle, the reciprocating action being transferred from the pump head to the cylinder through a series of galvanised steel pump rods running inside a steel pipe (rising main). Most rising mains are made from 50 mm galvanised iron pipe, although 40 mm pipe is becoming more common. Most rods are made of 16mm mild steel although 12 mm is also used. Pump cylinders are made of brass and are either 50 mm or 75 mm in diameter. The piston and footvalves are also made of brass. Most piston valves [as well as the seal, Morgan 1994] are made of leather, but neoprene is becoming more common.[19]

Here, the pump is defined neither in terms of its color nor by the parts you can see above ground. Instead the story is about its hydraulic components. It is, after all, the *hydraulic forces* that enable it to pump water out of the ground. As Morgan says, "the functional part of the pump is inside. It is hidden. And it is not all tangible. To you it will be clear how a pump works, because you have at least a basic knowledge of hydraulics. But for people in the rural areas the sudden emergence of water from a new pump is rather a miracle."[20] And although our knowledge of hydraulics was a bit rusty Morgan is right: a quick look at his illustrations helps to clarify how the pump works. To the informed eye another set of pictures brings the underground parts to life – the parts that achieve the miracle of the hand water pump.

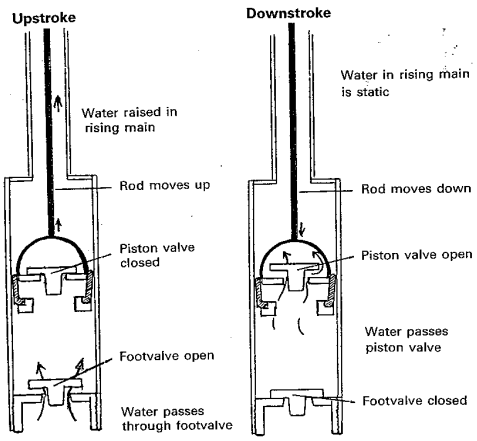

Figure 2: Hydraulics
Source: [Morgan, 169].

So maybe the hydraulic principles, or the components that make those principles work, define the pump? They do, because the hydraulic forces draw water from deep wells to the surface. And the hydraulic principles that it embodies, distinguish

the Bush Pump from other pumps. For instance, they trace a boundary between the Bush Pump and a common alternative – the Bucket Pump. The Bucket Pump is a bucket-and-windlass device while the Bush Pump uses pistons, valves and levers. This difference leads to other distinctions: the Bucket Pump is deployed in shallow, open wells and can be used by up to 60 people, while the Bush Pump can be operated in a wide range of well-types and serves up to 250.[21]

But even if its hydraulic principles separate the Zimbabwe Bush Pump "B" type from the Bucket Pump, this does not mean that it is unique. They define the pump – but not by setting it apart from all other pumps. This is because it belongs to a family of pumps with a "lever activated lift pump mechanism.'[22] *Within* this family, the Bush Pump's specificity lies not in its hydraulic principles, but in its capacity. The Bush Pump's strokes are more efficient and powerful than those of most other lift pumps; lifting water from wells up to 100 metres deep – which is about twice the depth reached by those other pumps – the Bush pump has exceptional competence. But the difference is not simply a matter of power and efficiency; it also has to do with durability. Made of steel and wood, the Bush Pump is designed to last longer than either of the others, whose major parts are mostly made of PVC. In this respect the solidity of the Bush Pump is more like that of the bucket-and-windlass Bucket Pump.

So the Bush Pump is specific.[23] We can describe it in terms of its difference from other pumps. But the characteristics that distinguish it from each of these also tend to be shared with one or more of the others. For the Bush Pump, *"being itself" means that it is continuous with a number of others.*

Headworks for health

There it is then, the pump delivered by V&W Engineering: pump head, lever, base, and underground parts. But is this it? Have we described and defined our object now? The answer is no, there is a problem, for when it's unloaded from the truck the Bush Pump yields no water. None whatsoever. It is not a pump.

If it is to work it has to be assembled. It needs to be installed, and installed properly. As a part of this, it needs to be cemented into concrete *headworks* to stop spilled water from finding its way into the well and contaminating it. It also needs a casing to stop the well from collapsing and letting mud, sand, and other pollutants fall into it. Only when it is set up in this way does it begin to provide water. But once this has been done it doesn't simply supply water but something even better: it becomes a source of pure, fresh, *clean* water. And so the Bush Pump turns out to be a technology that provides not just water but also health.[24]

As a health-promoting technology, the Bush Pump is not defined by its colour, by its hydraulic principles, or by the materials of which it is made, but by a set of *health indicators*. The principal health indicator for assessing devices which extract groundwater is the *E.coli* count. *Escherichia Coli* is a bacterium that lives in every human intestine. So long as it stays there all is usually well: *E.coli* in most of its variants lives harmoniously with *homo sapiens* in most of *its* variants. It is only when we encounter *E.coli* that are strange to us that we tend to fall ill.[25] So this is what makes *E.coli* a potential risk, in and of itself. More important is the way it works as a signal: if *E.coli* can pass from the human intestine into the water supply, then other bacteria will be able to move with it. And with the water, they may continue their journey to the next organism. And *this* is the health hazard that needs to be avoided.

Different techniques for obtaining water can be measured and compared in these terms, as indeed they are. For example, a study carried out by the Blair Research Institute in Harare during the rainy season of 1988 gives the following *E. coli* counts for five different water sources:[26]

Mean E. Coli counts for various ground water sources

Source	Mean E. coli/100 ml sample	Number of samples
Poorly protected well	266,42	233
Upgraded wells	65,94	234
Bucket pump (overall)	33,72	338
Blair pump (tubewells)	26,09	248
Bush pump (tubewells)	6,27	281

Table 1

Unprotected surface water may show *E.coli* counts of over 1000 per 100 ml sample. Figures collected by Zimbabwe's National Master Water Plan in 1988 demonstrate that in that year only 32% of the rural population used improved water sources in the wet season – a figure which climbed a little to 38.7% in the dry season.[27] A comparative study of 25 wells, carried out by the Blair Institute on samples taken in 1984 and 1985 shows a mean *E.coli* count of 475.39 for seven traditional wells (197 probes), 16.69 for eleven Bucket Pumps (261 probes), and 7.67 for seven Bush Pumps (191 probes). In this last study the mean for the Bucket Pumps is somewhat inflated, because one sample was abnormally contaminated. "The unusually high *E.coli* count for B 10 on 2.4.84 was caused by a defect in the concrete apron which cracked, and also infiltration of contaminated water from a nearby hollow used for making bricks. These problems were corrected."[28] Apparently a sound *apron*, part of the headworks of a pump, is crucial in reducing *E.coli* counts.[29]

Aprons and other features of the headworks are usually made by the future users of a new pump: a collective of villagers builds the headworks and installs the

pump. So the pump comes with a simple but very detailed set of instructions. [See Appendix 1 for a list]. These instructions insist that the borehole must be installed at a higher elevation and at least thirty meters from latrines and cattle kraals. They detail and illustrate all the steps to be taken in building a concrete slab and water run-off; they give exact measurements for all the parts to be made. Thus the instructions list the various elements a pump needs if it is to provide health by keeping *E. coli* and its colleagues at bay: it needs a bore hole casing which rises at least 500mm above ground level; a concrete apron of between 100 – 150mm; an auger full of fine gravel or 6mm granite chips to be poured into the tube well; a ring of bricks at least two metres wide as a rim for the apron; a water run-off channel at least six metres long that runs down, possibly to a vegetable garden; concrete of four parts stone, two parts washed river sand and one part cement.[30]

These elements and their measurements have been thoroughly tested. The precautions are crucial, both for installing more or less standard head works, and in translating these into step-by-step instructions. Because "[p]oorly made concrete headworks can crack, and will allow leakage of waste water from the surface back into the well or borehole. Similarly where handpumps are loosely fitted and worn in such a way that water can drain from the apron through the pump head into the well, then contamination of the well water is inevitable."[31] And once its well is contaminated, the Zimbabwe Bush Pump may still provide water, but it no longer provides health.

Village: Drilling the well

So the headworks are a crucial part of the pump – the pump that brings health. But if the pump is to work in *any* of its identities (as a proper mechanism, as a particular system of hydraulics, as a hygienic intervention) it also needs a hole. At this point it needs to collaborate with another piece of technology: a *tubewell drilling device*.

In Zimbabwe, and increasingly in other African countries, this device is often the "Vonder Rig." Invented and patented by Mr. Erwin Von Elling, and manufactured at his plant (which happens to be the same factory where the Zimbabwe Bush Pump is made), the Vonder Rig is hand-driven, portable, durable, and bright yellow. It is designed so that the boring of the water hole, like the process of making the headworks and installing the pump, can be almost entirely "community-based."

So communities bore wells. A video distributed by the factory shows that sometimes operating the rig turns into a village feast.[32] Village women push the iron crossbar to drive the auger into the ground, while village men sit on the bar to weigh it down and children dance around.

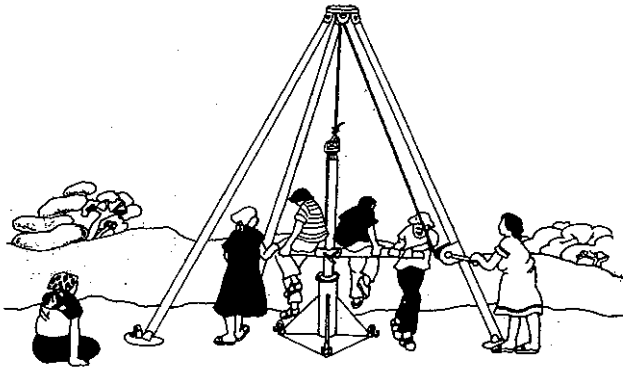

Figure 3: Community drilling a borehole
Source: [Morgan, 51].

According to the factory, the village is able to participate because the rig is manually operated and not mechanically powered.[33]

> The one great advantage of the hand operated drilling rig is that it makes full community participation possible at village level. There are many examples in Zimbabwe where the rig is operated fully under control of the villagers, which has an important influence on the success or failure of the final installation.[34]

And community participation is not only important in drilling the hole. It is crucial in finding the site in the first place. Some community members have more say in this than others. As a UNICEF worker explained, the *nganga* (especially when doubling as a local water diviner) may be imperative to the working of a pump.[35]

> Often, wells are drilled by NGO's purely on the basis of geological survey. However, in a country like Zimbabwe such wells do not always work. Even though the water that the well produces may be abundant and clear, and even though the new well may be nearer for its (intended) users than an older one that it is meant to replace, you may see a path traced out in the sand that leads around it. If the village women do not want to use the well, if it has been bored without consulting the *nganga* or was put into operation without his consent, the well is dead. Sometimes literally. There are instances in which a well was bored without the *nganga's* approval and, contrary to all measurements, turned out to be dry. Not a drop of water. And unfortunately, boring wells without consulting the *nganga* has happened all

> too often, especially when NGO's or governments are determined to keep the siting and boring of the well entirely in their own hands.[36]

Morgan and Von Elling have learned this lesson and taken it to heart. Not only do they make a concerted effort to make the pump simple, attractive, and easy to use and maintain, but they also state clearly and repeatedly, in instruction manuals and other publications, that local water diviners should be consulted before any decision about the siting of a water hole is made.[37]

Morgan and Von Elling thus suggest that village participation is key to the operation and maintenance of the pump.[38] So the village not only gets a pump, but it also gets instructions for how to install its water provider. Ideally, it is involved in all aspects of installation: it bores the hole, assembles the pump, constructs the headworks. And, together with the water diviner, it helps to pick the site. The village has joint ownership and collective responsibility for installation, operation, and maintenance. As the manuals declare: "The Zimbabwe Bush Pump Was Designed For Villagers to Maintain Themselves!"[39]

This suggests yet another way of describing and setting boundaries around our object. In critical ways the Zimbabwe Bush Pump includes the villagers that put it together. The pump is nothing without the community that it will serve. In order to be a pump that (pre)serves a community it not only needs to look attractive, have properly fixed levers, and well-made concrete aprons. It must also be capable of gathering people together and of inducing them to follow well-drafted instructions. It must come with a Vonder Rig and invite people to push bars, sit on them, or dance around them. It must seduce people into taking care of it. Thus the boundaries around a community-pump may be widely drawn. Indeed, they embrace the community.

National standards

Community participation is quite the thing in the theory of appropriate technology. It is 1980s wisdom to design projects, tools, and machines whose maintenance, installation, and operation, is "community based."[40] In Zimbabwe, this has become national policy.[41] From (by some, heavily criticised) "campfire" projects to the drilling of wells it is the village community that is the target for government operations, the level of collectivity most commonly addressed, and the unit the administration most strongly seeks to reinforce.[42] In Zimbabwean water policy the village is the preferred unit, the standard organisation on which intervention is based.[43]

In this way we arrive at another description of, another identity for the Zimbabwe Bush Pump. For the pump doesn't simply serve communities, helping to hold them together. It promotes something else as well. As it helps to distribute clean water, it

also builds the nation. For though it sometimes pours down all too abundantly in the rainy season, water is scarce in Zimbabwe.[44] And health in this country, plagued not only by AIDS and malaria but also by a host of water borne bacterial diseases, is a precarious policy issue. So while nation-building may involve writing a shared history, fostering a common cultural imagery, or promoting a standard language, in Zimbabwe it also has to do with developing an infrastructure for water. This involves a range of activities, from boring new wells and upgrading existing ones, to planning the construction of a pipeline from the mountains to the capital. And not only the government is involved. Universities, NGO's (Non Governmental Organisations), the GIS (the computerised Geological Information System), the V &W Engineering Company, many active villagers, and the Zimbabwe Bush Pump – all of these also participate.

As it is, there are great social divides in Zimbabwe between those who have plumbing in their houses, those who have water in their yards, and those who have to walk miles to get it. Setting up a national water infrastructure may help to bridge such divides. And government support for buying a pump may link up the village to the state, thereby enlisting villages in what is otherwise likely to remain an abstract nation.[45] So the Zimbabwe Bush Pump builds the nation. And it does so not only because it provides clean water if it is properly installed. It also helps that it is a local pump. Produced in Zimbabwe, designed in Zimbabwe, built with materials available in Zimbabwe, the Bush Pump complies with standards of quality and strength set in Zimbabwe. It is tailored to local circumstances, to local patterns of use and abuse. Its local origin means that it is well-adapted to the demands of Zimbabwean rural water supplies. And its local manufacture guarantees that spare parts will always be at hand.

In the world of water sanitation policy and development this is rare. As far as we know Zimbabwe is the only African country that produces its own pump. Relief programs, like UNICEF's "Water for the Children," usually carry their own model. This is why one finds water pumping devices strangely clustered on the world map: trucked all over the globe by relief organisations, pumps end up where these organisations happen to go – rather than near the sites where they are produced. Not so, however, in Zimbabwe. Here, UNICEF (a significant partner in the improvement of Zimbabwe's water infrastructure) was forbidden by the government to employ its usual pump. Buying its first ten "B" types in 1987 for trials, the organisation rapidly converted to the Bush Pump.[46]

As a local product the current version – the smaller, lighter, simpler "B" type Bush Pump – has been one of the government's two standard hand pumps since 1989. It is the model recommended for high-duty settings; that is, it is the pump of choice in all government-sponsored water supply programmes where demand

is high. That does not mean that the Bush Pump is Zimbabwe's most frequently used water lifting device. According to Morgan, there are an estimated total of 100,000 wells or water holes in the country, while (in early 1998) about 32,000 Bush Pumps have been installed – over half of which are "B" type pumps.[47] It *does* mean, however, that other pumps, with the exception of the Bucket Pump (which is the government's low-duty standard)[48], are gradually being phased out. As we write, this phasing out of the Bucket Pump has almost been completed.[49]

A national standard, the Zimbabwe Bush Pump is a nation-builder that gains strength with each new installation. Meanwhile, the Zimbabwean nation is a pump-builder, in that it oversees and encourages new installations of Bush Pumps. However willing it may be to travel elsewhere,[50] the "B" type is thus an unmistakably *national* pump (see figure 4).

A fluid pump

In Zimbabwe the Bush Pump "B" type has become a national standard because it is a good pump. And now, it is an even better pump because it has become a national standard. Sturdy, versatile, effective, locally manufactured, parsimonious, it is easy to service and easy to operate. It is so well-designed and parsimonious that, according to V & W's director, efforts to reverse engineer and reproduce it always result in a pump that has more parts; that is more complicated, and unnecessarily so. And as Morgan notes, "the designer knows when he has reached perfection, not when there is no longer anything to add, but when there is no longer anything to take away."[51]

Figure 4: A row of Bush Pumps at V & W Engineering
Photo by Marianne de Laet.

And yet. Even if nothing can be taken from it, it is not clear where this pump ends. For what is the Zimbabwe Bush Pump? A water-producing device, defined by the mechanics that make it work as a pump. Or a type of hydraulics that produces water in specific quantities and from particular sources. But then again, maybe it

is a sanitation device – in which case the concrete slab, mould, casing, and gravel are also essential parts. And while it *may* provide water and health, the pump can only do so with the Vonder Rig – or some other boring device – and accompanied by manuals, measurements, and tests. Without these it is nothing, so maybe they belong to it too. And what about the village community? Is it to be included in the pump – because a pump has to be set up by a community and cannot be maintained without one? But then again: perhaps the boundaries of the Bush Pump coincide with those of the Zimbabwean nation. For in its modest way this national bush-pump helps to make Zimbabwe as much as Zimbabwe makes it.

So the Bush Pump "B" type has a number of possible boundaries. A small device in some ways, in other ways it encompasses an entire state. But we're not interested in making claims about its *absolute* size or reach. Instead, we want to insist that the Bush Pump is – descriptively and practically – framed in a range of different ways.[52] The fluidity of the Bush Pump's boundaries, however, does not imply that it is vague or random; that it is *every*where or *any*thing. For however fluid it may be, the Bush Pump is clearly not a Bucket Pump. And providing healthy water with a pump on a solid concrete slab is not like doing so by building non-flushing, wind-ventilated latrines.[53] Digging a well by pushing a bar that is heavy because the men are sitting on it creates a community gathering of a different kind to one that meets to bury a neighbour. Holding a nation together with a pump is not like doing so with gifts of money or the reallocation of land.[54] Thus, the Bush Pump's various boundaries define a limited set of configurations. They each, one might say, *enact* a different Bush Pump. But these different Bush Pumps have in common that they are indeed a pump – and not a diviner, a rain cloud, or a water infrastructure chart.

There it is, then, our pump. Beautifully blue. But is it an *actor*: does it work?

The workings of the technology: Successes and failures of the Zimbabwe Bush Pump

> Children should be taught not to throw stones down the tubewell.[55]

All sorts of things can go wrong with a pump. As a technology the Zimbabwe Bush Pump "B" type is expected to *perform*. It must act, *do* something. It is made to *work*. And it is made to *keep* on working.[56] Designed for simplicity, durability, ease of maintenance, and assisted by manuals and instructions, it is created to survive. But despite all this a pump may *stop* working in all sorts of ways. It may become dirty. Its seal may erode. The pipes may wear, rust, or come apart. The children may not

be properly taught and throw stones down the well. The community may become disorganised. While the ways in which the pump works are many – it makes water, health, community, a nation – there are just as many ways in which it may fail.

Hydraulics: Down-the-hole parts

If the *hydraulics* fail in Bush Pumps then the pump is in trouble. This is true for Murgatroyd's original as well as for the later "A" and "B" types. It's in deep trouble, for the trouble is deep-down. Although in its standard form the Bush Pump uses well-proven and durable "down the hole" components, some of these eventually need to be replaced. For instance the leather seal may wear out, a common cause of pump failure. Rods may separate, and various things may go wrong with the footvalve, the piston, and the rising main.[57] If they break down, then they need to be repaired or replaced. But how to get them out?

In the standard model the diameter of the cylinder (the part that holds the hydraulic components, the piston and its seals, shown in figure 2) is greater than that of the rising main. And since it is at the bottom of the main its components cannot be pulled out. In order to repair damage to valves or seals (located in the cylinder and sized so that they fit tightly) the piston needs to be pulled to the surface. This means that the pump's (heavy) pipes and rods also need to be raised, that the pump must be taken apart, perhaps that the apron will be damaged. And since – unlike its installation – taking a pump apart to repair it demands a skilled team this means that the pump may stop working and fail to provide water if no skilled team is around.

In the latest version of the "B" type – not yet standard but maybe becoming so after the prototypes have been thoroughly tested – this is different. When its hydraulics break down they can be mended. For this new pump has "down-the-hole" parts that may be *extracted*. Its cylinder is 50 mm with a 50mm piston, and the rising main is reamed out just a little more than in the standard model. The piston still fits tightly in the cylinder, but – because the rising main is larger in diameter – is now narrow enough to slide through the rising main. In addition, the footvalve and the piston valve are inversely threaded, so that they can be screwed together and the footvalve can be pulled up as well.[58] This version of the pump uses lighter 12 mm rods instead of the 16 mm ones, and the rods are held together with eyes and hooks rather than threaded joints in order to make it easier to take them apart.

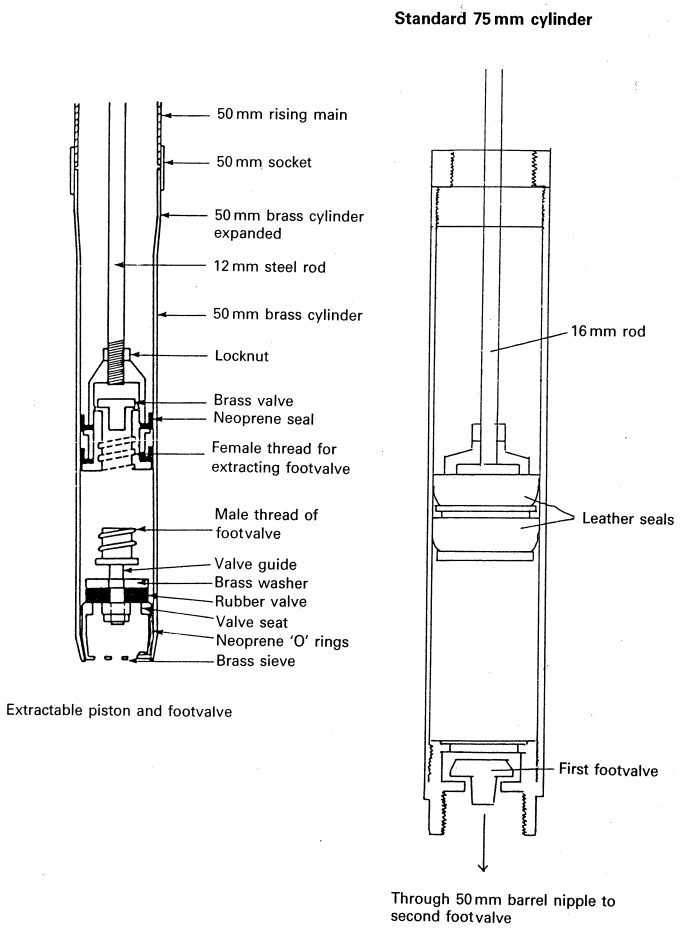

Figure 5: Cylinders
Source: [Morgan, 164].

As a result of these adjustments it is possible, even fairly easy, to take out the moving parts. And they can be removed without taking the entire pump apart; without destroying the headworks and possibly damaging the well. In this way the parts can either be repaired or be replaced – and this can be done locally.

> It is anticipated that the replacement of seals will be undertaken by Pump Caretakers or Pump Minders with the assistance of the community who use the pump. Community assisted maintenance of this type is desirable as this reduces the burden on the D[istrict] D[evelopment] F[und] and also involves

the community more in a simple and understandable procedure which can be undertaken with minimum risk.[59]

Whereas the design of the down-the-hole parts still looks rather complicated to the non-specialist, working on them sounds surprisingly easy. Two simple spanners and a few good men, that is all that is needed for routine replacement of the seal.

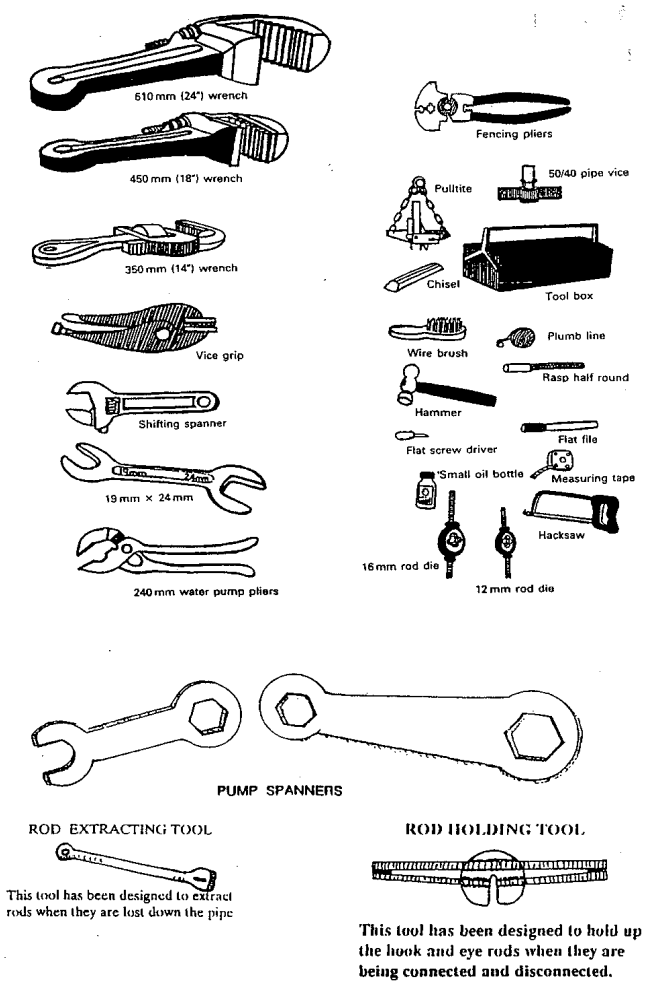

Figure 6: Tools and spares, as pictured in instruction manual
Source: [Morgan, 181]; Morgan, op. cit. note 12, 9.

So to make the "B" type easier to repair, some of the hydraulic parts can be altered. If 16 mm rods are too heavy to be easily taken apart, 12 mm rods may take their place. If disconnecting threaded rods is too hard, hook-and-eye connections will

TABLE 2

Bacteriological data for groundwater

Date	Traditional wells							Bucket Pumps											Handpumps							Comment
	W57/	W58/	W59/	W61/	W62/	W63/	W64/	B9/	B10/	B10/	B23/	B19/	B19/	B18/	B19/	B20/	B21/	/W34/	W3/	PP8/	W30/	W31/	W34/	W35/	W36/	
9.1.84	65	140	550	350	1800	1600	1800	0	2	0	35	0	0	25	2	-	-	-	8	2	2	0	0	-	-	
16.1.84	50	250	250	350	550	350	1800	8	225	2	0	0	0	9	550	-	-	-	275	7	45	0	7	17	-	Heavy rain
25.1.84	20	25	550	1600	1800	25	225	0	5	0	0	0	2	0	7	-	-	-	5	20	0	0	0	0-	-	
30.1.84	1600	425	170	900	1800	95	35	25	70	0	4	0	0	110	2	-	-	-	5	0	0	0	7	2	-	Heavy rain
13.2.84	35	110	225	95	1800	170	40	11	30	2	0	5	0	2	-	-	-	-	8	8	0	0	11	0	0	
20.2.84	250	17	20	250	1600	900	350	0	0	2	0	2	2	0	2	5	-	-	5	0	0	17	0	0	0	
28.2.84	50	1800	95	45	250	225	1600	0	0	0	0	2	0	5	2	0	-	-	13	0	0	0	0	5	2	
5.3.84	130	550	80	80	350	550	80	0	0	5	14	8	0	7	2	5	-	-	0	0	0	2	2	2	0	
12.3.84	330	350	550	550	1600	350	350	0	7	5	0	0	17	14	11	0	-	-	5	14	0	0	0	2	0	
20.3.84	250	40	425	550	1600	250	1600	11	35	11	0	0	7	17	5	5	-	-	5	50	0	0	0	0	0	
26.3.84	1600	17	250	550	225	170	120	0	11	8	0	2	0	0	2	2	0	-	2	0	2	0	0	0	0	
2.4.84	550	1600	250	900	95	1800	1800	0	1600	2	5	2	2	5	350	2	350	-	250	5	5	2	9	11	0	Rains and
9.4.84	225	35	14	40	140	1800	1800	0	4	0	2	5	0	7	2	0	14	-	2	2	0	DRY	2	5	0	flood
24.4.84	50	2	6	7	11	50	80	0	0	4	4	4	2	17	0	0	0	-	5	0	0	-	0	2	0	
7.5.84	170	8	40	1800	5	35	50	5	0	11	8	5	2	4	6	0	0	-	0	0	0	-	0	2	0	
14.5.84	57	13	50	110	550	80	900	2	-	35	0	0	-	5	0	0	2	-	2	0	13	-	0	5	2	
11.6.84	110	7	31	550	1800	14	140	0	0	9	8	2	0	0	DRY	-	0	-	0	0	0	-	0	2	0	
6.8.84	2	0	5	0	0	0	DRY	0	0	0	0	-	2	0	-	0	DRY	0	0	-	0	-	0	0	36	Mid winter
22.8.84	25	250	25	2	110	70	-	0	0	2	-	-	0	0	-	0	-	0	2	130	0	-	5	0	2	(no rain)
3.9.84	2	4	4	4	0	12	-	0	0	2	0	-	0	0	-	0	-	0	7	0	0	-	2	0	0	
24.9.84	130	14	-	20	17	-	-	0	0	0	0	0	0	0	-	0	-	0	0	0	0	-	0	0	0	
8.10.84	1800	4	25	8	2	32	-	0	0	8	0	2	0	DRY	-	2	-	0	4	0	0	_	0	0	2	
22.10.84	35	14	8	900	35	-	-	0	0	13	0	0	0	-	-	0	-	0	0	0	0	-	8	0	0	
5.11.84	80	17	55	80	50	1800	-	0	5	4	0	0	0	-	-	17	-	4	0	0	0	-	5	0	8	Rains
19.11.84	70	20	110	50	350	1800	-	0	2	0	0	0	0	-	-	0	-	5	5	0	0	-	8	0	2	Heavy rains
3.12.84	1800	70	1800	-	202	350	-	2	50	8	2	2	2	-	-	5	-	-	50	0	13	-	7	8	0	
8.1.85	350	40	110	1600	1800	900	-	2	0	0	-	0	0	-	-	2	-	0	13	25	2	-	5	2	2	Heavy rain
21.1.85	1600	1800	1800	1800	-	-	-	8	40	70	35	80	2	-	-	7	-	2	25	17	8	-	110	11	14	Heavy flood
11.2.85	1800	55	110	35	1800	50	-	0	0	5	2	2	0	-	-	0	-	0	2	0	17	-	5	5	-	Rains
25.2.85	350	11	275	00	225	130	-	4	0	5	0	0	0	-	-	2	-	0	2	0	2	-	0	0	25	Rains
11.3.85	1800	35	550	170	1600	130	-	11	11	8	7	8	0	-	-	0	-	13	8	0	0	-	2	0	13	Heavy rain
Total E. coli			93953					Total E. coli				4358							Total E. coli				1466			
No. samples			197					No. samples				261							No. samples				191			
Mean E. coli			475.39					Mean E. coli				16.69							Mean E. coli				7.67			

Source: these data were collected from traditional wells and tubewells fitted with Bucket Pumps and Bush Pumps, and analyzed by the Blair laboratory in Harare [Morgan, 77].

serve. And if a 75mm cylinder's piston can't pass through the 50 mm rising main, the cylinder may be reduced in size and the main slightly expanded. If something is lost in all this – a 50mm cylinder lifts less per stroke than a 75mm cylinder, and a 12 mm rod is not as versatile as its more sturdy 16mm friend – then something is gained: reparability. And if this advances long term performance, then the trade-off is beneficial.[60] The pump emerges perhaps less solid, but certainly more viscous: its elements are less rigidly linked. And for long term performance such fluidity may be just what it needs.

Mechanics: Nuts and bolts

One of the attractive features of the Zimbabwe Bush Pump "B" type is that since it is locally produced, spare parts are easy to come by. This erodes the boundary between pumps in working order and those that are broken, for it helps to turn "being broken" from a final *state* into an intermediate *stage*. But sometimes spare parts aren't even necessary. The pump proves to be adaptable in unexpected ways. Thus, though the seal is normally leather, if a spare leather seal is not available a properly-cut section from an old tyre may do just as well (though it doesn't last quite as long).

And consider the following – a more dramatic alteration in the above-ground section of the pump. As we have seen, this section comes in three pieces: a base, a pump head, and a lever. Each of these pieces is fixed with heavy bolts. The manuals and descriptions sternly advise that these bolts be tightened from time to time: "Keep all these bolts tight with a spanner", is the maintenance instruction that, like the spanners themselves, comes with the pump.[61]

Since users get wary of bolts coming loose and since Pump Minders lose spanners, bolts have been devised that don't need to be tightened so often.

> The wooden block [that acts as a lever]… is supported by a large head bolt. In the older standard pumps, the wooden block rotated around a length of 25 mm steel pipe (pivot tube), which was clamped within the [steel] plates [welded to the pump stand] by the nut and bolt. In the latest standard pump, this is a 35 mm diameter solid steel bolt equipped with a squared head, to avoid rotation. The bolt is manufactured with a shoulder and spring washer system which keeps it tight. Earlier head bolt systems, which were fitted with a lock nut system, had a tendency to come loose.[62]

These bolts, then, take over the jobs of Pump Minders and Caretakers and add to the endurance of the pump in yet another way.

However, further inspection suggests that tightening the bolts or providing bolts that do not come apart may not be that important after all. It appears that the device may do (for a while, at least) without many of its bolts and still not lose its ability to pump. Of the "B" type, the new model that became standard in 1989, Morgan writes fondly: "It is a very forgiving pump, and is able to endure much punishment yet will still perform when many parts are badly worn out."[63] And talking about the pump he recollects:

> visiting the pumps, I have been amazed at how well they function without some of their parts. I have seen pumps that have lost all the bolts that tie the base to the body. Apparently the body is heavy enough to be locked in place even without the bolts. But when I was touring some of the pumps with a Swiss visitor last week, I was amazed to see a pump that had no bolts left in the lever. In order to attach the block to the lever they had stuck steel bars through the holes. Now *that*'s what I call resilient technology and ingenious adaptation.[64]

The people in this village ingeniously adapted the pump. So while the design shifts, making the Bush Pump ever more reparable, its hydraulic elements easier to replace, its mechanical components better adjusted to their tasks, the extent to which the device can be repaired may surprise even the adapting inventor. With amazement he notes that some bolts need not be replaced by original spare parts at all. Steel bars can do the job.

Hygienics: Standards revisited

So mechanics and hydraulics may be tinkered with to a considerable extent before the pump stops lifting water. But is this also true for hygienics? In discussing this we will shift away from the adaptability of the pump itself, to consider what it means for it to *work*. A pump works as a provider of water if water comes out of it when the pump handle is properly operated. But how to determine whether or not a pump is a successful technology for health?

We have already considered this, so it may seem naive to ask it again. We said that there are quality standards for water, *international* standards. According to the International Reference Centre for Community Water Supply and Sanitation (IRCCWSS) in The Hague, the levels of Coliform present in acceptable drinking water should be less than 10 per 100 ml sample; and the number of *E.coli* less than 2.5 per 100 ml.[65] The norms are clear: they distinguish clean water from water which is contaminated. They can be used to determine whether or not a specific

pump acts as a health-promoting technology: simply do a Coliform and an *E.coli* count of the water it pumps up and compare these with the standards.

However, in Zimbabwean rural areas there are a number of reasons why this is not so easy after all. To begin with, it may be fairly difficult to organise the measurements required in vast, "peripheral" rural settings. It requires someone to take the appropriate water samples and do a *Coliform* or an *E.coli* count that has little "noise" and may be seriously compared to the counts found in the rich, well-equipped, and well-staffed Dutch laboratories in The Hague. Nevertheless, the Blair Institute musters its resources and does such measurements all the time. But, and this is the follow-up point, despite all these efforts the numbers only tell about that moment in time. Over, say, a whole year, the pump's performance may be better or worse. For in the rainy season, when the soil is soaked with water and bacteria thrive, the situation is likely to be quite different from that in the dry season, when the arid soil enables far fewer species to survive.

What does this mean: that it is impossible to say whether a pump provides health or whether it fails? That the Blair Institute should stop doing these measurements? No, these things can be said and done. But – and this is what we can learn from the Blair Institute in Harare but not from the laboratories in The Hague – such measurements do not achieve significance by being compared with allegedly universal standards. Instead, there are other, again more fluid, ways of handling them properly.

A first move is to recognise that in the Zimbabwean context questions of health are relative, not absolute. As Morgan argues: " [t]he important question is, how meaningful are the standards in practice."[66] Health questions don't have to do with setting standards scientifically, but rather with the practical comparison of alternatives. Thus, even though a protected Bucket Pump well may have an *E.coli* count of 25, it may be sensible to continue using it if the closest alternative is a shallow unprotected well with a count that is ten times higher. Other options, like purifying the well and installing a standard Bush Pump – bound to result in a lower *E.coli* count – may cost too much. And even if it is possible to find the money for a Bush Pump, this may not be better in the long run if the community is too small to properly maintain the Pump.[67]

Secondly, though there is no doubt a relation between *E.coli* counts and *health*, it isn't linear. It is not a direct or a rigid relation; it is fluid. And it depends not only on the *number* of *E.coli*, but also on who(se) they are. For, as we mentioned above, *E.coli* may make us sick when they are foreign, but they are less likely to do so if we are familiar with them. So even if the *E.coli* count of a particular water sample is 25 – ten times the acceptable levels according to the IRCCWSS standards – this does not necessarily mean that the health of the community using the well is critically

impaired . If the number of users of the well is relatively small *and* changes little, then the "users can more easily harmonise with the well or tubewell itself, including the micro-organisms that may pass to and from the well via the user."[68]

It is all well and good, then, to determine mean *E.coli* counts from a significant number of samples, taken from a series of pumps at different sites on different dates, in order to compare performances of pump types and measure them against the IRCCWSS standards – but this is not enough to determine whether or not these pumps *work* properly to promote health. For although such surveys provide a lot of information, they do not tell whether a particular groundwater source is sound. Morgan is very clear on this. Witness the following table of results from the Blair Research Laboratory. Taken from Morgan's prescriptions for appropriate sanitation measures, it exemplifies the way in which he emphasises the continuous monitoring of local sites, his attention to variability, and his tribute to the significance of the local order of things.

In the end, then, standards like those issued by the IRCCWSS hardly apply in the Zimbabwean context because they not only *create* but also *require* uniformity.[69] Such standards only make sense if instances can be meaningfully compared. A meaningful comparison between the *E.coli* count of different sources requires them to be more or less uniform in other respects. But in Zimbabwe one water source is *never* quite like any other. The conditions at one well are never the same as those at another. And although they may be the same as they were a week, a month, a year ago, or at the beginning of the season, it is more likely that something will have altered. The number of users, their identities, the amount of rainfall, the bacteria – all may have changed significantly. In some Zimbabwean contexts, it may be the identity of the users that is most important in determining whether a pump works or not.

As a promoter of health the Bush Pump thus works in a number of different ways and with varying degrees of success. The limits to its performance are related to its cost, to the precariousness of its siting, to its construction, to its well-size and depth, and to its maintenance. Its very installation may cause it to fail if it changes the local situation in ways that could neither be foreseen, nor easily monitored. So it makes no sense to try to determine whether the Bush Pump provides health in terms of a solid standard.[70] There are, indeed, moments – for instance when an entire village suffers from chronic infection due to contaminated water – when it is possible to say that a specific Pump failed to provide health. There are others, such as when *E.coli* counts stick to zero for long stretches of time, when the opposite is the case. But a lot is going on between these two extremes. So instead of a binary boundary we see fluid transitions once again, here.

Community: Villages or families

The decision to standardise the handpumps in the rural water programme was made by the Zimbabwean Government's National Action Committee in 1987. Maintenance was a significant factor in this decision. Morgan:

> without maintenance the pumps can fail and remain out of order for months. It is therefore the maintenance program, rather than the pump itself which determines whether a handpump program will be successful in the long term, assuming, of course, that technical faults in the pump itself have been reduced as far as possible.[71]

But, as we have argued above, the pump and the maintenance program can hardly be thought separately from each other – as the pump's working order depends on the maintenance program, which in turn depends on a community to keep it up and running. And so the Bush Pump *requires* a community to maintain it if it is to work.

Meanwhile, a working pump also *constitutes* its community. It is through development projects such as Zimbabwe's program for providing rural water that communities form themselves around a pump; it is through such programmes that they acquire a shape, a size, and a materiality that they did not have before. After all, if pumps are to be successfully maintained, some degree of organisation and division of responsibility are needed; the community needs to assume joint ownership and so affirm itself *as* a community. And so with a Bush Pump – or any other standard pump – it acquires a piece of equipment that it subsequently enrolls in its efforts to organise and form itself.

A pump may fail to marshal a community around it. It may prove too weak: in one way or another insufficiently attractive to become a centre. If this happens, if a pump fails to make the community it needs, then the community will not take care of the pump either. The bolts are not tightened. The spanners disappear. Kids throw stones down the well. The aprons are not kept clean. The pump is not used. All these failures follow from the first: the failure of the community to materialise as a responsible and proprietary body.

It is possible that this puts limits on the size of the target community. For, although the government assumes that the village is the standard unit of organization, the kind of "community" that keeps up a pump is not pre-given in this way. If it is too small, as we have seen, maintenance is a tall order. But if it is too large failure is quite likely as well: "… maintenance carried out by the community [like] sweeping aprons and keeping the water run-off clear… is practical in units owned

by a few families, but far less so in heavily used communal units, where there is no sense of ownership."[72]

So what happens if the community-building part of the Bush Pump fails? The answer is that if it fails comprehensively then the pump in question may fall into disrepair. It may stop being used and die. But the pump project and the Bush Pump "B" type do not necessarily die with it. For with changes in policy, the operation and maintenance of the pump may be shifted to another kind of unit with an alternative kind of responsibility and ownership. The village unit may be replaced by one comprising only a few families. And the pump may be put somewhere else: not in the middle of the village but in one of those family's back yard.[73] So that rather than an elaborate system of communal responsibility an alternative arrangement, one of private ownership takes shape. Pump distribution

> …may be an important factor to the future success of pump maintenance. In several projects, pumps are placed so that each one serves about 5 families (30 persons). This arrangement ties in with the extended family system in Zimbabwe. The families using a single installation are closely related and may already be accustomed to using their property collectively and sharing financial responsibilities. It is very possible that the distribution of pumps to suit the extended family system may be very crucial for successful village level maintenance.[74]

Then does the Zimbabwe Bush Pump work? It may – but perhaps enabling it to work dependably requires some modification of the Government programme for improving rural water supplies. For aiming at extended families rather than villages means a shift from boring new wells and installing Bush Pumps, to upgrading existing wells – and in some cases choosing other water lifting devices like the Bucket Pump.[75] It fragments the terrain more unevenly, making the local even more local than it was when the village was the organising unit of choice. Such a change might make rural Zimbabwe look different, made up of units that are different from those the government has been seeking to reinforce. No wonder an article headed "Now in my backyard – Zimbabwe's upgraded family well programme" reports that "[t]he well programme is a hit with the people but goes against the government grain."[76]

Standardisation: Keeping up the supply

Even if smaller units emerge in the course of Zimbabwe's rural water supply project, that does not mean that the Zimbabwe Bush Pump "B" type is not a national

standard. The Bush Pump may to some extent have to share the territory with upgraded wells and other pumps, but it is still the preferred national water device. That is, if the manufacture of its hydraulic elements and other parts continues. The success of the national standard, after all, depends on the local manufacture of new pumps and spare parts. If this were to fail, villages with a pump wouldn't be in too much trouble for the time being – until they need spare parts, that is – but the nation that needs pumps for newly bored wells would have a problem indeed.[77]

Spokespeople in Zimbabwe pointed out to us that the continuation of its manufacture has been a fragile element in the working of the Zimbabwe Bush pump type "B." For a long time it seemed as if it might be its *most* fragile element – and if this was the case, then it was precisely because it is the least fluid. Until recently, both Bush Pump and Bucket Pump were produced in a single plant, run by a single person whose engineering expertise, fierce quality standards, authority and enthusiasm for appropriate technology formed the fircely idiosyncratic mix on which its manufacture relied. A equally committed person who might take over did not seem to be around. So it was a matter of genuine concern how long V&W Engineering would be able to manufacture the two standard high quality pumps – and that the nation's water infrastructure, the arbiter of life, illness, and death for so many, itself depends on the life, illness and death of that single figure, the engineer-director of the pump-producing plant. However, the manufacture of the pump is at present no longer under threat – because its manufacture has been decentralized. The design and process of manufacture are now shared with other producers. "The Bush Pump is now made well by at least 6 companies and moderately well by another 6 companies…. This has been encouraged by UNICEF… The threat … that quality manufacture could not be assured in the future has now been overcome."[78]

A fluid outcome

It is not easy to assess the successes and the failures of the Zimbabwe Bush Pump "B" type. For if the pump must act, what is it to do: provide water or provide health? Build communities or make a nation? And when does it succeed in doing any of these? The criteria for success are not clear-cut. So the Zimbabwe Bush Pump does not only have fluid boundaries, but the evaluation of its activities is fluid, too. While some of its parts are essential, many can be replaced with something else. Even if many of its elements are transformed "the whole" does not necessarily fall apart. And the standards that seem ready to be applied to it may stop making sense, or change. There are, to be sure, limits to the Bush Pump's flexibility and elasticity. There are points where nothing works, everything fails. But before such dead

ends are reached – *if* they are reached at all – many varied things may happen to a Zimbabwe Bush Pump. As indeed they do.

The place of the maker: The centre of the Zimbabwe Bush Pump distributed

> …no individual has total command over it. It is in the public domain.[79]

We have argued that the Zimbabwe Bush Pump is a fluid actor. Its brings a lot about, but its boundaries and constitution vary and its success and failure, instead of being clear-cut are a matter of degree. Although one knows a Zimbabwe Bush Pump "B" type when one sees it, we claim that the technology has no core. Or has it? For there has been, we mentioned him, a single stronghold in its manufacturing: the engineer-director of V&W Engineering, the plant where the Bush Pump is produced. "Without Mr. Von Elling the Pump would not be this good… its future uncertain," Peter Morgan insists.[80] But Von Elling tells another story. When questioned, he acknowledges that the pump depends on a combination of his and Morgan's individual strengths. But he adds a little later: "The pump is really Dr. Morgan's invention. It is his thing. We just manufacture it".[81]

The pump's possibilities for acting may depend on another actor who brings it into being. It *may* be his thing. But whose thing, exactly? Walking around at V&W Engineering and talking to people who are in the position to know, it becomes clear that Morgan is right: Von Elling is the centre of the Bush Pump's production. Its *manufacture* depends on him. But what about the *development* of the pump? What about the inventions that shape, reshape and gradually improve the pump? Is Von Elling, in his turn, right that these activities, so crucial to the "B" type, all depend on Morgan? Clearly, with the distributed manufacture of the pump, Von Ellling's centrality has become a moot point. And as to Morgan's centrality – he turns out to be an interesting actor because he doesn't assume that he is one. Instead, he manages his own dissolution. This partly explains the Bush Pump's attractiveness and perhaps some of its dissemination as well: the fact that there is a fluid hero behind it.

Authorship-ownership

Dr. Peter Morgan started his African career as a microbiologist in Malawi doing fundamental research on the bilharzia cycle. One of his papers led to an invitation by the Zimbabwean (then Rhodesian) Ministry of Health to come to Harare and

do research there for a few years. So it was a government official who initiated this move to Harare – not Morgan himself. He stayed in Zimbabwe, but he did not stay in basic science. Asked why, he doesn't mention a particular decision. Instead, he cites an American colleague who, early on, challenged him on his engagement in a rather esoteric study of one of the many parasites threatening the health of Africa's rural population. Didn't improving rural health really depend on water sanitation? Taken by the suggestion, Morgan became a government scientist involved with Zimbabwe's water sanitation program. His colleague's challenge made him shift his attention from bilharzia to the Bush Pump and various other technologies intended to improve water infrastructure.

Dr. Morgan has invested much work and effort in improving the Bush Pump. But he has never claimed authorship.[82] He refuses to take out a patent on the Pump, or on any of its recent modifications, although, according to officers of the African Regional Industrial Patent Organization in Harare, the "B" type might have been eligible for exclusive property rights.[83] But in Morgan's eyes the current pump is no more than a perfected version of a long-established and locally-developed technology that has always been part of and belongs in the public domain. It is not the product of the eyes, the hands, and the brain of a single man, but a result of collective action and of evolution over time. Morgan knows that the pump is good, but he insists that this is not because he made it well but because he had great materials, just the expertise that was needed, and dedicated people to work with.

So according to Morgan the pump is no more his than it is Murgatroyd's, Von Elling's, or the Pump Minders' who substitute sticks for bolts. A comparison with Louis Pasteur (in Bruno Latour's version) is striking.[84] Their displacements are rather similar: Morgan moved from Malawi to Zimbabwe, from bilharzia to Bush Pump, from fundamental science to pragmatic technologies, in much the same way that Pasteur moved from crystallography to bacteriology, from Petri dishes to cows, and from the secluded Paris laboratory to the Neuilly farm crowded with journalists. But while Pasteur skillfully hid the activities of all the other actors making up the vaccination network to emerge as its prime mover, Morgan never stresses the possible brilliance of his insights or the ingenious character of what he has invented. Instead, he presents them as matter-of-fact, collective and mundane. And he insists that it is the combination of external inspiration, fortunate coincidence, and collaborative effort that makes the difference between a good technology and one that doesn't work.

The rejection of the role of master-mind may be read as an expression of Morgan's modesty. And so it is. But something else is going on, too: granting the pump's ownership to "the people" contributes to its success. Because when the users – be it actual users, donors or government – pay for the pump, they pay for materials and production costs. But they do not pay for the right to use it. And they do

not pay for a name, for legal and maintenance fees, for the overhead of patent institutions, or for the inventor's retirement pension. Since such costs are not included in the price of the pump, the people have access to an affordable technology. And in the Zimbabwean context this greatly helps the Bush Pump to spread.[85] Morgan, then, seems to dissolve his own actorship, how to say this, *actively*. He *gladly* submerges in the various surroundings of which he and the pump are part. When asked about the secrets of the pump's success, he stresses that

> the pump is a government thing, developed by a government employee, in government time, at a government agency. There is no patent on it. No names are attached to it. It is the national handpump. That is its strength. That no individual has total command over it. It is in the public domain.[86]

Sometimes abandoning control may contribute to spreading what one has been making.

Implementation

The dissolution of the maker goes beyond the invention of the pump. It is a telling feature of its implementation as well. For Morgan is not only busy improving the hydraulics and mechanics of the Bush Pump, but he also helps to implement it. Again, however, he does so not by taking command, but by trying to let go. By allowing for surprises. And such surprises do, in fact, occur – and steer the further development of the pump.

> I encounter surprises. For instance, I developed a pump that yields more water per stroke. Initially, when I started to develop the extractable down-the-hole components, I worked with small (50 mm) casings and cylinders, that would hold light pipes, in order to make pumping and maintaining as easy as possible. But then you don't get very much water per stroke. So in order to improve the yield per stroke I developed a pump that has a larger cylinder, but that, accordingly, needs heavier pipes. I was worried about this pump because it would make maintenance more difficult, and for me sustainability was the primary target in developing the pump with extractable parts in the first place. So I expected that this new variety would not meet great demand. But now, everyone is ordering the larger pump. Although I may not find it the best way to go. It's not up to me. Sometimes you just cannot tell.[87]

Sometimes you just cannot tell. And it may be important to avoid wanting to do so. Take the crucial question as to *where* the well for a new pump must be drilled. Zimbabwe has a Research Institute for Remote Sensing and Environmental Science in Harare that might seem perfectly suited to answer this question, for here GIS surveys are carried out and satellite maps compiled. But the institute does not determine the constitution of the nation's developing water network. Although nicely coloured schemes faithfully map how much water is to be found where, and expensive satellite pictures painstakingly identify its sources – from reservoirs to aquifers to individual wells – this knowledge from the capital centre is not enough to build a water infrastructure in the rural periphery.

Instead the map and the GIS survey, as well as the civil engineer employed by the NGO, and Peter Morgan for that matter, are made small and turned into "mere" facilitators. They are turned into what, with a telling reversal, we might call peripheral agents. The true centre is elsewhere and it comes in great numbers. It is in the well-to-be-made and in its prospective users. It is at the village level, where rationales and arguments that come from the capital are added to the advice of the *nganga* about which sites might be best for a well. Does the map show a few spots in the village where water might be expected? Does the manual say that a good distance from the cattle kraal must be respected? Fine. Those messages travel on paper along with the experts, and people listen to them. But the *nganga* must speak before the rig is set up and installation of the pump begins.[88]

Morgan, as a promoter of *distributed action*, insists on this. He is firm about the necessity of abandoning control. Implementation, he maintains, depends on involving those who will use the pump. It therefore requires room for their methods and insights. Without this, any pump is bound to fail. For, as he says, in water development it is all too common that the new and the foreign does not work, and that "all that glitters… end[s] up as a rusty heap of useless technology".[89]

Monitoring

Sometimes Morgan goes back to visit the sites of his water pumps. But when he does so he does not carry a bag of nuts and bolts. He is not intent on keeping the pumps as they were delivered: intact, in shape, shining like new. Instead, he tries to learn from the way the pumps have evolved on-site, from the ways in which users have repaired and adapted their devices. Instead of striving to keep the pumps as they were, he is curious to see what they have become. So once a pump is out there, it is out there and it will have to do without any further unsolicited intervention.[90]

Morgan likes to see what has become of his pumps – he likes to be surprised. But going out to check on Bush Pumps is not something he does regularly; it is not

an element of a strategically designed system of monitoring. It is rather something that happens fairly erratically, incidentally. It is mainly to give others a chance of learning about the Bush Pump in its village environment that Morgan goes out to visit at all. So it can happen that what he learns about the pumps is a result of his efforts to teach others. Still surprised, it seems, he says: "If it hadn't been for my Swiss visitor, I would not know now that the pump can even work without those bolts in the lever – that I had thought, so far, to be the really crucial ones."[91]

Morgan, then, is driving the Bush Pump precisely because he is not central to it. However, not being an *actor* does not mean that Morgan is turned into someone who is *passive*. He puts a lot of effort into dissolving – believing that it is precisely this which creates pumps that yield water and health in their Zimbabwean sites.[92] So what should we call what happens here? Morgan's creates a non-creator subject, a dissolved self. Not so that he will fade away, but in order to get clean water flowing everywhere. Perhaps all this is so appealing to us because it is so far removed from the control-drive of the modern subject – and even further from the shape this subject takes in generals, conquerors, and other exemplars of strong and solid authority. Serving the people, abandoning control, listening to *ngangas*, going out to watch and see what has happened to your pump: this is not the line taken by a sovereign master.[93] Here we have, instead, a feminist dream of an ideal man.[94]

To conclude

The Zimbabwe Bush Pump is easy to love.[95] Not only because it provides access to clear water for many people in rural Zimbabwe – which is certainly a good thing. But also because, in the way it does so, it teaches us something crucial about the kind of actorship that technologies may take upon themselves. They may be both modern – providing equally clean water in many places – and non-modern – adapting to very different rural Zimbabwean villages. In this article we have related various aspects of this actorship by using a single term: the notion of the *fluid*. The Zimbabwe Bush Pump is fluid. We have tried to sketch what in the title we call, with a smile, the *mechanics* of this fluid technology.

The first aspect of the Pump's fluidity is that its boundaries are not solid and sharp. The Pump is a mechanical object, it is a hydraulic system, but it is also a device installed by the community, a health promoter, and a nation-building apparatus. It has each of these identities – and each comes with its own different boundaries. To write about the Bush Pump in this fashion means that we do not mobilise the arid trope of describing a small technological artefact as if it were surrounded by large social environments – to which it inevitably remains alien.[96] In each of its

identities the Bush Pump contains a *variant* of its environment.[97] This also more sharply frames the question about whether or not the Bush Pump succeeds in its activities, since this is different for each of its identities.

The second, related aspect of the Bush Pump's fluidity is that whether or not its activities are successful is not a binary matter. There are many more relevant answers to this question than a simple "yes" or "no". The pump may work as a water provider and yet not bring health. It may work for extended families but fail as a connecting element in larger communities. It may provide health in the dry season but not in the rainy season. It may work for a while and then break down. Good technologies, or so we submit after our encounter with the Bush Pump, may well be those which incorporate the possibility of their own break-down, which have the flexibility to deploy alternative components, and which continue to work to some extent even if some bolt falls out or the user community changes.[98]

And then there is the actor behind the Pump, who refuses to act as such. Dr. Morgan's carefully sought dissolution, his deliberate abandonment, is not simply an asset in any man, but is especially suited to the dissemination of the Bush Pump. Pleased with what he calls the "forgiving nature" of the Bush Pump, he has made it after his own image – infused it with a fluidity that he incorporates himself as well. It may be that to shape, reshape and implement fluid technologies specific kind of people are required: non-modern subjects, willing to serve and observe, able to listen, not seeking control but rather daring to give themselves over to circumstances.

This, then, is what we have to add to the collective effort of updating traditional notions of the *actor*. Our actor, the Bush Pump, goes to show, once again, that actors do not have to be humans. And its story tells that actors, technologies as well as the engineers involved with them, may be fluid – for the better. Now – as an addendum, but not an afterthought! – we would like to briefly attend to the normativity incorporated in what we have just written.

In our tales of the Zimbabwe Bush Pump we have marshalled different kinds of *good*. Some of these have a background in political ways of reasoning – for instance when we say that it is good if water is distributed equally among a people. Others belong within a tradition of ethics, like saying that it is a virtue of the Bush Pump that it treats villagers with respect for their specificities. Yet others are aesthetic: the pump's parsimony, it's beautiful blue colour, its ingenious hydraulics.

But beware. None of these *goods*, or so it seems to us, is universally valid. They are *goods* in, of, and to the Zimbabwe Bush Pump. And so it is with *fluidity*. We suggest that the possibility that fluidity is a good should be considered in other cases, especially in cases of technologies transferred to or designed for so-called intractable places. But we do not want to set up *fluidity* as a new standard to replace,

or necessarily to supplement, others – for instance sturdiness. It *may* be a good – and we suggest that you find out for yourself whether or not it *is* in the cases that *you* happen to deal with.[99]

This is a matter of normative style. What kinds of relations to the good might one want to establish ? Keeping a *neutralising* distance from it may be helpful in opening up fields that have been occupied by set moralities for too long – but once such fields are indeed opened up, the risk is that neutrality becomes sterile. It brings nothing new but leads instead to all too predictable stories.[100] In the *critical* tradition scholars approve or disapprove of technologies, people, situations, arguments. This makes sense if there are clear-cut *points of contrast* from which to judge. But this isn't always the case.[101] In our story, it is most certainly not the case; for we have not offered you any other pump stories to compare, nor have we listed criteria that good pumps should always meet. How to be normative when there is no single, self-evident standpoint to speak from? That is what we would like to learn. So we do not seek to put ourselves in a position of *judging* the Zimbabwe Bush Pump. It is, from where we stand, not possible to say whether or not it is unequivocally *better* than its siblings and competitors – or even, for which sites and situations it might be so. Rather, by using notions such as *love*, we want to signal how we are interpellated by it.[102] So maybe this is an exercise in praise after all. For we never set out to pass judgement on the Zimbabwe Bush Pump, but have allowed ourselves to be *moved by* it. And this article is an attempt to move you, reader, too.

Appendix 1: Installing the "B" type Bush Pump step by step

Stage 1. Leave 500mm of the 150 mm diameter steel casing above ground level in a bore hole
Leave 400 mm of the 150mm diameter steel casing above slab level in a well
Measure the depth of the bore hole or well
Stage 2. Fit the pump stand to the casing
Stage 3. Thoroughly clean the footvalve
Stage 4. Connect the footvalve to cylinder
Stage 5. Clean all the 3 meter lengths of 50mm GI pipes
Stage 6. Connect the cylinder to the lowest pipe
Stage 7. Lower cylinder and footvalve and first length of pipe and clamp
Stage 8. Lower all pipes. Always use plumber paste at the joints
Stage 9. Connect the final length of pipe. Lower the pipe and connect the water discharge unit of the pump head
Stage 10. Bolt the water discharge unit in place
Stage 11. Check piston assembly. The rod is securely screwed into the piston and held in place with a brass pin. Check that the rubber poppet valve is free to move. Check the rubber seal. This must be fitted with the seal lip facing upwards. If the seal is worn or damaged replace it with a new one. Use a small screwdriver to remove and replace the seal.
Stage 12. Lower the piston and first pump rod down through the rising main

Stage 13. Take the second rod and pass its hook through the eye of the lower rod. Continue to lower rods one by one. When the rods become too heavy to support by and use a rod clamp. Lower all the rods until the piston rests on the foot valve. Where full lengths of pipe are used, one extra rod is required to make the final length.
Stage 14. Mark the rod at the place shown by the arrow in the diagram. Pull up the rod and cut off straight at this mark.
Stage 15. Thread the rod with a 16mm die. The thread should be 50mm long. To avoid cuttings down the pipe, fit a rag around the rod on the pump discharge assembly.
Stage 16. Assemble the floating washer housing and washers as shown, so that the lower floating washer lies inside the housing and the upper washer lies above the housing. Add rubber buffer and U bracket. Tighten rod lock nut on U bracket.
Stage 17. Bolt the floating washer housing together. Note: [these] illustrations show the pump being fitted before the apron and water run-off have been made. However, it is normally essential to finish the headworks before the pump is fitted.
Stage 18. Position the wooden block and the two large head bolts after applying a thin layer of grease to each. Tighten the nuts of each bolt against the spring washers.
Stage 19. Attach the steel handle and tighten the handle U bolts.
Stage 20. Test the pump.

From V&W Engineering A manual for the installation dismantling and maintenance of the "B" type Bush Pump, Mvurumanzi Trust, Harare 1994

Notes

We warmly thank those we spoke with in Zimbabwe: Dr. Morgan, Mr. Von Elling, the scientists and managers at SIRDC (the Zimbabwe Scientific and Industrial Research and Development Council), Unicom workers, and the director and patent experts at ARIPO (the African Regional Industrial Property Organization) – who gave us their time and their stories and who welcomed Marianne de Laet so courteously into their worlds of inventions and patents. We also thank the Netherlands Organisation for Scientific Research, that provides Marianne de Laet with a research grant for studying the travel of patents and Annemarie Mol with a research grant for studying the normativity incorporated in technologies. Lucy Suchman and three anonymous reviewers for *Social Studies of Science* were most helpful in sharpening our argument. And finally we thank John Law: he was inspiring, encouraging and critical. And he corrected our English.

1 The materials for this article come from interviews with health workers, patent experts, and pump makers in Zimbabwe; from manuals and handbooks; from visits to the pump factory and government scientific research institutes. Some quotes are from notes, others from transcriptions. Since we are not engaging in a rhetorical analysis, we thought it justified to leave out the repetitions, pauses, and interjections that are characteristic of speech; in view of readability we have, here and there, abridged the words of our spokespartners and streamlined them into "writing" language. Also, we want to make it clear from the outset that we mobilise empirical materials in order to make a set of theoretical points. This article, then, does not intend to provide an ethnography of the use of water and water resources in Zimbabwe, not does it offer a comparitive evaluation of handwaterpumps in general.

Detailing the trials and tribulations of *one particular* handwaterpump's gestation, policies, and use, it aspires to add to the literature on appropriate water devices but by no means captures or covers this body of work. For a brief introduction to the problems surrounding groundwater and its use, see the "UNICEF information papers on groundwater" (*http://www.unicef.org/wwd98/index.htm/)*; also the FAO series on land and Water Development, its Water and Land Bulletins, and its Water Reports; and "Who gets the last rural resource? The potential and challenge of lift irrigation for the rural poor" *IDS discussion paper no. 156* (Brighton: Institute of Development Studies, 1980). For work on other pumps see for instance Peter Fraenkel, "Water Lifting Devices", FAO Irrigation and Drainage paper 43 (Rome: FAO, 1986), or our protagonist's comprehensive analysis, P. Morgan, *Rural Water Supplies and Sanitation* (London: Macmillan, 1990). Much of the literature on water, irrigation, and pumps is about South-East Asia; see for instance S. Biggs, C. Edwards, and Jon Griffiths, *Irrigation in Bangladesh* (Brighton: Institute of Development Studies, 1978), on hand pump use in India. For an analysis of groundwater problems in (West-)Africa, that presents an anthropological analysis of the network configured around the technology, see H. Maat "Water bij de uien", *Kennis en Methode*, Vol. XIV No. 1, 1994.

2 Unwilling to reduce flexibility to interpretation, we situate ourselves in the semiotic tradition in science and technology studies. For this specific semiotic's departure from matters of meaning see e.g.: A. Mol and J. Mesman, "Neonatal Food and the Politics of Theory: Some Questions of Method", *Social Studies of Science*, Vol. 26 (1996), 419-444. For a powerful critique of the perspectivalism that comes with foregrounding "interpretation" see: M. Strathern, *After Nature. English Kinship in the twentieth century*. (Cambridge: Cambridge University Press, 1992).

3 There is a diffference between a hero in the sense of the fore-ground figure in a drama, where fore-grounding is the *author*'s choice, and the trope of heroic actorship, where this figure *assumes* that (and acts as though) its actions present all the agency in the play. Our hero is of the former kind; a hero by way of fore-grounding and by abondoning agency rather than assuming it. We agree with John Law who, in *Organizing Modernity* and other work, takes to task conventional technology studies for all too easily marshalling the heroic agent as a bottom-line mover in, for instance, innovation and socio-technical change. (Oxford: Blackwell, 1994). For the notion of agency through abandonment see also E. Gomart and A. Hennion, "A sociology of attachment: music amateurs, drug users" in J. Law and J. Hassard, *Actor Network Theory and After,* Oxford: Blackwell, 1999. Note also that our remarks about our hero are not "personal"; they center around his actions – we do not venture to say anything about his intentions, his motivations, or his personality. For modest action can be emulated; a modest personality cannot.

4 See, respectively, M. Akrich, "La construction d'un systeme socio-technique. Esquisse pour une anthropologie des techniques", *Anthropologie et Sociétes*, Vol. 13, no. 2, 1989, 31-54; M. Akrich "Essay of Techno-Sociology: A Gasogene in Costa Rica", P. Lemonnier (ed.), *Technological Choices* (London/New York: Routledge, 1994), 289-337; M. Akrich "The De-Scription of Technical Objects", J. Law & W. Bijker (eds.), *Shaping Technology/Building Society* (Cambridge: MIT Press, 1992), 205-224. For work on technology transfer the journal *Technology and Culture* is a wonderful source; Staudenmaier, in *Technology's Storytellers. Reweaving the human fabric* (Cambridge, MIT Press, 1989), provides an overview of publications on the issue during the journal's first twenty years of existence; an anthology edited by T. Reynolds and S. Cutcliffe, *Technology and the West* (Chicago: University of Chicago Press, 1997), offers a selection of articles on technology transfer published in the journal.

The problem of technology transfer goes to the question of the "nature" of technology: in conventional notions of technology transfer – as the word indicates – the nature of the technical object is taken to be stable and fixed, while by stories like ours and Akrich's this very assumption is undermined. Whereas this question has been addressed by historians and sociologists of technology (see for a first exploration the volume edited by W. Bijker, T. Hughes and T. Pinch, *The Social Construction of Technological Systems: New directions in the sociology and history of technology* (Cambridge, MIT Press, 1987), it has, until recently, hardly been an issue in the philosophy of technology, which was rather interested in the impact of technology on society and the ethical questions surrounding such impact. (See e.g. J. Habermas *Technik und Wissenschaft als Ideologie* (Frankfurt: Suhrkamp, 1968); J. Ellul, *Le Bluff Ttechnologique*. Paris: Hachette: 1987). Currently – treading in the footsteps of history and sociology of technology but at odds with many of the findings from these fields – philosophers of technology are taking an "empirical turn" (see P. Kroes & A. Meijers, (eds.), *Philosophy of Technology. The empirical turn*, forthcoming), in order to assess the "nature of technical objects". In articulating the fluidity of (at least some) technical objects, we engage a philosophy of technology that runs counter to this analytical quest for a fixed and distinctive nature of technology.

5 See for this A. Mol & J. Law, "Regions, Networks and Fluids", *Social Studies of Science*, Vol. 24 (1994), 641-71. As Akrich's stories tell us, in the arena of technology transfer the lesson about fluidity still needs to be learned.

6 P. Morgan, in *Rural Water Supplies and Sanitation* (London: Macmillan, 1990), 160.

7 We are of course not the first to attempt such an update. Identity has been long theorized in constructivist psychology and ethnomethodological sociology as a situational and flexible range of posibilities rather than a fixed and solid whole. And including "non-humans" in the category of "actors", to attend to what it is they bring about, has, in Paris, been done since the early eighties. See e.g. M. Callon "Some elements of the sociology of translation: Domestication of the scallops and the fishermen of St.Brieuc's Bay", in J. Law (ed.) *Power, Action, and Belief: A new sociology of knowledge?* (London: Routledge and Kegan Paul, 1986, 196-233); M. Callon "The Sociology of an Actor-Network: The case of the electric vehicle", in M. Callon, J. Law, and A. Rip (eds.) *Mapping the Dynamics of Science and Technology* (Basingstoke, U.K.: Macmillan, 1986). Whether this was a wise move has subsequently become the focus point of an overheated debate. (In A. Pickering (ed.) , *Science as Practice and Culture* (Chicago: Chicago University Press, 1992)). Obviously, we build on this French semiotic tradition, in which "actor" is a technical term for all active entities rather than a title of honour that may be used for humans alone. By so attributing "agency" to humans and non-humans alike, the term is stripped from intentionality and the path is cleared for simply tracking people, objects, their interactions, and their effects. Note that in following both the Bushpump and its maker we focus not on intentions, but on actions, movements, and effects.

8 And hence, it is not quite a boundary object. A boundary object, a figure that features in ethnomthodological theory, moves between worlds, in which it gets interpreted in different ways. While the object's boundaries remain firm, its variety is due entirely to the different ways in which it gets interpolated in those worlds. Our notion of fluidity serves to flag the way in which object and world are intertwined; it points to the flexibility of the pump's definition and the variability of its perimeter. For the notion of boundary object, see for instance Bowker, G., and L. Star *Sorting Things Out. Classification and its Consequences*. (Cambridge, MIT Press, 1999). The theoretical text about "the actor" that comes closest to

the present one is not about technical objects at all, but about drug addicts and amateurs of music. Emilie Gomart and Antoine Hennion mobilise these people in order to challenge traditional notions of the actor in a way that we build on here. The actors concerned act while and through *abandoning* themselves. E. Gomart and A. Hennion, op. cit. n 3.

9 See B. Latour & M.Callon vs. H. Collins & S. Yearley in A. Pickering (ed.), op. cit. note 7.

10 The term "heterogeneous engineer" comes out of the work of John Law, see J. Law "Technology and heterogeneous Engineering: The case of Portuguese expansion", in W. Bijker, T. Hughes, & T. Pinch (eds.) *The Social Construction of Technological Systems: New directions in the sociology and history of technology* (Cambridge, MIT Press, 1987, 111-134). In his later work Law has taken a lot of trouble to undermine the managerial undertones, for instance by making an extensive analysis of what it is to "manage", in J. Law, op. cit. note 3, and later by reexamining the notion "heterogeneous", see: J. Law "Hidden Heterogeneities. The design of an aircraft" in: J. Law and A. Mol, *Complexities* (Durham, Duke University Press, to appear).

11 B. Latour, *The Pasteurization of France* (Cambridge: Harvard University Press, 1988).

12 P. Morgan, op. cit. note 1, 160.

13 We came across this water pump by chance. One of us is engaged in a research project in which she investigates the travel of *patents* into developing countries. Her research strategy of following patents brought her to Zimbabwe, where spokespartners at the African Regional Industrial Property Organization pointed out this remarkable technology, the Zimbabwe Bush Pump, which stands out because no patent claims have been filed on it. In this article we touch upon but do not explore this particular feature of the pump. For the way patents and development are explored in this project, see e.g.: M.K. de Laet "Intricacies of Technology Transfer: Travel as Mode and Method" in *Knowledge and Society* Vol. 11, 1998.

14 Morgan op. cit. note 1, 153.

15 Ibid., 67.

16 Murgatroyd, paraphrased in ibid., 154.

17 Interview VE, June 19, 1997 "We like to paint our products brightly, make them attractive. They work better that way.'

18 Morgan op. cit. note 1, 160.

19 Morgan ibid., 154-155. In his comments on this article, Dr. Morgan noted that the "40 mm pipe is being phased out and is rarely used. Also 12mm rods are being phased out and 16mm rods are used almost everywhere" (letter April 28, 1998).

20 Interview PM, June 30, 1997.

21 Morgan, op. cit. note 1, 68.

22 Most commonly seen in Zimbabwe, and all tested by the Blair Research Laboratory in Harare, are four pumps, each of which belongs to a different "family". These are the Bush Pump (a lever action steel-bodied reciprocating pump used in shallow to deep (up to 100 metres) protected wells, whose yield depends on cylinder size but maxes 40 litres per minute); the Blair Pump (a direct action hand-operated reciprocating pump with a PVC body yielding 15-40 litres per minute, used in shallow (up to 12 metres) small-diameter wells only) and the Nsimbi pump (similar in yield and materials to the Blair pump, but with lever action); and the Bucket Pump (a bucket-and-windlass pump, yielding 5-10 litres per minute, for use in open, shallow, large-diameter wells). Less common is the rotary pump, a fourth family of pumps (using a rotor system this pump distinguishes itself by its low breakdown rate and it may be used for 10 years without servicing.) Blair and Nsimbi pump are limited in durability

and yield and, therefore, in the scope of their use. Many varieties belonging to these four pump families are in use over the world. See Morgan op. cit. note 1, 62-68.

23 Dr. Morgan pointed out to us that this is not to say that the Bushpump is *better* than those other pumps. "All pumps have their merits ... I think the Bushpump is good – but I also respect the work of others." (letter, 3/28/98). And as we argue further on, whether or not a pump is good depends on more than the specifications of the pump alone.

24 Obviously, the relation between clean water and health is not as straightforward as this sentence makes it seem. Good water is essential to health, but in order for people to be healthy, more than water is involved – for instance personal hygiene, nutritious food, and so forth. We narrow our concerns to the water, here.

25 The co-existence of human organisms and their fellow-travelling organisms such a *E.coli* is so durable that one may seriously wonder whether it makes biological sense to separate these organisms out as independent individuals. Maybe in demarcating the *viable* human *E.coli* deserves to be *included* rather than *excluded*. For this, and thereby for an extensive discussion of fluid boundaries of living organisms, see L. Fleck's classic study , *Entstehung und Entwicklung einer wissenschaftlichen Tatsache* (Frankfurt: Suhrkamp, 1980; original 1935).

26 Source: Morgan, op. cit. note 1, 253.

27 Ibid., 44.

28 Ibid., 77. For comparative data of this study see table 2 below.

29 Another quote illustrates this point: "weaknesses in design or construction are revealed most dramatically during rainy spells, when the rain helps to flush surface contaminants back into the well or other water source. The hygienic seal of the water point is a most important feature of a well head and is tested most thoroughly during the rains. It is at this time when contaminants from the surface most commonly find a route and drain back into the underground aquifer." (Morgan, op. cit. note 1, 18-19.)

30 P. Morgan & E. Von Elling "Bucket Pump Manual for Fieldworkers", (Harare: Blair Research Laboratory, Zimbabwe Ministry of Health, 1990), 4-10.

31 Morgan op. cit. note 1, 18-19.

32 Video Vonder Rig; factory visit V&W Engineering Harare June 20 1997; interviews VE and PM June 1997.

33 One of the limits of our material is that we do not know how the village women appreciate pushing an iron crossbar with their men sitting on it. Neither do we know how the pump fits in with the other tools and material objects that the villagers live and work with. See for some interesting examples of studies that start not with material from fluid inventors and industries but with more classic anthropological "village material": M.-J. Arnoldi, C. Geary and K. Hardin (eds.), *African Material Culture* (Indiana University Press, 1996.) And of course the classical collection by A. Appadurai (ed.) *The Social Life of Things*. (Cambridge: Cambridge University Press, 1986), as well as P. Lemonnier's edited volume op. cit. note 4.

34 V&W Engineering "Instructions for Drilling Tubewells with the Vonder Rig." (Harare: Blair Research Laboratory, 1988), 16.

35 Reasons for including a *nganga* or a local water diviner in the well-siting process are neither exclusive "social", nor exclusively "technical". The *nganga* is in charge of sacred places and rituals. Not all *nganga* are water diviners, not all water diviners are *nganga*; *nganga* have specialised areas of expertise, varying from history and legal issues, to indigenous medicinal knowledge, to water and its likely sites. Drilling wells without consulting a *nganga* would be unwise – not only because when they act as water diviners they know about aquifers, but also because they know about people: "Natural springs are often sacred places and …

controversy [may arise] when these are upgraded or protected without consulting the nganga or traditional hierarchy." (Morgan, letter 3/28/1998).

36 Interviews with technical experts at UNICEF Zimbabwe, June 1995.

37 See for instance Morgan op. cit. note 1, 24; Morgan & Von Elling op. cit. note 33, 6.

38 "In Zimbabwe, village level participation is actively encouraged in all water and sanitation schemes. It is now well established that without this participation, communities cannot generate the commitment for maintenance as they do when they are involved." (Morgan op. cit. note 1, 106).

39 Morgan & Von Elling op. cit. note 33, 29.

40 The World Bank, for instance, has in the past few years shifted its focus from providing loans to nation-states, to providing assistance directly to local NGO's. Similarly, UNDP increasingly provides grants to local groups. See e.g. P. Uvin "Scaling Up the Grassroots and Scaling Down the Summit: The Relations Between Third World NGO's and the UN", T. Weiss & L. Gordenker (eds.), *NGO's, the UN, & Global Governance* (Boulder: Lynne Riender Publishers, 1996), 159-176.

41 The fact that community participation is national policy does not mean that it is actual practice. Morgan comments that the move towards Community Based Maintenance is as yet in its experimental stage, and that "we are still on the road to achieving this reality." (letter, 3/28/1998).

42 The "campfire" project displays a conflict of local interests – some of which affirm themselves as global goods. The project entails an effort to relay some of the responsibility for wildlife conservation (affirmed as a global interest but defined as such in a particular setting) to the inhabitants of rural areas, while relaying profits from wildlife tourism to the villages. In practice, this comes with a ban on the killing of (protected) animals – that often end up damaging crops or threatening the subsistence of the local population. Whereas the ban on killing wildlife and poaching is heavily enforced, the protection of rural areas is taken somewhat lackadaisically. As a result the local population, according to some commentators, gets the rough end of the deal.

43 See P. Morgan, E. Chimbunde, N. Mtakwa, A. Waterkeyn "Now in my backyard – Zimbabwe's upgraded family well programme", *Waterlines*, Vol. 14 No. 4 (1996).

44 That is, it is scarce in certain places in Zimbabwe. Note that Zimbabwe itself can also be framed in many ways; for instance, as a whole (water is scarce there) or as a bundle of local areas (water is scarce in some places in Zimbabwe, but not in others).

45 Of course the question of whether and how the nation can ever be anything *but* an abstraction is the substance of much debate in post-colonial studies. See e.g. H. Bhaba (ed.), *Nation and Narration* (New York: Routledge, 1990), and R. Werbner & T. Ranger (eds.), *Postcolonial Identities in Africa* (London: Zed Books, 1996). On the formation and fragility of nation states in Africa see B. Davidson, *Africa in History* (London: Paladin, 1979), or A. Gordon & D. Gordon (eds.) *Understanding Contemporary Africa* (2nd ed.) (Boulder: Lynne Riender Publishers, 1996). For a recent analysis of politics-society relations in the "Third World" which pays at least some attention to technology see M. Kamrava, *Politics and Society in the Third World* (London: Routledge, 1993).

46 Interview PM, June 30 1997.

47 P. Morgan "The Zimbabwe Bush Pump. A Manual for the Installation, Dismantling and Maintenance of the "B" type Bush Pump", (Harare: Mvuramanzi Trust, September 1994); P. Morgan "Zimbabwe's User-Friendly Bush Pump", *Waterlines*, Vol. 14 No. 2 (1995). Most current numbers from Morgan, letter 3/28/1998.

48 Morgan op. cit. note 1, 67, 160.
49 Morgan, letter 3/28/1998.
50 UNICEF has adopted the "B" type not only for use in Zimbabwe, but is beginning to promote its use in other places as well. The pump is used widely in Namibia, and is being tried in South Africa and Swaziland (Morgan, letter 3/28/98). We have not looked into this but we will not be surprised if the stories of the pump's boundaries, successes and failures in these other places turn out different from the one we tell here.
51 Morgan op. cit. note 1, 160.
52 For a development of the notion of framing see M. Callon, op. cit. note 12.
53 The Blair latrine is another improvement of a conventional device, in this case the pit latrine, developed in Zimbabwe. A latrine of very simple but particular construction, it deploys wind, solar radiation and the relative position of its elements to create air currents that keep it fly-free and odourless. Water is used to clean the latrine but is not necessary for its operation. In rural areas where water is scarce this is the latrine technology of choice.
54 A 1997 government initiative to reallocate land from wealthy white farmers to the rural poor has been analysed in newspaper reports and scholarly commentaries as an effort to strengthen the withering support for Robert Mugabe's ruling coalition in Zimbabwe – and thus, as an exercise in nation-building.
55 Morgan & Von Elling op. cit. note 33, 29.
56 Expecting completely fluid phenomena to "work" is too romantic, while expecting mechanics of whatever kind to "function" without any fluidity signals too great a belief in metrics. See for this: J. Law and A. Mol, op. cit. note 13.
57 Morgan (1995), op. cit. note 50.
58 Since the publication of the manual on which our technical description is based, the pump has evolved further. Morgan writes: "The method of lifting the footvalve [on the bottom of the piston] through the rising main has been abandoned – the footvalve always became cemented in the base of the cylinder. The footvalve is not extractable, but is reliable and heavy duty." (Letter, 3/28/98).
59 Morgan (1994), op.cit. note 50.
60 Of course, communities and designers can diverge on what is beneficial. In the series of pumps that is currently in production, 16 mm rods are used, because popular demand turns out to favour pumps with greater capacity (and thus with wider mains and heavier rods) over pumps with lighter components (and thus easier repair).
61 Morgan (1994), op.cit. note 50, 14.
62 Morgan, op. cit. note 1, 160.
63 Ibid., 154.
64 Interview PM, June 30 1997.
65 Morgan op. cit. note 1, 249.
66 Ibid., 249.
67 There is another delicate balance here, which varies with circumstances and make-up of the community. As we will see below, a community may also be too *large* to maintain a pump properly.
68 Morgan, op. cit. note 1, 252. Incidentally, the wave of *E.coli* contamination in US hamburger meat in the summer of 1998 was so alarming, not because the *E.coli* is in itself deadly, but because if it comes from a foreign body it may have deadly effect. And because hamburgers are eaten in great numbers, of course.

69 This point has been highlighted by many others who investigated standardisation. See for an example in a medical setting: M. Berg, *Rationalizing Medical Work* (Cambridge, MA: MIT Press, 1997).
70 It should be clear that we are by no means suggesting that a Bush Pump does *not*, in general, provide water with less *E.coli* than, say, a Bucket Pump!
71 Morgan, op cit. note 1, 67.
72 Ibid., 108. Note that our discussion eschews knowledge of what a "community" "is"; in other words, as we are interested in what happens when the pump enters a site, and argue that the pump contributes to shaping community, we do not seek to sort out which kind of user configurations will be likely to adopt the pump.
73 But one more word on the users. The community is not necessarily the village. It therefore makes little sense to define what will be a workable unit in advance; the failure of some water pumps on the village level and the occasional regrouping of family units around this technology suggests that the units form in the process. Which is of course old technology studies wisdom. See for an early articulation M. Callon, "Struggles and Negotiations to Define what is Problematic and what is Not. The Socio-logy of Translation", K. Knorr, R. Krohn and R. Whitley, (eds.), *The Social Process of Scientific Investigation* (Dordrecht: Reidel, 1980), 197-220.
74 Morgan, op. cit. note 1, 107.
75 Aligning the number of users with a pump is also a matter of cost. The Bush Pump is not only more difficult to maintain than the Bucket Pump; it is also more expensive. Since villagers are expected to contribute towards the purchase price of a pump, the installation of a Bush Pump requires a larger user population. Even if there were no village contribution to the cost, a certain number of people is needed to convince the government (or other subsidising institution) that a Bush Pump is a sound investment. So, while a smaller number of users may guarantee more careful maintenance of the pump the Bush Pump's cost may be prohibitive for such a small community.
76 See Morgan et al. op. cit. note 46. Whereas the government was still reluctant to adopt the program in 1996, by early 1998 it had been convinced of its value. (Morgan, letter 3/28/98).
77 As would organisations like UNICEF which, having been enticed (by whatever means) to employ the Bush Pump in Zimbabwe, are now adopting the pump for wider use.
78 Morgan, letter 3/28/98.
79 Interview PM June 30 1997.
80 Interview PM, June 30 1997.
81 Interview VE June 19 1997.
82 The relation of authorship and ownership has been more thoroughly analysed for copyright than for patents; see for instance L. Rosenthal, "(Re)Writing Lear. Literary Property and Dramatic Authorship" and J. Peters, "The Bank, the Press, and the Return of "Nature". Of Currency, Credit, and Literary Property in the 1690s", both in J. Brewer & S. Staves (eds.), *Early Modern Conceptions of Property* (London: Routledge 1997), 323-338, 365-388. See also M. Rose, *Authors and Owners: The Invention of Copyright*, (Cambridge, MA: Harvard University Press, 1993), and R. Merges, *Patent Law and Policy* (Charlottesville: Michie Company, 1992).
83 Interviews ARIPO, June 1997.
84 B. Latour, op. cit. note 10; interview PM, June 30 1997.
85 This is controversial. Recall Aristotle's critique of Plato "that which belongs to everybody belongs to nobody." Moreover, advocates of patenting dispute the validity of such calculation, arguing that if novel technology is not patented the producer will have to calculate

costs deriving from attempts by others to produce copies of the technology at a lower price. According to such arguments, there is a "social cost" attached, for instance if copying the product results in consumers settling for unpatented, less preferred products that are sold at competitive prices. See P. David, "Intellectual Property Institutions and the Panda's Thumb", M. Wallerstein, M. Mogee, and R. Schoen (eds.) *Global Dimensions of Intellectual Property Rights in Science and Technology* (Washington, D.C.: National Academy Press, 1993), 19-61.

86 Interview PM, June 30 1997.

87 Interview PM, June 30 1997.

88 These comments are based on interviews at the Zimbabwean Science and Industrial Research and Development Centre, Department of Remote Sensing and Environment, June 1997, and on interviews at UNICEF Harare, June 1995.

89 Morgan, "Small steps count – building on traditional methods for rural water supply", *Waterlines*, Vol. 15 no 3, 1997.

90 On Morgan's part, that is. The government's current upgrading and installation programme *does* include a modest effort to monitor its pumps.

91 Interview PM, June 30 1997.

92 This active abandonment may be compared with what Gomart and Hennion so astutely observe in the way drug addicts and amateurs of music seek to dissolve, by actively "being taken" by drugs and music respectively. See E. Gomart & A. Hennion, op.cit. note 3.

93 In our reflections on the kind of masculinity that Morgan (re-)presents we have also been inspired by another, slightly different version of it, that of the novelist Paul Auster. Auster's version is cast as an implicit rejection of, and a creative alternative to, what in the USA is called a *WASP*. See e.g. P. Auster, *The Invention of Solitude* (Sun Press, 1982); or P. Auster, *Hand to Mouth. A Chronicle of Early Failure* (London: Faber and Faber, 1997).

94 This remark is of a public, not a private nature. We do not mean to say anything about *Peter* Morgan, in a personal sense; his modesty is to us not a personality trait. For though interviewing him was much fun (and, to be sure, not all interviewing is!), we cannot claim to know him "personally". With "ideal man", here, we refer to *Dr.* Morgan, a public figure in the space of technology design and water politics. What we are up to is not to intrude into a private life, but to mobilise terms that are coined in the private sphere and put them to use in relation to public issues. With this move we situate ourselves in the tradition of feminist scholarship, where it has been done before. See e.g. S. Ruddick, "Maternal Thinking" in: J. Trebilcot (eds.) *Mothering: Essays in Feminist Theory* (Totowa, N.J: Rowman and Allanheld, 1984). But we may also link ourselves in a footnote to Luc Boltanski's work on *agapè*. Bolanski draws attention to forms of self-effacing love that operate in the public domain, however much the tradition of critical sociology has always denounced any reference to them as misleading ideology. See L. Boltanski, *L'Amour et la Justesse comme compétences* (Paris: Editions Métailié, 1990).

95 The trope of the love for technologies is brought into play by Bruno Latour in his *Aramis, ou l'amour des techniques* (Paris: Editions la Découverte, 1993). Latour, however, is a bit vague as to his object of love. Is it Aramis, of which he lists such wonderful characteristics? Or does he indeed ask us to love *technology* in general? That seems too humanist a requirement to us and moreover a missed chance to separate out what is loveable from what is not.

96 See e.g. Bijker & Law "General Introduction", op. cit. note 4, 1-14. Bijker and Law argue that the technical is always, and at the same time, social and vice versa: the social and the technical are not two different and separate realms.

97 For how an object contains its environment, see M. Serres, for instance *Hermès V. Le Passage du Nord-Ouest*. Paris: Editions Minuit, 198 . Here, as in many other places, Serres describes how the nature of an object varies with the methods by which it is measured, assessed, or appropriated. There is, for instance, no "length" of the coast of Britanny, Serres argues, for the length of the coastline followed by foot is different from that covered by following the highway; from the water the coastal length is yet quite a another matter. Not only is the *distance* different in each of these instances; each length, by including its specific mode of measurement, is a different *thing*. Likewise, the Bushpump contains its environment: it is a different thing when it is sitting on the premises of V&W Engineering, than it is when pouring water in, say, Marondera.

98 We may have learned this from the Bush Pump, but it is a fairly classical argument. That redundancy is a good trait in technologies has for instance been said in respect with military technologies which are supposed to carry on working in "extreme" circumstances. See: J. Law, *Aircraft Stories. Decentering the Object in Technoscience* (Durham: Duke University Press, 2002).

99 In his history of the cross-over between ethnomethodology and science studies Michael Lynch examines how *ethnomethodology* takes as its object the local organisation of social activities, thereby offering an alternative to phenomenological accounts that are based on a psychology of consciousness. See M. Lynch, *Scientific Practice and Ordinary Action. Ethnomethodology and Social Studies of Science* (Cambridge: Cambridge University Press, 1993), especially chapter 4. See for this argument also J. Potter & M. Wetherell's wonderful "guide" to discourse analysis *Discourse and Social Psychology. Beyond Attitudes and Behaviour* (London: Sage Publications, 1987). In analogy with this move away from the conscious subject, what may be needed in STS now is an alternative to the generalised ethics of the responsible subject; a – how to say it – *topoi-ethicality* that points to what may be good in local arrangements and that explores what happens when elements from these localities start to travel.

100 Whereas in a mythical past before STS epistemology structured all thoughts in relation to science, approaching "false" and "true" statements in a symmetrical way has been highly liberating. However, such neutralising moves shouldn't lead to *general bans* on normativity, but only to bans on *general normativity*. One of the more urgent tasks for Science and Technology Studies seems, to us, the reassessment of the character of normativity itself. For an attempt see J. Collier "The Nature of Metascientific Claims", (Ph.D. Dissertation Virginia Tech).

101 Standpoints and points of contrast are not necessarily points of departure. They may be acquired or changed in the process of engaging with a subject, an object or a topic. So rather than a *standpoint epistemology*, however subtle it may be handled, we would like to develop a *travel-bag normativity* that can be taken along and fluidly adapted. For a nuanced version of the former, see: D. Haraway, *Simians, Cyborgs, and Women* (New York: Routledge, 1991). And for some elements towards the latter, see G. Robertson et.al. (eds.) *Travellers's tales. Narratives of home and displacement* (London: Routledge, 1994).

102 Not every interpellation, however, should be taken as a reason for praise. In good Althusserian fashion one may doubt whatever one is seduced by. For an example of this, analysing various relations between men and machines, see J. Law, "Machinic Pleasures and Interpellations" in: B. Brenna, J. Law and I. Moser, *Machines, Agency and Desire*, Oslo, University of Oslo, TMV Report 33/98.

Vicky Singleton

Training and Resuscitating Healthy Citizens in the English New Public Health

– Normativities in Process

Introduction

The English Government Plan for the New Public Health (1999, 2000) promotes distribution of health care expertise and technologies, participation of individuals and communities and partnerships between communities and the Government. A crucial component of the Plan is the Healthy Citizens Programme that aims to empower individuals in particular ways. The Healthy Citizen enacted through the Plan is knowledgeable, has health skills, is active in the community and participates in her own care. In this paper I ask how this Healthy Citizen is enacted in the daily, located practices that constitute delivery of the New Public Health Plan. My concern is thus with the Healthy Citizen in action and in the embodiment of the Healthy Citizen Programme.

To explore this I consider a Community Heart Care Initiative in a large rural community in the North West of England. The Initiative aims to train *all* members of the community in Cardio-Pulmonary Resuscitation (CPR) in order to prevent deaths from heart attack[1]. I consider how the practices that constitute the Initiative enact Healthy Citizens, and show that individuals who participate are more valued than those who do not or cannot do so. This fits with Petersen and Lupton's (1996) argument that the New Public Health produces normativities about how we should and should not live. However, in practice it turns out to be more complicated, for I also try to show that in both the Plan and the Initiative normativities are simultaneously produced *and* undermined and contested. What it is to be a Healthy Citizen is enacted in numerous, diverse and contested ways. Normativities are situated, dynamic and fluid. They are normativities-in-tension, and the Healthy Citizen turns out to be an unstable identity. Such normativities in practice are complex and deeply textured. They are simplifications, generalisations and they

collapse differences while they are also emergent, precarious, negotiated effects. For this reason I argue that a key question is not the production of normativities per se but rather the *kinds or modes* of normativities that are made. My central argument is that normativities might be considered as process rather than a product.

Saving Lives: Our healthier nation (1999)

The Government White Paper tells about "a new, modern approach to public health", (Forward, Tony Blair):

> Everyone in the country is affected by this programme and we have to do our best to make sure that everyone is committed to it. (p7)
>
> We want to see a new balance in which *people, communities and Government* work together in *partnership* to improve health. (pix, original emphasis)
>
> we are setting tougher but *attainable targets* in priority areas. (pviii, original emphasis)

These quotes highlight the three key foci of the New Public Health: individuals, partnerships and targets. The "old" public health was based upon mass solutions for mass populations whereas the "new" is an appreciation of individuality and is based upon localised solutions for a diverse population. It responds to the diversification of production that is an effect of the global economy and to the increased sophistication of society, culture and public expectations. At the same time, a crucial motivation for the necessity of this "third way" is the persistence of health inequalities or "variations" – for instance, the different mortality rates that relate to income and education.[2]

Prime Minister Tony Blair argues that the New Public Health is "new" because "…it refuses to accept that there is no role for anything other than individual improvement, or that only Government can do something." (Forward, 1999)[3] The third way for public health rejects top down planning and also individual victim blaming. Indeed, it is about "opportunity and responsibility". (pvii, Jowell, 1999) The New Public Health is a "three-way partnership" that requires "individuals, communities, local organisations and Government to contribute…" (p3, Secretary of State for Health, 1999). It is about *partnership* and *participation*. "We" does not mean "we, the government" but rather "we, the country" (pvii, Jowell, 1999).[4]

Healthy Citizens Programme

The New Public Health is ambitious and it is filled with promise. Crucial to it is the New Public Health Plan with its Healthy Citizens Programme,[5] which is about "ensuring people have the knowledge and expertise they need to deal with illness and health problems" (p33, Secretary of State for Health, 1999).[6] It is about *empowering* individuals by increasing and improving access to information. Patients come to participate in their own care and there is training in health skills. One strand of the Healthy Citizens Programme focuses on *Health Skills*. This comes in two parts. First there is "Health Skills for First Aid". The Government is investing £31 million to "expand existing training for people to learn health skills, including first aid, mainly using existing providers" (p35, ibid.) Second there is "Health skills: Defibrillators". The White Paper claims that, "In England only two to three people in every 100 survive a cardiac arrest compared to eight to nine in Scotland and 11 in the United States" (p36, ibid.). Two layers of action are proposed:

1. Money to provide automated defibrillators in public spaces where they are most needed such as railway stations and airports defined as "public areas used by large numbers of people where the incidence of cardiac arrest is likely to be relatively high" (ibid.).
2. A training programme in the use of defibrillators targeted on those who work in or near pilot sites but also members of the public. The claim is that "This will help to de-medicalise and demystify immediate care and enable more people to be both competent and confident in managing emergencies" (ibid.).

The White Paper argues that many deaths from cardiac arrest (heart attack) in the UK are avoidable and preventable. People trained in Cardio-Pulmonary Resuscitation (CPR, a procedure that provides artificial respiration and heart massage) and in the use of automated defibrillators could save lives following cardiac arrest.[7]

The Healthy Citizens Programme is proposed as key to the delivery of the New Public Health. It proposes that emergency care be partially re-located and made local to the community through distribution of medical technology to public sites and distribution of medical expertise to members of the public. As we have seen, it aims to demedicalise and demystify immediate care through training in skills such as CPR and provision of automated defibrillators that will save lives while enabling confident and competent citizens. The Healthy Citizen enacted through the Plan is skilled, competent and active in maintenance of their own health and that of members of their community.

Normativities and the New Public Health

The New Public Health is about a Healthier Nation as well as about a nation in good health. This is performed as a subtle but important break with the past.[8] Public health has always been concerned with populations rather than individuals. But the New Public Health treats the population as a collection of individuals rather than as a homogeneous mass. Furthermore it acknowledges the heterogeneity of health as well as of "the public". This means that its definitions of health and the location, forms of intervention and practitioners of health care are all broader. Health is heterogeneous because all aspects of life can contribute to health including what you eat, how physically active you are, whether you smoke or not, what kind of sex you practice, how you cross the road, how much sun your skin is exposed to and how much alcohol you drink.[9] So too, health care takes place in multiple locations including homes, public spaces, hospitals, clinics, community meeting rooms and even public houses. Finally, the people who carry out health care are diverse and include professional health workers, family, friends and neighbours. In these ways the New Public Health seems to acknowledge the limitations of a purely biomedical model of health and to appreciate that self, community and state each play an important role in the achievement of public health. It acknowledges that there are multiple ways to achieve public health including saving lives, achieving targets, promoting development of communities and partnerships and making Healthy Citizens that are active and responsible.[10]

The New Public Health can be seen as a move in the right direction for health care. It is an attempt to develop health policy and practices sensitive to the complexity of the relationships between the state and the individual and to the multiple meanings and causes of "good health".[11] Indeed the New Public Health is itself a complex construction in which various diverse elements are placed in new relations to one another.[12] For instance, the distribution of expertise and formation of partnerships is associated with developing skills and empowering individuals, which are, in turn, associated with locating care in the community. It is constituted by localised initiatives and reflexive citizens. Public health is taken to be an on-going project that involves perpetual self-monitoring. The New Public Health is concerned as much with how we live (the means), as with how we die (the ends).[13]

So, with all this attention to complexity, multiplicity, diversity, heterogeneity and the redefinition of the nature of expertise it seems that, at one level, the New Public Health is working without definitive constructions of how the world is and how we should live. It seems, that is, to work against the construction of normativities, at least in the form of centrally defined, simplified definitions of how we should live. It is optimistic, and in some ways counts as a new approach. It promises

health for the whole nation that is not founded on, nor involved in production of, rigid definitions of the subject or the object of public health. Here is an example of its optimism:

> We want to see *healthier people in a healthier country*…. We want to see everyone take the opportunity of better *health – now and for the future*. (pxi, Secretary of State for Health, 1999, original emphasis)

The burden of great potential: Normativities in tension

David Hunter, Professor in Health Policy and Management, observes, "It was Churchill who said that "there is no heavier burden than a great potential" and the NHS plan certainly falls into this category.… The proof of the Plan will be in its delivery." (p75, 2001)

I am particularly interested in what happens to the Plan in practice, but I am also concerned with its "great potential". It is attentive to difference, appreciative of context, and generous and inclusive in its definitions of health, expertise and health care. At the same time, partially hidden behind the optimism we can see the, perhaps inevitable, work of simplification, construction and definition. Generosity is directed by an authoritative centre. Sensitivity to multiplicity and to process, the emphasis on community participation and individual empowerment, is part of an "action plan" that involves achievement of "bold objectives" and setting "new, tougher and challenging targets" in reducing death rates in priority areas. (p1– 2, Secretary of State for Health, 1999)

We begin to glimpse more and more tension within the Policy. Its commitment to centrally defined targets does not fit comfortably with a commitment to localisation of health care. Particular ways to live and to be healthy emerge as at once optional and as obligatory. Health is an opportunity and participation is voluntary but both are precisely pre-defined and closely monitored. The Plan betrays a tense relationship between distribution and centralisation of expertise. That is, while the New Public Health aims to empower individuals, to forge partnerships and encourage community and individual participation it is also about "setting tougher but *attainable targets* in priority areas" (pviii, Secretary of State for Health, 1999, original emphasis):

> *Target: to reduce the death rate from coronary heart disease and stroke and related diseases in people under 75 years by at least two fifths by 2010 – sav-*

> *ing up to 2,000,000 lives in total* (p72, Secretary of State for Health, 1999, original emphasis)[14]

The Healthy Citizens Programme is part of the implementation of the National Service Framework. This framework sets national standards and defines service models for health promotion, disease prevention, diagnosis, treatment, rehabilitation and care. It aims to reduce variations in health care and to improve service quality. The Healthy Citizens Programme is to help in the "fight against coronary heart disease and stroke" (p81, Secretary of State for Health, 1999). The Healthy Citizen promises to be an identity in tension – an empowered, informed, skilled and active member of her community who must, nevertheless, work towards meeting goals that have been defined centrally, by the Government.

Petersen and Lupton are critical of such tensions:

> …attempts to "emancipate" or "empower" marginalised groups through such strategies as community participation, based on humanistic, neo-liberal principles, may be regarded as ever more complex ways of defining, regulating and normalising the members of such groups (p180, 1996)

My concern is somewhat different. Rather than treating such tensions as obscuring strategies of oppression and normalisation, I want to take them seriously in their own right. Yes, there are simplifications, generalisations and definitions about how we should and should not, live. But if we take the tensions seriously then we learn that the identity of the healthy citizen of the plan is complex, situated and multiple. In their tensions, the normativities enacted in the New Public Health Plan are *both* multiple, flexible, located modes of living and being healthy, *and* unified, inflexible, simplified definitions of how we should live. But such tensions are not necessarily disruptive, confusing or obscuring of power relations. As much other recent work in Science and Technology Studies suggests, such tensions may be inevitable, necessary, productive and deserving of serious attention (Haraway, 2003; Law, 1998; Mol, 2002; Singleton, 1998; Timmermans and Berg, 1997). Indeed, I suggest that it is the tensions inherent to the Plan that, at least in part, afford its "great potential". The great potential is that the Plan enacts new *kinds* of normativities.[15]

Appreciating process

The approach that I develop in this paper has a series of commitments.

Firstly, it attempts to work outside a dichotomous approach to medicine that would evaluate the New Public Health as either a monstrous beast or a saviour and it attempts to work neither in awe nor in hatred (Mol, 1998). Instead I seek to engage with and to participate in the practices of the New Public Health acknowledging that it is being made here and now, before my very eyes and through everyday work of the members of the Initiative.[16] I also seek to work within and with, rather than upon and outside. My aim is not "objective" distance but rather situated participation (Haraway, 1991).

Secondly, my approach is less focused on the human than is the case for much medical sociology. For example, Petersen and Lupton (1996) argue that the assumptions on which the New Public Heath is based have not been critically explored in medical sociology, and they seek to put this right by examining the construction of the subject and power/knowledge relations. I accept their suggestion that actors are always "unstable and multiple" (p173, 1996), but want to add that they are also, always, impure and heterogeneous. Materiality and relationality are central to my argument. To be a Healthy Citizen is to associate with various non-human as well as human entities – and this may both be difficult and a source of inequity related to access and competence.

Finally I press another difference that is much subtler. My approach, I suggest, is less concerned with goals than with process. It is less about *evaluating* the New Public Health than the on-going work of *making* it. It is concerned with the enactment of the New Public Health rather than the product.[17]

All of the above leads me to an analysis of the New Public Health in practice. The following questions guide my interference. They are questions concerned with "how" rather than "why". How does a person become a Healthy Citizen? What materials, emotions and activities are involved? Science and Technology Studies, as well as other disciplines such as Health Policy and Organisational Studies, have frequently told us that practices may differ from plans (For example see Hunter, 2001; Gherardi et. al., 2003; Mol and Berg, 1998; Singleton, 1998; Singleton and Law, 2004). My case study is interested in the ingredients that are mixed together, here and now, before my very eyes in my own community, in the making of the Healthy Citizen (Latour, 1987).

Heart of the Shire Initiative (1999)[18]

A leaflet produced by The Heart of the Shire, tells us that its aims are to:

- Train all members of the community in cardio-pulmonary resuscitation
- Provide defibrillators and train first responder volunteers in their use

- Provide fully equipped fast response units.

It also explains that:

> The Heart of the Shire appeal has been set up to create a "chain of survival", which will provide training and equipment to ensure the … critical links in the emergency treatment of sudden cardiac arrest are available to people in our community. Providing these procedures quickly may determine whether someone lives or dies. (Heart of Shire, 2001)

The leaflet, titled "Take Heart", is widely available. I picked up my copy at a local agricultural show and I saw copies at the community doctor's surgery, in the community library, in local shops and in the local dentist's waiting room.

Crucial components of The Heart of the Shire are: Healthy Citizens trained in CPR; publicity and information leaflets; regular updates on the initiative in a community magazine; community CPR training sessions; and fund raising events and activities.[19] The story goes that the Initiative is a grass roots initiative rooted within the local community. It is the brainchild of one local, energetic, dedicated woman. The appeal began in July 1999 and the first training session was in October 1999 – the same time as the White paper was published. The timing of the White Paper and the development of The Heart of the Shire seem to be related. The Heart of the Shire is an effect of the joining together of the especially responsible local citizen, Mrs. Illsby, and her community, with the county ambulance service. This would seem to fit the proposals of the New Public Health Plan of community and professional partnerships and grass roots initiatives. Consider the following account taken from my fieldwork notes.

Mrs. Illsby[20] lives in a large village on the coast in North West England. The nearest hospital is 20 miles. One terrible day her husband collapsed at their home. She telephoned for an ambulance. Her husband died before the ambulance arrived. According to Mrs. Illsby, her husband died because the ambulance took too long to arrive at her home. Motivated by this experience, the story tells that Mrs. Illsby searched for alternatives to the long wait for an ambulance often experienced by members of rural communities. She discovered a programme of public Cardio-Pulmonary Resuscitation that thrived in Seattle, US. Having visited Seattle to see for herself she contacted the local Ambulance Service and it was through the collaboration and commitment of herself and the Chief Executive of the local Ambulance Service that The Heart of the Shire Appeal was started to fund the programme of community training in CPR. The additional First Responder Scheme was an "effective spin off" from the public CPR training. (Heart of the

Shire, 2000) The First Responder Scheme is a group of community members who volunteer to be on call to respond to a cardiac arrest in the community. They carry automated defibrillators with them.

This story about the origin of The Heart of the Shire seems to play a significant role in the development and durability of the Initiative. This history is retold in many places such as the public CPR training sessions, at fund raising events, in the community magazine and in homes when fund-raisers seek donations. The story seems to encourage support and participation by members of the community by defining the initiative as being owned by the community rather than the health service. So, we might say, according to local lore of the Over River community, that the Initiative is a partnership between the community and the Shire Ambulance Service and the partnership originated in the community.[21] Indeed, Mrs. Illsby is now somewhat of a local hero. And looking through the lens of the New Public Health, she epitomises its informed, responsible and empowered Healthy Citizen. She took the baton of responsibility for her own health and that of her community from the government and local and national health service managers, ran with it and passed it over to a New Public Health partnership that co-ordinates individual, community and government participation.

Healthy Citizens are Active

The leaflet mentioned above titled "Take Heart!" is trying to enrol volunteers or donations of money. In the process it bears close scrutiny in its construction of a Healthy Citizen. It seems that ones" donation, done quickly, can save lives. Conversely, the unwritten message of the leaflet is that not contributing, whether through volunteering for training or making a donation, could be contributing to a person's death – and that person is another member of one's own community, a neighbour in the broadest sense of this term.

My own involvement in the programme started with a visit from a neighbour, carrying a money collection box, requesting money and active participation. The discussion that ensued was full of accusations of blame about other inhabitants of the local community who failed to show an interest in the programme despite the fact that "they would expect us to help them if something happened to them". The non-participants were referred to as "couch potatoes", "stupid and ignorant" about the causes and risks of heart disease and as "short-sighted", unable to think long-term about their own future needs (Fieldnote diary, March 2000).

At a CPR training session which included repeated calls for volunteers to become First Responders – a step further than carrying out CPR in terms of active

participation as it involves being responsible for an automated defibrillator and responding to emergency calls – I noted the following exchange between a First Responder and a member of the audience:

> *Audience*: I'm committed to the idea of the programme but it is difficult for me to commit to becoming a First Responder, I'm on my own with three children and a job and I don't think it would be right. I wouldn't have the time or energy.
> *FR*: Well, Kate is one of our star First Responders (points admiringly to a young girl in a nurse's uniform that is seated in the audience). She is such a good person. She has an ill mother to care for, as well as an elderly mother-in-law that she drops in on every day, and she works at the local nursing home and she still gets to most of the calls even if she is not on call.
> *Audience*: But as a single parent I know that I could not just leave the house if I was on call.
> *FR*: Well there are other ways of involving yourself, you could do administrative work for the programme, or make cups of tea at these training events. Just write down on the form what you could offer.

Active participants are the Healthy Citizens of the New Public Health. Moreover, the more participation the more moral and "good" one is. First Responders are frequently referred to as "dedicated people" and as altruistic, caring people "giving up time to train and to be available night and day to respond to neighbours in their hour of need" (p16, Hulley, 2002). They are defined as "*active* in our community" (Heart of The Shire, Over River Branch, 2001, my emphasis).

It seems that The Heart of the Shire is about resuscitating citizens in more ways than one. It is about training people to carry out CPR and at the same time about training people to be "good" citizens. Being a Healthy Citizen emerges as a variety of things including: not dying from cardiac arrest because a member of your local community can resuscitate you; being trained to resuscitate another; giving money to train others; and demonstrating ones' support for The Heart of the Shire. That is, being a healthy citizen is not just about physical health; it is also about practical skill and community participation. Through and through the Healthy Citizen is the *active* citizen – donating time, interest and/or money to the initiative.

Healthy Citizens participate in their community

To participate in the Initiative is to fulfil one's duty to one's community. The metaphor of being part of a "war effort" frequently appears. This is a war on community ill health, the key attacker being the heart. Cardiac arrest is constructed as unpredictable and promiscuous – "it's all but impossible to predict who will have a sudden heart attack, or where or when it will happen". A heart attack is a predator on which we need to wage war and "First Responders often think of themselves as "Front Line Soldiers"' (Maxwell, May 2002). So individuals and the community are at risk from an indiscriminate assassin. The community is in danger, and all members of the community should be involved in saving lives. Participation in the Initiative is about becoming a part of something important. The leaflet "Take Heart!" encourages the reader to "Become part of the biggest emergency heart care response programme in the country!" (2001). To participate is to participate in a community that is pulling together to make itself safe and healthy. Many leaflets refer to "our community". The object is to "train EVERYONE within the community". The Initiative is, at once, an effect of and enacts a community. It is a grass roots initiative situated in the community while it also offers an opportunity for people living in the Over River area to become part of a community, and to achieve a sense of belonging.

The following "call to arms" was collected from a community doctor's surgery. It is an A5 sheet of white paper, photocopied, not glossy in any way, simply black writing on white paper using standard font, the use of bold and capitals is in the original.

> IN 12 MONTHS THE [HEART OF THE SHIRE] HAS *TRAINED OVER 400 RESIDENTS IN CPR, 20 FIRST RESPONDERS ACTIVE IN OUR COMMUNITY PROVIDING 2 FULLY EQUIPPED FIRST RESPONDER TEAMS (95 calls attended since Dec'99) 8 FULLY QUALIFIED TRAINERS*
> We aim to train EVERYONE in the Over River area to recognise the signs and symptoms of a Heart Attack and how to perform CPR (cardio-pulmonary resuscitation)
> Please continue to support this vital scheme in your village (Heart of the Shire, 2002, original emphasis)

There are two logos of equal size at the top of the page: The Heart of the Shire and the Shire Ambulance Service. Again this reminds us that this initiative is a partnership between medical professionals and the community. Nevertheless the "home made", cheaply produced look of the leaflet serves to situate the partnership

firmly within the community, as a community responsibility. The leaflet also invites the reader to attend a forthcoming fund-raising "garden party offering fun for all the family" at a home in the Over River area. Once again we are being reminded that being a Healthy Citizen in the Heart of the Shire is an overtly social activity about collective responsibility. It is about participating in a community.[22] And we are reminded that the Initiative is a grass roots initiative located in the gardens of local homes, agricultural shows, libraries, village halls and churches.

Here, then, life saving techniques are thoroughly and completely entwined with social and moral responsibilities to the community. They belong within the community, rather than in the hospital or clinic. Being a Healthy Citizen is not only, or even most importantly, about saving lives in the form of having skills in medical techniques such as CPR and defibrillation. It is about many things that are neither physical nor medical. In particular, it is about participation and adopting responsibility in particular ways, in one's local community.

Healthy Citizens are skilled

The same leaflet offers "*FREE CPR TRAINING TO ALL!*" Below this line it reads: "LEARN HOW TO RECOGNISE THE SIGNS AND SYMPTOMS OF A HEART ATTACK AND HOW TO PERFORM BASIC LIFE SAVING SKILLS" (original emphasis).

The Heart of the Shire is about life and death and it is exciting, engaging, frightening and empowering. It is about members of the public as heroes, about people collapsing, about emergency care, about responders rushing to the scene in their neighbour's hour of need. Consider the following excerpt from the monthly update about The Heart of the Shire published in the free and widely distributed community magazine.

> There is no greater feeling of helplessness than when you are faced with a fellow human being who is choking or having a heart attack, and you don't know what to do to help them.
> I have been in this position several times in my life and it is the main reason why I became a First Responder. I needed these skills.
> The training we give is second to none. We are glad to pass our skills on to you at our Public Training Sessions.
> Please come along [to a CPR training session] and learn a skill which may help you save a life (Maxwell, March 2002).

Training in CPR is the means of preventing death from heart attack, a way of avoiding mortality.

Following the invitation to attend for free CPR training described above, the reader is invited to attend a village venue, typically a local community centre, a church hall, a village meeting place or even a public house. I have attended two of the training sessions and I detail some aspects of my experiences of this below.[23]

> A friend accompanies me. We park our car next to a car with magnetic signs on the bonnet and in the back window saying "First Responder on Call" and "Emergency".[24] This is a normal, everyday, maroon coloured saloon car. The signs distinguish it from other vehicles. We must be in the right place. It is not obvious in any other way for we are at a United Reformed Church, a brick building with arched windows and a pitched roof porch topped by a small white cross. This is a simple, small, building - easy to pass by without a second glance. We enter the church. But there is no alter, nor pews, just plastic chairs arranged to face a large white screen placed in front of a stage with drawn curtains. Next to the screen is a table covered by a blue cloth and topped with a computer and an automated defibrillator. There is also a piano, a couple of religious pictures hung on the walls and people. There are three men in blue boiler suits with reflective strips on their ankles and edges of their sleeves and a crest embroidered on the left breast pocket of the suits topped with their name. There is a woman in sweat shirt of the same colour blue with a large heart on the front and thirty or so other people, some sitting and some standing, that are not in any kind of uniform but in everyday informal clothes. The woman in the blue sweatshirt is kneeling on the floor assembling two halves of a human "dummy".

Training to be skilled in CPR is made accessible and widely available. It is physically and socially located in the community. It often takes place in the evenings when many people are not at work and/or can get child care and travel assistance. It is also accessible in its very familiarity and mundane appearance. It is constituted in large part by an array of "every day" and known things. For example, it takes place in non-medical, local places such as church halls and community meeting places and it includes a piano, neighbours, cups of tea, biscuits, and the chairs that you might sit on when you attend church on Sunday morning.

Nevertheless, a member of the Over River community who attends training in order to become a skilled Healthy Citizen also encounters many unfamiliar and extra-ordinary elements.[25] Indeed the citizen skilled in CPR is an effect of the mixing together of a diverse array of elements including tea, biscuits and familiar

chairs but also human dummies, a computer, an automated defibrillator and boiler suits with reflective strips. This is what acute medical care is made of in the community in the 21st century. The skilled citizen is an effect of associations between an array of human and non-human entities and the non-human entities are as crucial to the making of the skilled citizen as the human. Becoming a citizen skilled in CPR is not a "pure" enterprise; it is material through and through, mediated by various materials and persons. It involves negotiating and associating with an array of entities. Moreover, making and maintaining relations with an array of heterogeneous entities *involves work*. And this work is not benign – it is demanding and may be distressing if not terrifying. For example, it includes handling a human "dummy", imagined as a person collapsed in pain and dying, in order to practice performing mouth to mouth resuscitation and cardiac massage. It also involves manoeuvring the body of another trainee to practice first aid procedures such as placing a collapsed body in the recovery position. In addition the Healthy Citizen trainee meets, perhaps for the first time, a defibrillator. This can be a frightening technology – it is associated with death and trauma and the trainees are told that its use involves administering violent shocks to the fibrillating heart in order to stop the heart. Further, the training may be distressing because trainees face their own potential for sudden death and that of their friends and neighbours. This is the detail of the work of embodying Healthy Citizen.

Furthermore, there may be inequity in who has access to, and the competence to negotiate with, various technologies and materials that are necessary to embodiment of the Healthy Citizen in The Heart of the Shire. For example, during one of the training sessions I observed an elderly woman who could not practice CPR on the dummy because she could not bend down. Other members of the community have mentioned various issues that affect their ability to perform the role of Healthy Citizen including availability of transport to travel to training sessions or to respond to emergency calls and availability of money to donate.[26] So, the skilled Healthy Citizen in The Heart of the Shire is an effect of a complex set of associations between an array of heterogeneous entities.[27] Because being a Healthy Citizen is an effect of mixing together an array of heterogeneous elements the work involved in being a Healthy Citizen in The Heart of the Shire may be different to that of being a Healthy Citizen in another initiative or indeed to being a Healthy Citizen within The Heart of the Shire at different times and in different places.[28]

Distribution of expertise and re-medicalisation of immediate care

> Jane calls us to order. She introduces herself as a First Aid Trainer. She introduces other colleagues such as Bob, a First Responder and first aid trainer, and also mentions various volunteers who are in the kitchen preparing the tea and biscuits that we will be offered later. Now Jane begins the presentation proper. "The whole idea is to work with the Shire Ambulance Service to provide community training in Life Support…. All the volunteers are trained by the Shire Ambulance Service using guidelines developed by the Shire Ambulance Service." Bob backs this up with, "The paramedics are good, but they have to get here. This is a rural area and we might wait 20 to 30 minutes for an ambulance. We need to act in the first 5 to 10 minutes." Later Jane tells us "We are not medical people so we can't answer medical questions" (Fieldnote, training session, August 2001).

It seems that Jane is telling the trainee Healthy Citizens about the distribution of power, or responsibility. Although she assumes that the initiative is firmly rooted within the community, she is keen to stress the limitations of the volunteers and she continually defers to the Shire Ambulance Service. This deference was obvious throughout the training and offers insight into the tensions that are inherent to the practice of this newly formed public health partnership and to the embodiment of Healthy Citizen. In some ways it seems that the Initiative in action, while obviously about the distribution of knowledge and skills, is not necessarily about distribution of expertise. Indeed in some ways the practices of the Initiative validate expertise as residing with medical practitioners – the ambulance service and the hospital. It seems that the truly difficult work of medicine is always going on elsewhere. As Lisa Hulley, Community First Responder Manager based at the Shire Ambulance Service NHS Trust writes, "Community First Responders…. carry out life-saving treatment *until the emergency ambulance arrives*." (p16, 2002, my emphasis) And, a First Responder writing in the local community magaizine states, "*IN AN EMERGENCY ALWAYS CALL 999"* (Forrest, p17, 2002, writers emphasis).

There are repeated references to hospital care, to first and foremost calling for an ambulance, with the addition of, "The First Responders are called out utilising a protocol by the 999 Emergency Control Desk" (ibid). Various members claim that the Initiative does important work to "support" the work of the ambulance service and the hospital. This suggests that, in direct contrast to the aims of the Healthy Citizens Programme as defined in the Plan, through the practice of this Initiative immediate care is, in some ways, remedicalised and remystified. This leads me to

suggest that one effect of the Initiative is a form of re-enchantment with medical practitioners and medical science. The Initiative is firmly rooted in a biomedical approach to health that prioritises intervention and the use of medical technologies and its practices serve to validate this approach. Petersen and Lupton write:

We have emphasised the continuing belief in the power of science, in social progress through science, and in the rational control of problems as they are evident in the discourse and strategies of the new public health…" (p177, 1996)

What I have been describing lends some support to this conclusion. The Initiative is underpinned by a belief in the primacy and efficacy of medical science. Medical explanations of, and responses to, heart attack and death are privileged above possible alternatives. Yet, the practices of the Heart of the Shire suggest a more complex account. The Initiative is located in the community, it is about members of the community developing skills and engaging with medical practices and technologies. There is an on-going demystification and remystification of medical science, just as immediate care is being de-medicalised and re-medicalised at the same time. This is another ambivalence played out in the practices of the Heart of the Shire that betrays normativities in tension. Healthy Citizens are an aspect of a complex process of negotiating the identity of medical care in the New Public Health.

Normativities and negativities in tension

Through the training practices, the leaflets and the commentaries of its members, The Heart of the Shire demands and defines a particular type of participation and activity. Participation is necessary at the level of the individual and the community and is a partnership with medical professionals. Participation is active engagement and involves giving money and time and being trained in CPR. In addition, the practices of The Heart of the Shire make death by cardiac arrest in the Over River community avoidable and "medical" intervention through CPR and defibrillation is made preferable to any other response. In these ways The Heart of the Shire is engaged in the production of some "new" normativities.

Furthermore, all the practices that constitute the everyday work that is The Heart of the Shire involve new relations between a diverse array of humans and non-humans. Responsibility for the health of the Over River community is disseminated across these new relations and the array of entities that they associate. The Heart of the Shire is the effect of a particular distribution of skills, information, practices, materials and technologies. This particular distribution, to some extent, transfers knowledge, materials and practices from medical practitioners and clinical locations

to lay practitioners and public locations. In this way, the New Public Health could be seen to meets its promise to demystify and demedicalise immediate care. However, as the previous section of this paper suggested, the practices that constitute The Heart of the Shire also, at the same time, serve to medicalise and to mystify immediate care and in the process to privilege and enchant medical science. Hence, this is another tension in The Heart of the Shire - a tension between distributed expertise and centralised expertise. In practice this tension emerges as incompatibilities in the role of the Healthy Citizen. The empowered, skilled, responsible Healthy Citizen is also aware that medicine does the truly important, difficult and necessary work and that he or she is a mere assistant who follows the orders of medicine.

Within the Initiative diverse versions of how we should live and die are enacted along side one another. For example, there is discussion about the work carried out by trained citizens that is not seen to assist medical intervention. Responders told me, albeit as if ashamed, that "Much of what we do is TLC and support." (First Responder, Ted, 2001) TLC is Tender Loving Care. Many responders told me of that CPR saves lives in very few cases and that the most important thing they do is to hold the patients' hand. Furthermore, a local evaluation of the initiative stated that, "First Responders have also been known to look after the family pet" (p16, Hulley, 2002), but followed this with an exclamation mark to highlight the humour and unimportant status of such an intervention. The normativities that emerge within the Initiative are in tension, ambivalent, contested.

Importantly, the practices of The Heart of the Shire that construct normativities also, and at the same time, construct negativities – norms for how we should not live. Crucially, people should actively participate in the Initiative and emerge as "bad", lazy and stupid if they do not. Hence, while the Initiative is about training and skill development it is, at the same time, about deskilling in some important ways. Holding the hand of someone following their heart attack, looking after their pet while they are taken to hospital, become less important to carrying out CPR. I do not doubt or fail to appreciate the time, energy and skills that all those involved in the Initiative offer. Rather, I want to open a space to query the logic through which, in order to acknowledge their activities, non-participation is categorised negatively and is not a reasonable option. It can only be the result of ignorance, laziness, or perhaps fear or lack of humanity. It can only lead to regret and inadequacy.

The following is an extract from an article published in the free community magazine, it makes disturbing reading:

> Earlier this month a lady stopped me and said "You're the First Responder who came to my husband". She told me how he, an extremely active man of

> 80, collapsed and died at home.
> Although I had arrived quickly I was still too late, and she asked if there was anything she could have done to help him until I had arrived with my defibrillator.
> I could only reply that sometimes the kiss of life and heart massage (CPR) can act as a heart/lung machine and keep the circulation going until a defibrillator can be used to restart the disfunctioning heart.
> She then told me that he'd had a slight heart attack a few months earlier but she'd never got around to attending one of our CPR Public Training Sessions and hadn't know what to do.
> This brought home to me how important it is that we all know what to do when someone has a heart attack" (Maxwell, p19, April 2002)

Many First Responders as well as medical professionals acknowledge that CPR saves a life in very few cases.[29] Considering this particular case, a man of 80 with previous history of a heart attack, one wonders how useful CPR administered by his wife could have been. It seems that the key effect of this article is to promote guilt and to suggest how inadequate it is not to be trained to perform CPR. The horror of this story lies in the possibility that rather than being able to grieve the death of her husband and to celebrate his active and long life this elderly woman may be left with the feeling that had she learned CPR, she could have saved husband. It emerges that, within The Heart of the Shire, to resist being a Healthy Citizen through failure to attend the training in CPR is to be deviant or lacking in some way. Involvement in this precisely defined way is a matter of personal and community responsibility and a measure of commitment to one's community, to one's neighbour and to one's family.

In some ways, in its practice The Heart of the Shire, as Petersen and Lupton (1996) suggest of the New Public Health, is prescriptive about how we should live our lives and conduct our bodies, both individually and collectively. Here we have seen some of the ways in which it is morally, socially, physically and materially prescriptive. Those in The Heart of the Shire community *should* not die of a heart attack, *should* be trained in CPR, *should* participate and *should* become familiar with an array of materials and technologies such as human dummies, automated defibrillators, leaflets, collection boxes, money, boiler suits and car signs. Herein lies the complexity. The initiative provides training, facilitates skill development and offers opportunities and responsibilities. But it also, at the same time, dis-empowers.[30] That is, like the Norwegian disability policies described by Ingunn Moser (2000, 2003), it makes as much, if not more, "lack" and inadequacy as it does skill and competence. Through The Heart of the Shire some people become competent,

confident, skilled Healthy Citizens and some people become abnormal, incompetent, inadequate, deviants lacking in the skills necessary to be a Healthy Citizen. Furthermore, some people embody elements of both – they participate but in diverse ways such as holding the hand of a patient rather than carrying out CPR.

Normativities in process

In this article I have tried to put flesh on the bones of the Healthy Citizen Programme through an analysis of The Heart of the Shire in action. The paper has outlined some of the normativities produced through the plan and through the practices that constitute The Heart of the Shire. The New Public Health plan defined a series of normativities including empowerment of individuals to become Healthy Citizens who are participating and skilled and are active members of their community that is, in turn, working in partnership with government and local professionals. These normativities emerged as in tension. That is, they sit uncomfortably with commitment to centrally defined targets, claims to the authority of medical knowledge and to the necessity of medical intervention. In many ways it seemed that the New Public Health, at least in its plan, was ambitious. It promised not only new normativities but also new kinds of normativities that are flexible, emergent, located and co-exist in tension with more conventional centrally defined versions of how we should and should not live and die. In this paper I have explored what happened to the promise of the New Public Health in its delivery. Put another way, I have in particular been interested in the work of living the potentially productive tensions.

The analysis has suggested that The Heart of the Shire produces unconventional kinds of normativities and negativities. Moreover it demonstrates their production through new practices. Importantly, these new modes of production are highly invasive, mundane, accessible, difficult to delineate and embedded within the community. They are ubiquitous, seeping into the fabric of the community and changing what it means to live and to die in this community while also affording space to negotiate about what it is to live and to die. The focus becomes broader. It is no longer simply about which norms are produced, about what count as norms. It is also about *how* they are produced: what one might think of as *modes* of normativity. My argument is that The Heart of the Shire in practice produces normativities that are fluid, located and precarious. And it does so in new ways: that normativities are effects of located, mundane, accessible and familiar practices.

This implies that the normativities of the New Public Health Plan are better conceptualised as a *process* rather than a *product*. The tensions that characterise the

Plan are productive of a different mode of normativity – one that is modest, emergent, and precarious. They afford us a glimpse of the conditions of possibility of the co-existence and co-emergence of different normativities. The insight is that tensions may be conducive to such co-existence. Helen Verran's wonderful account of how different knowledge practices can live alongside one another in Nigerian classrooms tells of "emergent ontologies" that are made possible through living in vulnerable places of dissonance and tension (Verran, 1999). One way of conceptualising what I have met within the Heart of the Shire is to tell of "emergent normativities" that are made possible through the members of the Initiative living vulnerably and in tension in the Heart of the Shire with its contested knowledges, deference to medicine, community training. Such "on-the-ground work" is responsive to the histories and locations of the disparate knowledge practices and groups and aware of the necessity to build joint futures (p7, Haraway, 2003). In The Heart of the Shire this is an argument for mutual respect of *both* specificity, individual needs and located materiality (the 80 year old man may need to be allowed to die rather than be resuscitated, his wife may need to accept this and to care for him rather than attempt to resuscitate him) *and* of general advice, skills and training, community needs and de-contextualised guidelines. In important ways, The Heart of the Shire is about living with and constructing multiple ways of being, doing and knowing heart attack, healthy citizenship and community living that do not necessarily fit comfortably together.

Donna Haraway (2003) has recently written about companionship and significant otherness. Her problematic is how dogs and people might live together with a mutual respect that means acknowledgement of both the wonders and the dangers of one another. It is about living in the differences and appreciating that moments of communication and connection are often hard earned, are a privilege and, in this way, are precious.[31] In The Heart of the Shire there are partial connections between different ways of living and responding to heart attack. Different normativities co-exist thereby allowing us a glimpse of a new kind of normativities – that are precarious, emergent, situated, modest but also productive. In this way The Heart of the Shire suggests a new ordering of public health practices in which diverse enactments of Being Healthy Citizen co-exist and are *appreciated* for their differences as well as their connections.

Notes

1 The article draws upon participant observation in 2 community CPR training sessions, analysis of publicity leaflets and written commentaries and interviews with participants.

2 Thereby the New Public Health may sometimes experience priorities in tension – one of a series of tensions that, I will argue, characterise the New Public Health in policy and in practice. For example, the empowerment of individuals and communities may not quite fit with the achievement of Government defined and set targets in reduction of death rates in priority areas. "Things that don't quite fit" was the title of a workshop at Lancaster University (April, 2002) organised by John Law and Vicky Singleton. The papers presented considered an array of empirical foci including medical protocols on Alcoholic Liver Disease, innovative teaching methods, guidelines for the management of the legal system and a system for administration of drugs in hospital. All of the papers were concerned with the productive tensions that can arise from the ways in which systems inevitably do not quite fit the locations in which they are practised.

3 This could also be framed as a question about the relationship between the individual and the institution or between the private and the public. And put another way, the White Paper is about the relationship between society and medical science, between expert and lay knowledge. More of this later when I will be drawing upon work from Science and Technology Studies to think about the role of science in the New Public Health.

4 In this way the New Public Health is engaged in distribution of that which was centre. The policy performs healthy nation as an effect of "working together". The healthy nation that is proposed is an effect of the centre, the government, adopting a role as one element among other influences. So, while drawing upon "old" distinctions between the local and the central, the third way is also engaged in distribution activities, in queering the local/central distinction, eroding it in a *new ordering* of the world – the New Public Health. This world is inhabited by entities in partnership, working together, with local entities becoming crucial nodes in the healthy nation and central nodes becoming just one part of the new ordering – new associations, roles and materials - that is the New Public Health.

5 I will, for the moment, suspend discussion of the false dichotomy between plan and action that many science studies scholars have so meticulously exposed and attempted to reconceptualise. This paper hopes to contribute to these discussions.

6 This programme has three principal stands: NHS Direct – a nurse-led helpline and internet service offering information and advice on health; Expert Patients Programme - to help people manage their own chronic illnesses, people take the lead; Health skills – to help themselves and other people undergo training to learn health skills including first aid…It is the latter with which I am concerned in this paper.

7 While this article will not be focusing on the use of the automated defibrillator, this technology is a crucial actor in The Heart of the Shire initiative. Indeed, it will become clear to the reader that the availability of automated defibrillators is a major influence on the development of the initiative.

8 Tessa Jowell (1999) claims that the New Public Health recognises the realities of the present rather than the habits of the past.

9 See "Ten Tips for Better Health" that is advice offered by the Chief Medical Officer, Liam Donaldson, in Saving Lives (pxiv, 1999)

10 One could dispute just how "new" the New Public Health is. Indeed the use of "New" is possibly a rhetorical devise. It is not at all clear that there is a break with the past. Public Health

has always acknowledged the heterogeneity of health as it has, for example, always been concerned with environmental factors as much as with physical. However, it does seem that the New Public Health has encompassed increased heterogeneity as it encompasses almost every aspect of life. There is a wealth of literature concerned with the history of public health. Here I am offering a brief overview of current policy as represented by the Government.

11 Indeed, the New Public Health could be a useful vehicle to consider some of the concerns of contemporary social theory about the relationship between the centre and the periphery, the situatedness of expertise and the multiplicity of the subject.

12 I develop this way of thinking from the actor-network approach (ANT) in Science and Technology Studies. In its early stages the approach was associated with a particular group of writers including John Law (1986), Michel Callon (1986) and Bruno Latour (1987). For later developments in ANT see Law and Hassard (1999). For ANT things are always the effect of a network of relations between an array of heterogeneous entities.

13 In Giddens (1991) terms, it seems that the New Public Health is a product of the Late Modern Age as it sets out goals for itself and its citizens to achieve through a process of self-monitoring. The self is an enterprise, as is public health. One of the critiques of the New Public Health developed by Petersen and Lutpon (1996) is that such a focus on self-care can lead to a narcissistic preoccupation with the self that may be in tension with the empathy of duty and community participation.

14 Coronary Heart Disease and stroke is one of the four priority areas targeted by the New Public Health. Coronary Heart Disease, along with other diseases of the circulatory system, is said to account for 200,000 of the half a million deaths that occur in the UK each year. It is also argued that although death rates from Coronary Heart Disease have fallen since the 1970s England still has one of the worst rates in the European Union. In addition the white paper cites evidence of a widening gap between the best off and the worst off in the United Kingdom.

15 Petersen and Lupton's form of engagement is an attempt at, as well as a plea for other researchers to engage in a more reflexive way of viewing the New Public Health achieved through disruption of its taken-for granted beliefs and approaches. Their book is an extremely insightful theoretical consideration of the New Public Health that also speaks to practitioners. It hopes to lead them to more reflexive practice. I will discuss this later but I am not sure that we nor all the practitioners of the New Public Health need to be more reflexive, certainly not all the time. Indeed, perhaps sometimes we need to be less reflexive. In another arena, Mary Ann Elston (1997) in her consideration of the relationships between Science and Technology Studies and Medical Sociology calls for a reflexive approach from both sides. The former need to be more attentive to the structural aspects of medical care and the latter to medical technologies and skills in practice, and both aware of the assumptions which they bring to their analyses. Again, I might question the value of increased reflexivity and would call upon Haraway (1997, 2003) to help me think productively about this.

16 I want to add that I care about The Heart of the Shire and experience a deep ambivalence about it. As Donna Haraway said of her motivation for choosing research foci: it is, "something I can't say yes or no to but I want to do something about it".(Public Lecture at Lancaster University 12th March 2003)

17 Although I will not be developing the notion of "performance" explicitly in this paper, it is implicit in the analysis. Law and Singleton (2000) offer an account of the turn to performance in Science and Technology Studies.

18 The red rose is often used on the publicity material. It has been a long-standing symbol of the county of "the Shire" as well as a symbol of love and caring. The red rose is also a symbol appropriated by non-communist social democratic political parties such as the Labour party in the United Kingdom.

19 The following account of The Heart of the Shire draws upon interviews with an array of participants in the initiative including trainers, responders, trainees, untrained members of the community, upon leaflets and published updates, and upon participant observation in two CPR training sessions and various local fund raising events.

20 I have changed all names to secure anonymity. This story is collated from fieldwork notes.

21 Although this is strictly the case, the distinction between The Heart of the Shire Appeal and the Shire Ambulance Service is rarely made clear and the initiative is referred to as The Heart of the Shire.

22 Although elsewhere (Singleton, 2005) I will be discussing how this collective responsibility is frequently located within the individual. It is often the individual that is evaluated rather than the community.

23 The abbreviation of CPR, once a term that was used only by medical professionals, now appears to circulate freely in the public domain, in large part as a consequence of The Heart of the Shire initiative. The same could be said of the technology of automated defibrillator – once a frightening and especially medical technology.

24 This is taken from my fieldwork diary, session dated August 2001. The diary recorded different sessions of fieldwork activity and includes both my own accounts of activities and also verbatim quotes when possible.

25 Some of which may be frightening or disturbing as well as unfamiliar, see below.

26 In discussion with a First Responder (Bob) I was told that a responder must have their own car to travel to calls. He said that his wife often accompanied him to a call, she drove the car. Both are retired. He said he liked her to accompany him, in part for the support she provides and also for safety reasons, saying that you never know what you are going to meet. To be a First Responder it helps to have a partner and it is essential to have time and to have a car.

27 So too, The Heart of the Shire itself is another set of newly formed and shifting relations between an array of re-defined entities. For example, the Shire Ambulance Service has become linked in a "professional" capacity to trained members of the community carrying automated defibrillators – a technology that was previously used only by professional medical staff. Further, it is linked to lay members of the community trained to carry out CPR, to community members trained in training others to carry out CPR, and also to cars, to magnetic signs, to dummies, to village halls and to churches. The partnership that is The Heart of the Shire is not only between people but also between various materials.

28 I would argue that being a Healthy Citizen is an effect of shifting sets of relations that change over time and place.

29 Recall the quote from the Secretary of State for Health "In England only two to three people in every 100 survive a cardiac arrest compared to eight to nine in Scotland and 11 in the United States" (p36, 1999). Although this information is used to support the necessity for automated defibrillators and training in first aid such as CPR, it could also demonstrate the futility of such actions given the widespread high mortality rate for sufferers of cardiac arrest.

30 Elsewhere I have discussed some of the implications of a "should" discourse in relation to the UK cervical screening programme and women's participation (Singleton, 1996).

31 I am very grateful to Kath Smart for bringing to life both the wonder and the hard work of human/animal communication and for her additional and equally amazing ability to communicate this to me.

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Part 3: From the Laboratory to Politics and Economics

Bruno Latour*

To Modernize or to Ecologise? That is the Question**

Will political ecology pass away?

This paper explores the destiny of political ecology.[1] It is very much influenced by the French political situation and the continuing marginality of the various Green parties. It relies on three different strands. First a very interesting model to understand political disputes devised by two French sociologists, Luc Boltanski and Laurent Thévenot in a book that is not yet available in English[2] (Boltanski & Thévenot 1991). Second, a case study by the author on the recent creation by law of what could be called "local parliaments of water" (Latour & Le Bourhis 1995).[3] Third, a long term project in philosophy to develop an alternative to the notion of modernity (Latour 1993) and to explore the political roots of the notion of nature. The point of the paper can be stated very simply: political ecology cannot be inserted into the various niches of modernity. On the contrary, it requires to be understood as an alternative to modernization. To do so one has to abandon the false conceit that ecology has anything to do with nature as such. It is understood here as a new way to handle all the objects of human and non-human collective life.[4]

For the last ten years or so, the question has arisen as to whether the ecomovement is in fact a new form of politics or a particular branch of politics. This uncertainty is reflected in the difficulty that the environmental parties have experienced in carving out a niche for themselves. On track for rapid integration into people's everyday concerns, environmentalism could well follow in the footsteps of the nineteenth century hygiene movement – a movement with which, obvious differences

* Translated by Charis Cussins

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notwithstanding, it has a great resemblance [5] – with the defence and protection of the environment becoming a feature of everyday life, rules, regulations and goverment policy, just as as preventive vaccination, the scientific analysis of water quality and health records did. One would no more drop litter in the woods than spit on the floor, but that does not make habits of good manners and civility into an entire political project. Just as there is no "hygienists party" today, there will soon be no green party left. All political parties, all goverments and all citizens will simply *add* this new layer of behaviour and regulations to their everyday concerns. A good indicator of this progressive normalisation of ecologism will be the creation of specialised administrative bodies, like those for Bridges and Highways or Water and Forests, which would be all the more effective since they would be cast in the mould of the well-established de-politicising tradition of public-sector administration (Lascoumes 1994).

The inverse solution consists of making ecology responsible for all of politics and all of the economy, on the basis of the argument that everything is interrelated, that humankind and nature are one and the same thing and that it is now necessary to manage *a single system of nature and of society* in order to avoid a moral, economic and ecological disaster. But this "globalisation" of environmentalism, even if it constitutes the common ground of numerous militant activities and of the public imaginary at large, still doesn't seem to replace the normal domain of political action.

As convinced as its adherents might be, this submersion of all politics and all of society into nature seems unrealistic. It would appear to lack political sense and plausibility, for at least two reasons that are easily understood.[6] In the first place, the nature whole into which politics and human society would supposedly have to merge transcends the horizons of ordinary citizens. For this Whole is not human, as is readily seen in the Gaia hypothesis (Lovelock 1979). Second, the only people who would be capable of defining these connections and revealing the infinitely complex architecture of this totality, would be *specialists* whose knowledge and breadth of view would remove them from the lot of common humanity (Lafaye and Thévenot 1993). In any case, these scientific demigods would not belong to the ordinary rank and file of county councils, administrative boards and local organisations. Accepting that ecology bears on every type of connection would be thus to lose sight of humanity twice: first to the advantage of a unity *superior* to humankind, and second to the advantage of a technocracy of brains that would be *superior* to poor, ordinary humans.

Consequently, on the one hand, ecology integrates itself into everyday life without being able to become the platform for a specific party and, on the other, it becomes inflated to the point of assuming responsibility for the agendas of all the other parties, while handing the pen to men and women who do not belong to the

world of politics and who speak of a global unity which no longer has the political domain as its horizon.

However, practical experience does not confirm either of these two extreme hypotheses.[7] Militant action remains both far more *radical* than one would believe if the hypothesis of ecology becoming a fact of everyday life was correct – nothing to do, in this respect, with hygiene which was always the concern of a few prominent administrators – and far more *partial* than it should be if one were to accept the hypothesis of globalisation. It is always *this* invertebrate, *this* branch of a river, *this* rubbish dump or *this* land-use plan which finds itself the subject of concern, protection, criticism or demonstration.

In practice, therefore, ecological politics is much less integrable than it fears, but a lot more marginal than it would like. To express this paradox of totality in the future and present marginality, there is no shortage of formulae which enable it to get out of the problem: "think globally, act locally," integrated management, new alliance, sustainable development, and so on. According to political ecology, it should not be judged by its modest electoral results.[8] It begins with individual cases, but it will soon, slowly but surely, incorporate them all into a general movement that will end up embracing the whole earth. According to political ecology, the courage to address itself to small causes rightly comes from the certain knowledge that it will soon have to assume responsibility for all the major issues.

If this were indeed the case, we should be witnessing the rise, perhaps hesitant but certainly irreversible, of a political ecology taking up, day after day, the whole task of political life. Yet the scenario of ecology becoming a synonym for politics seem increasingly improbable. This is certainly the case in France where, although the number of environmental parties is increasing, they still do not account for more than five per cent of the votes, and even this total appears to be declining. In spite of the presence of three candidates in the 1995 French presidential elections, green parties could well go out as they came in, like any other passing trend. For a party that must take responsibility for Mother Earth herself, there is more than one problem in this continuing marginalisation. It is a challenge that is making it necessary to rethink the very basis of its aspiration to become global.

In this article, I would like to advance the hypothesis that the rise in power of political ecology is hindered by the definition it gives itself, *as both politics and ecology*! As a result of this self-definition, the practical wisdom acquired after years of militant action is incapable of expression by a principle of classification and ordering – about which I'll say more below – that would be politically effective. As the propheth Jonah said of the Hebrew people, "it can't tell its left from its right". Without this principle of ordering, political ecology makes little impact upon the

electorate and does not manage, using all the arguments that it nevertheless so effectively reveals, to develop lasting and consistent political viability.

Is political ecology an original type of justification?

In their pioneering work, Boltanski and Thévenot have offered us the ideal acid test to see whether or not political ecology can survive as an original form of politics, or if, on the contrary, it can easily be dissolved into very ordinary regimes which have been put in place during the last century or so.

By studying in details how ordinary people engaged in disputes over right and wrong *justify* their action, these authors have been able to identify *six different* regimes of justification (which they call "Cités" in French). The novelty of their approach is to have proven that each of those regimes is complete although utterly contradictory with the others. In other words, it is possible to demonstrate that in contemporary French society, people engaged into disputes, may ascend to six different overarching principles ("principe supérieur commun"), each of them engaging a full-fledged and coherent definition of what humanity should be ("principe de commune humanité"). Each regime is the result of a long history of political philosophy, and has now become an everyday competence activated easily by every member of the society. Each of them defines through trials a scale of right and wrong ("grandeur" et "petitesse"), that allows one to pass judgement and to settle disputes. Each of them, and that is the great strenght of the model, allows to *denounce* the others because they lack morality or virtue.[9]

We do not need to go into the details of this majestuous theory. For the present paper, the great interest of this model is that it allows to test whether or not political ecology offers a *new* principle of justification, or if it can be *reduced* to the six others which have been sedimented through the course of time. Is political ecology old wine in new bottles, or, on the contrary, new wine in old bottles?[10]

At first glance, the answer is clear. There can be no "ecological regime" since it is very easy to show how any of the empirical sites tackled by green politics borrows its principle of justification to one of the six Cities already in place –in fact we will limit ourselves here to the Domestic, Civic, Industrial and Commercial regimes of justification.

The majority of issues considered – in the case of the landscape, water and waste, natural parks etc. – can be related easily to what Boltanski and Thévenot call the "domestic regime", the principle of which is to justify the worth of a human by the quality of his lineage and the solidity of his roots. And it is true that many practical disputes in ecology are always a question of defending a particular

territory, a particular aspect of national heritage, a particular tradition or a territory against the de-sensitised, de-territorialised, stateless, monstrous character of an economic or technical enterprise. Starting from these principles of justification, one can denounce the "industrial regime" and, more recently, the "civic regime" without scruple. This is probably why political ecology appeared so original in the beginning. In short, it gave back value to the "domestic regime" which two centuries of republican and revolutionary spirit had reduced to a mere "domesticity," to the domain of the home. Thanks to ecology the domestic domain became once more what it was before the Revolutionary ethos.

The curious alliance between conservatives, conservationists of heritage and nature conservationists would thus be easily explained. Against the "civic" and "industrial regimes," another justification has been revived after centuries of pitiless denunciation. By attacking a bullet-train line, by protecting a garden, a rare bird's nest or a valley spared by the suburbs, one could finally be simultaneously reactionary and modern. In short, the originality of ecology would only last long enough to partially rehabilitate the quality of the private domain. Nature, it is easy to see, is becoming as "domestic" in the Vallée de Chevreuse as among the Achuars.[11] In this revamped "domestic regime" the state of highness is achieved by ancientness, by durability and by familiarity; the state of smallness, by the anonymity of people without roots nor attachments.[12]

If many burning issues of political ecology can be reduced to the "domestic regime", other issues can be reduced even faster within the "industrial regime" (Barbier 1996). This is the case notably in all the battles over waste, pollution and the like.[13] Here again, the originality of ecology disappears rapidly in favour of equipment and regulations designed to end waste and reduce pollution. After the initial cries of horror at the accounts to be balanced, the costs to be met and the equipment to be installed, it is "business as usual" for ecology in the "industrial regime". Domestic waste is becoming a raw material that is managed like any other raw material by simply extending the production process. Pollution rights are traded on a market in environmental goods which is fast ceasing to be exotic. The health of rivers is now monitored like the health of the workforce. It is not worth treating ecology as a separate concern; it is more a question of using it to explore new and profitable business opportunities. There was a waste problem. We put an end to it. There was a pollution problem. We put an end to it. It is now only a question of controlling, monitoring and managing. That's all there is to it. *Exit* the bearded and hairy ecologists: they've become obsolete.

Are the ecological issues that cannot be reduced to the "domestic" or "industrial" regime, a proof that there is something original in political ecology? No, because they can appear –although it is slightly less straightforward– reducible to a third

regime, the one that Boltanski and Thévenot call the "civic regime" and that is defined by "general will". In this regime, worth is defined by the ability of one agent to disentangle oneself from particular and local interests so as to envision only the General good. In its aspirations to globality, ecology encounters in the definition of the general will an opponent which is all the more formidable since it has the support of almost all mainstream political institutions since the mid XVIIIth century.

Here again, it seems, ecologists do not manage to establish their justifications for long and cannot claim to represent more than one lobby among many. Although some Green party may speak in the name of the common good, it is always the *elected* mayor who signs the land-use plan and not the association that is defending, often for its own petty reasons, some end of a garden, some bird, some snail or other (Barbier 1992); it is the local goverment who closes a polluting factory and not the manufacturer who, in the name of efficiency, is exploiting employees; it is the Water Board who protects resource for everyone and not the angling association which has its own fish to fry. Rehabilitating domestic traditions and extending efficiency to include natural cycles is one thing; directly opposing the general will on such terrain is quite another and an extremely delicate issue.[14]

The new compromise that enables the "civic regime," without modifying itself in any lasting way, to absorb most ecological issues consists in *extending* the electorate deemed to participate in the expression of the general will to include future generations of citizens.[15] Future generations are indeed mute, but no more so than the minors who have just been born, the ancestors who are already dead, the abstainers who are said to "vote with their feet", or the incompetents which have rights through various sorts of stewardships. At the cost of a slight enlargement in the number of electors, the "civic regime" can absorb most of the issues pending. At the cost of a delicate compromise with the "domestic regime", it could even reconstruct this "community of the dead and the living", which would permit it to be of both on the Right and on the Left, thus casting its net wide and thereby diluting the green vote even further.

On the basis of these various reductions, there would therefore be no "ecological regime" since the issues that it raises can all be resolved in the "domestic," "industrial" and "civic regimes". What is left could easily be pigeonned-holed into the "commerce regime", as can be witnessed in the unashamed processing of the numerous "green products," "green labels" and other "natural" products.[16] With this hypothesis one could account for the necessarily ephemeral vogue for ecology.

If we follow this not very charitable reduction, we could say that there is no durable originality in the political philosophy of ecology. To be sure on seeing the irruption in debates of waterways, landscapes, noise, dustbins, the ozone layer and unborn children, it was some time before civil society recognised its ancient

preoccupations.[17] This is why for several years, many have believed in the originality of this new social movement before realising that it did not, underneath it all, pose any real threat. We remain humans, after all, despite taking nature into account. Consequently, as the old regimes regain their importance, the originality of ecology is being gradually eroded and its electoral favour dwindles with each election.

Another reason would make the failure of the environmental parties inevitable. Outside the "civic regime", a party has no chance of situating itself within the classic framework of the Left–Right scenography. Trying to define a super-will is at once accepting the classic framework of political life, but hurtling toward defeat if one can only oppose the habitual spokespersons and electors with mute entities – birds, plants, ecosystems, catchment areas and biotopes – or specialists – scientists, fanatics, experts, activists – speaking in their name but on their own authority. Without a new type of spokespersons, natural entities have no voice or are only represented by a specialist knowledge that is incommensurable with public life.[18] By becoming a party, political ecology was forging ahead. But by rejecting party life, it would run the risk of becoming either a branch of the associated movements for domestic community or else a specific sector of industrial or market production.

Should we abandon the principle of common humanity?

To escape this horrible fate it would seem that there is but one solution, and that is to depart from the model of Boltanski and Thévenot by abandoning its principal axiom, that of common humanity. All the regimes developped by the six types of political philosophy have humanity as their measure. They disagree on how to rank humanity and about the yardstick that allows to order smallness and highness in each of the six "Cités", but they all agree that "humanity is the measure of all things". This is what make these six principle of justification, no matter how contradictory with one another, all completely incompatible with the racist or eugenic or social darwinist reactionary politics developped during the last century. How is it possible to abandon the notion of common humanity, without immediately falling into the danger of "biopolitics"? The standard answer is that ecology is no longer about humans – even extended to include future generations – but about nature, a *higher* unity which would include humans among other components associated with other ecosystems.

We saw above the political incoherence of this solution. How can political life be mixed up with a total unity – nature – which is only known by the science of complex systems? At best, one would arrive at a sort of super-Saint-Simonism, a government of experts, of engineers and of scientists who would abolish the difference

between the "civic regime" and "industrial regime" by the controlled management of natural cycles. At worst, it would lead to an organicism which would abolish the difference between the "domestic regime" and all the other regimes, and which would be prepared to sacrifice "mere humans" to maintain the only truly worthy object: Mother Earth. Perish humanity so long as elephants, lions, snails, ferns and tropical rainforests recover their "equilibrium" of yesteryear: the permanently disequilibriating state of intense natural selection.[19]

It is difficult, one would imagine, to present oneself in front of one's electorate with a programme that envisages the possibility of making them disappear in favour of a "congress of animals" who don't even vote or pay taxes! As for abandoning the framework of elections altogether, one could certainly do that, but it would be in the name of a fundamentalism that would abandon democracy once and for all. And to whose advantage? Leaders directly inspired by nature? Or mad scientists versed in the sciences of complexity? Faced with such an alternative, the reaction of the ordinary citizen is understandable: "I would rather live a shorter life in a democracy than sacrifice my life today – and that of my descendants – to protect a mute nature represented by such people." One can see the difficulty of discovering the "seventh regime," which now resembles those cities, lost in the jungle, that the "raiders of the lost ark" hoped to find.

Either one accepts the principle of common humanity, and then there is no longer the slightest originality in political ecology which reduces, with more or less difficulty, to the three (or six) other regimes. Alternatively, by retaining the originality of political ecology, i.e. its equal concern for non-humans and humans, one departs from the framework of the most elementary morality and the healthiest of democracies. Faced with such intellectual dilemmas, one can understand why the environmental parties have considerable difficulty explaining to themselves, to their members and to their electors the meaning of their fight.

What if ecology did not concern itself with nature?

Perhaps we've taken the wrong route. Perhaps we have misunderstood the model that has guided us thus far. Perhaps we have too slavishly followed what political ecology *says about itself* without paying enough attention to its *practice* which, happily, differs greatly from its explanations of itself. In seems, in fact, that the originality of political ecology is a lot more subtle than we have so far imagined it to be.

Let us reconsider things by measuring the distance that separates practice from self-representation by setting up two constrasting lists: the first states what

political ecology believes it ought to do without really managing to do; and the second sets out the advantages of not following the ideals that it flaunts with so much obstinately.

What ecology believes it ought to do without managing to

Political ecology claims to talk about *nature*, but it actually talks about endless imbroglios which always involve some level of human participation:

– It claims to protect nature and shelter it from humans but, in all the empirical cases that we have read or studied, this actually amounts to greater human involvement and more frequent, increasingly subtle and more intimate interventions using increasingly invasive scientific equipment (Chase 1987; Western and Pearl 1989; Western et al. 1994)

- It claims to protect nature for its own sake – not as a substitute for human egoism – but at every turn the mission it has set itself is undertaken by men and women who see it through, and it is for the welfare, pleasure or conscience of a small number of carefully selected human beings that one manages to justify it.
- It claims to think with systems known by the laws of science, but every time it proposes to include everything in a higher cause, it finds itself drawn into a scientific controversy in which the experts are incapable of coming to agreement.[20]
- It claims to take its scientific models from hierarchies regulated by cybernetic control systems, but it is always displaying surprising heterarchic assemblages whose reaction times and scales always catch off balance those who think they are talking of fragility or of solidity, of the vast size or of the smallness of nature.
- It claims to talk about everything, but only succeeds in shaking up opinion and modifying power relations by attaching itself to particular places, biotopes, situations and events: two whales trapped in the ice, one hundred elephants in the Amboseli National Park (Cussins 2004) or thirty platane trees on the Place du Tertre in Paris.
- It claims to be becoming more powerful and to embody the political life of the future, but it is everywhere reduced to the smallest share of the electoral ejector and jump seats. Even in countries where it is a little more powerful, like Germany, it only brings to bear a secondary force.

One could despair at this severe appraisal. But one can also seize all the advantages that there would be if political ecology were to disabuse itself of its own illusions.

Its practice is worth infinitely more than its utopian ideals of a natural super-regime, managed by scientists for the exclusive benefit of a Mother Earth who could at any moment become a cruel or unnatural mother.

Let's return to the list of its misconstruals, now considering the "defects" of its practice as just so many positive *advantages*. The encrypted message which permits the discovery of the lost city is immediately illuminated by a new meaning.

What ecology (happily) does extremely well

- Political ecology does not and has never attempted to talk about nature. It bears on complicated forms of associations between beings: regulations, equipment, consumers, institutions, habits, calves, cows, pigs and broods that it is completely superfluous to include in an inhuman and ahistorical nature. Nature is not in question in ecology; on the contrary, ecology dissolves boundaries and redistributes agents and thus resembles premodern anthropology much more than it thinks.[21]
- Political ecology does not seek and has never sought to protect nature. On the contrary, it wants to take control in a manner yet more complete, even more extensive, of an even greater diversity of entities and destinies. To the modernism of world domination, it adds modernism squared.[22]
- Political ecology has never claimed to serve nature for its own good, since it is totally incapable of defining the common good of a dehumanised Nature. It does better than protect nature (either for its own sake or for the good of future generations). It *suspends our certainties* with regard to the sovereign good of human and non-human beings, of ends and means.
- Political ecology does not know what an eco-political system is and does not rest on the insights of a complex science whose model and methods would, anyway, if it existed, totally escape the reach of poor thinking and (re)searching humanity. This is its great virtue. It doesn't know what makes and doesn't make up a system. *It doesn't know what is and isn't connected.* The scientific controversies in which it becomes embroiled are precisely what distinguish it from all the other politico-scientific movements of the past. It is the only one that can benefit from another politics of science. Neither cybernetics nor hierarchy make it possible to understand the agents that are out of equilibrium, chaotic, Darwinian, as often as they are global, sometimes rapid, sometimes slow, that it brings into play via a multitude of original experimental devices whose mixed unity precisely does *not* – and this is the point – form an exact and definitive science.

- Political ecology is unable and has never sought to integrate all its very meticulous and particular actions into a complete and hierarchised unity. This ignorance with regard to totality is precisely its saving grace since it can never rank small human beings and vast ozone layers, or small elephants and middle-sized ostriches, into a single hierarchy. The smallest can become the largest. "The stone that was cast aside has become the corner stone."

Political ecology has, fortunately remained marginal until now because it has not yet grasped either its politics or its ecology. It believes it is speaking about nature, the system, a hierarchised totality, a world without human beings, a certain science, and it is precisely these too well-ordered statements that marginalises it, while the hesitant statements of its practice would perhaps permit it finally to attain political maturity if only it could grasp their meaning.

By comparing those two lists, one can see the new solution towards which we can now turn. If we leave aside the over-lucid explanations that ecology gives of itself, and focus solely upon its embroiled practical application, it becomes a completely different movement, a wholly other destiny. *Political ecology makes no mention of Nature*, it does not know the System, it buries itself in controversies, it plunges into socio-technical imbroglios, it takes control of more and more entities with more and more diverse destinies, and it knows less with any certainty what they all have in common.

What is common in the expression "common humanity"?

Before crying "paradox!", an attempt should be made to explore this new avenue. Messages, even decoded, can have a double meaning. Now, if we return to the regimes model, we can see that, at the price of a fundamental but minuscule reinterpretation of the central axiom, the "seventh regime", which had escaped our looking for so long, suddenly emerges like Merlin's castle.

What in fact is "common" humanity? Boltanski and Thévenot were content with the usual reading offered by the canonical commentators of political philosophy they chose to consider. They took for granted the detached human offered to them by the humanist tradition, the human whose ultimate risk would be to be confused with a-human nature.[23] *But non-human is not inhuman*. If ecology has nature as its goal and not humans, it follows that there can be no regime of ecology. But if the aim of ecology is to *open up* the question of humanity, it conversely follows that there is a "seventh regime".[24] The meaning of the adjective "common" in the expression "common humanity" changes totally if the non-humans are not "nature".[25]

The question opened up by the "seventh regime" is to know what would a human be without elephants, plants, lions, cereals, oceans, ozone or plankton? A human alone, much more alone even than Robinson Crusoe on his island. Less than a human. Certainly not a human. The regime of ecology does not at all say that we should shift our allegiance from the human realm to nature. That is why it has taken so long to find it, for that requirement appeared too absurd. The regime of ecology simply says that *we do not know* what makes the common humanity of human beings and that, yes, maybe, without the elephants of the Amboseli, without the meandering waters of the Drôme, without the bears of the Pyrenees, without the doves of the Lot or without the water table of the Beauce they would not be human.

Why don't we know? Because of the *uncertainty concerning the relationship between means and ends*. To define ecology, it might be sufficient, strangely enough, to return to the definition that Kant gives of human morality, a definition that is so well known that people forgot to see that it is in fact wonderfully apposite for non-humans. Let us get back to this most canonical of all definitions:

> Everything in creation which he wishes and over which he has power can be used merely as a means; only man, and, with him, every rational creature, is an end in himself. He is the subject of the moral law which is holy, because of the autonomy of his freedom. Because of the latter, every will, even the private will of each person directed to himself, is restricted to the condition of agreement with the autonomy of the rational being, namely, that it be subjected to no purpose which is not possible by a law which could have its origin in the will of the subject undergoing the action. This condition requires that the subject never be used simply as a means but at the same time as an end in itself. (Kant 1956: 90)[26]

The style is abominable, but the thought is clear. In this definition of morality *only* the first sentence, which presupposes a creation composed of mere means presented to human ingenuity needs to be modified. Let us generalise to all the beings of the Creation the aspiration to the kingdom of ends. What do we find? An exact definition of the practical connections established by ecologists with those they are defending: rivers, animals, biotopes, forests, parks and insects. They do not at all say that we should not use, control, serve, dominate, order, distribute or study them, but that we should, as for humans, *never consider them as simply means but always also as ends*. What doesn't hold together in Kant's definition is the truly incredible idea that simple means could exist and that the principle of autonomy and freedom would be *reserved for man in isolation,* i.e. for the inhuman. On the other hand,

what doesn't hold together in ecology's theories is the improbable belief in the existence of a nature *external to humans* and threatened by the latter's domination and lack of respect.[27]

Everything becomes clear if one applies this admirable Kant's sentence to elephants, biotopes and rivers: "that [they] be subjected to no purpose which is not possible by a law which could have its origin in the will of the subject undergoing the action [let's say, the actor itself]. This condition requires that the subject [the actor] never be used simply as a means but at the same time as an end in itself." It is this conjunction of actors who *can never take each other as simple means* which explains the uncertainty into which we are plunged by the "seventh regime". No entity is merely a mean. There are always also ends. In other words, there are only mediators.

Let's come down from the heights of moral philosophy to listen to what the actors engaged in the defence of, for example, a river have to say. "Before, water went its own way," says an elected representative, "it was part of the furniture, it was part of the environment". This paradoxical statement gives a clear indication of the status of water which, contrary to ecological myth, passes from the outside to the inside of the social world. Whereas it was a simple means, part of the furniture, it now has become the subject of political concern. *To enter the realms of ecology, it must leave the environment*. But the paradox is resolved by ecologists themselves: "We are defending the fulfilment of the river, the river outside any human context, the river-river", says one activist, seeming to justify the outrage of the moralists and seeming to follow to the letter the mythologies of this social movement. But then he immediately adds: "When I say the river outside of its human context, I mean the aggressive human context that treats the river solely as a tool." And here he is applying Kant's slogan to the letter. He is not defending the river for its own sake, but he doesn't want it to be treated simply as a means.[28]

By adopting this perspective, one understands that the ambiguous phrases that seemed to be easily reducible above to the "industrial regime" – because that regime does not take account of nature solely for itself but also for the good of humans – explores in fact a "seventh" type of regime, by applying the (slightly rewritten) Kantian law: As one water-authority engineer explained:

> You have to be extremely humble when dealing with a river. You pay for work which takes you the next thirty years to complete. In work carried out to increase productivity it's necessary to *get rid* of the water, to straighten, clean and calibrate – that was the watchword. We didn't know that rivers took their revenge by regressive erosion that we corrected with pseudo-natural sills. It's a slow process, there are still local agricultural authorities where a river after land consolidation appears as a drainage ditch on the map! Fortunately, there

> is a great deal of pressure from anglers and nature conservationists. There is a clear generation gap; they all talk about the natural environment but, in the same corridor, you can have a bloke who makes everything straight and consolidates land with a vengeance, while another puts back in meanders and "chevelus". [29]

Such an analysis does not confirm either the notion of nature saved for its own sake by sacrificing human interests or that of free human beings dominating nature to promote their own freedom alone. A canalised river is seen as something bad and undesirable within the "seventh regime", not because this futile development will be seen as expensive – taking thirty years to complete and being quickly eroded – but because the river has been treated as merely a mean, instead of *also* being taken as an end. By conspiring with a "law which could have its origin *in the will of the subject undergoing ther action*", according to the Kantian expression, rivers are allowed to meander again, to keep their dishevelled network of rivulets, to have their flood zone.[30] In short, we leave the mediators partially to deploy the finality which is in them.[31]

An alternative to modernisation

This suspension of certainty concerning ends and means defines another scale in the regime of ecology which, this time around, cannot be reduced to the other regimes of political philosophy. There is a scale though, like for all other regimes, and trials that rank very precisely smallness and highness. In the "Green city" what is small is *knowing for sure* that something has or, conversely, has not a connection with another, and knowing it absolutely, irreversibly, as only an expert knows something. Someone has value in the "green city", some one is high when it *leaves open* the question of solidarity between ends and means. Is everything interrelated? Not necessarily. We don't know what is interconnected and woven together. We are feeling our way, experimenting, trying things out. Nobody knows of what an environment is capable.[32]

One of the advantages of this definition of the scaling inside the Green regime is that it removes an obstacle that had slowed everyone down in the march towards the lost city. In spite of its claims, fundamentalist ecology, or "deep ecology", occupies the state of Worthlessness in the "seventh regime". The more certain an ecology is that everything is interrelated, seeing humans simply as a means of achieving Gaia, the ultimate end, the more worthless that ecology. The more strident, militant and assured it is, the more wretched it is. Conversely, the state of highness

peculiar to this "seventh regime" presupposes a deep-rooted uncertainty as to the nature of attachments, their solidity and their distribution, since it only takes account of mediators, each of which must be treated according to its own law.

One can understand how such an outcome has, for a long time, concealed the lost regime under a thick camouflage of foliage. Political ecology can only come to fruition on condition that those who have terrorised it thus far are reduced to their rightful place. Fundamentalist ecology has, for a long time, fulfilled the same role vis-à-vis political ecology as the Communist Party vis-à-vis socialism: a raising of the bidding so well justified that it paralysed its adversary/ally into believing it was too soft, too compromised, too much of a "social-traitor." And yet there is no outbidding, no gradation of virulence in the political courage or radicality of the different movements, since deep ecology simply does *not* have a place in the regime of ecology – just as, conversely, there is no place for the tranquil certainty of the modernists who have, until now, released into external nature objects with no other purpose, no other risk than those they thought they knew all about it.[33]

One might be surprised that, to define the "seventh regime", it is necessary to invoke the practice of the ecological movements and set it in opposition to the theoretical justifications of their followers. Nevertheless, the reason for this shortcoming seems clear to me. To justify the regime of ecology, it is necessary to be able to speak about science and about politics in such a way as to suspend their certainties twice: with regard to subjects, on the one hand, and objects, on the other. All the other regimes clearly belong to the world of political philosophy. They are all anthropocentric. Only the "seventh regime" forces us to speak about science and to plunge human beings into what makes them humans. But since enthusiasts of the sciences are loathe to undertake the task of justification, which would force them to throw out their epistemology, and since the partisans of the political sciences find that they need to know far too much science and need to be too interested in non-humans in order to give an account of these debates which completely escape the usual framework of public life, one cannot find authors who are interested in both.[34] In order to disentangle the "green city", one has to deal at once with science and with politics and to disbelieve epistemology as much as political philosophy. This is why the regime of ecology is still waiting for its Rousseau, its Bossuet, its Augustin or its Hobbes.

In the new regime, everything is complicated and every decision demands caution and prudence. One can never go straight or fast. It is impossible to go on without circumspection and without modesty. We now know, for example, that if it is necessary to take account of everything along the length of a river, we will not succeed with a hierarchised system that might give the impression, on paper, of being a wonderful science with wonderful feedback loops but which will not

generate new political life. To obtain a stirring up of politics, you have to add uncertainty so that the actors, who until now knew what a river could and could not tolerate, begin to entertain sufficient doubts. The word "doubt" is in fact inadequate, since it gives the impression of scepticism, whereas it is more a case of enquiry, research and experimentation. In short, it is a *collective experimentation* on the possible associations between things and people without any of these entities being used, from now on, as a simple means by the others.[35]

Political ecology, as we have now understood it, is not defined by taking account of nature, but by the different career now taken by all objects. A planner for the local agricultural authority, an irrigator, a fisherman or a concessionaire for drinking water used to know the needs of water. They could guarantee its form by assuming its limits and being ignorant of all the ins and outs. The big difference between the present and the previous situation does not lie in the fact that, before, we did not know about rivers and now we are concerned about them, but in the fact that we can no longer delimit the ins and outs of this river as an object. Its career as an object no longer has the same form if each stream, each meander, each source and each copse must serve both as an end and a means for those claiming to manage them.

At the risk of doing a little philosophising, we could say that the ontological forms of the river have changed. There are, literally speaking, no more things. This expression has nothing to do with a sentimentalism of Mother Earth, with the merging of the fisherman, kingfisher and fish. It only designates the uncertain, dishevelled character of the entities taken into account by the smallest river contract or the smallest management plan. Nor does the expression refer to the inevitable complexity of natural milieux and human–environment interactions, for the new relationships are no more complex than the old ones (if they were, no science, management or politics could be done on their behalf, as Florian Charvolin (1993) demonstrated so well). It solely refers to the obligation to be prepared to take account of other participants who may appear unforeseen, or disappear as if by magic, and who all aspire to take part in the "kingdom of ends" by suddenly combining the relationships of the local and global. In order to monitor these quasi-objects, it is therefore necessary to invent new procedures capable of managing these arrivals and departures, these ends and these means – procedures that are completely different from those used in the past to manage things.

In fact, to summarise this argument, it would have to be said that ecology has nothing to do with taking account of nature, its own interests or goals, but that it is rather another way of considering everything. "Ecologising" a question, an object or datum, does not mean putting it back into context and giving it an ecosystem. It means setting it in opposition, term for term, to another activity, pursued for three centuries and which is known, for want of a better term, as "modernisation".

Everywhere we have "modernised" we must now "ecologise". This slogan obviously remains ambiguous and even false, if we think of ecology as a complete system of relationships, as if it were only a matter of taking everything into account. But it becomes profoundly apposite if we use the term ecology by applying to it the principle of selection defined above and by referring it to the Kantian principle for the justification of the green regime.

"Ecologising" means creating the procedures that make it possible to follow a network of *quasi-objects* whose relations of subordination remain uncertain and which thus require a new form of political activity adapted to following them. One understands that this opposition of modernisation and ecologisation goes much further than putting in place a principle of precaution or prudence like that of Hans Jonas. Or rather, in defining the regime of ecology, we manage to select – from among the arguments of the principle of precaution – those which belong to the new political life and those which are part of the old repertoire of prudence. In ecology, it is not simply a matter of being "cautious" to avoid making mistakes. It is necessary to put in place other procedures for politico-scientific research and experimentation.[36]

In contrasting modernisation and "ecologisation" (it will obviously be necessary to find another term, which is less unwieldy and more inspirational and mobilising!), one could perhaps escape the two contrary destinies with which we began. Political ecology can escape banalisation or over-inflation. It doesn't have to take account of everything and especially not nature, and in any case not nature-for-nature's-sake. Nor does it have to limit its designs to the existence of a body of administrators responsible for the environment, just as other bodies are responsible for school health or for monitoring dangerous factories. It is very much a question of considering everything differently, but this "everything" cannot be subsumed under the expression Nature, and this difference does not reduce to the importation of naturalistic knowledge into human quarrels. To be precise, starting from the green regime and according to the Boltanski–Thèvenot method, the interplay of denunciations of the other regimes and the inevitable compromises to be agreed with them, one could perhaps drag political ecology from its present state of stagnation and make it occupy the position that the Left, in a state of implosion, has left open for too long.

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de l'innovation on the novelty of political ecology. It is thus very dependant on the many case studies pursued there on water politics, waste management, history of ecology and political science. I owe a special debt to Charis Cussins and David Western who have shaped most of the arguments here presented (for which of course they are in no way responsible).

Noter

1 This term does not have the same specific meaning in this essay as it does in Anglophone academic debates surrounding the political-economy of environmental use, as in, for example, Bryant (1992) and Peet and Watts (1996). Rather, it serves two purposes here. First, it is used as a general term used to signify the environmental movement as such or the green parties and groups who in various ways have sought to politicise environmental issues. Second, though, its meaning is reconfigured as the chapter proceeds; see note 7 below.

2 The book by Boltanski and Thévenot which Latour uses as his point of departure in this article is now available in English: *On Justification. Economies of Worth*, New Jersey, Princeton University Press 2006..

3 All the quotations by officials and activists on water used in the present article are taken from a study by the Centre de Sociologie de L'innovation on the novelty of political ecology. The new law of 1992 on water requires catchment of sensible rivers to be represented in "Commissions locales de l'eau" (CLE), which are a very original experiment in the French context since they aim in part to make politically visible the river's health and sustainable good .

4 "Non-human" is my technical term to designate objects freed from the obligation to do politics through nature. Nature is here considered as what assembles all entities into one whole. It is thus a political definition that is sometimes *opposed* to human politics or, as is the case here, *merged* with politics. On the genealogy of this bizarre way of doing politics through the notion of a nature cast away from all human politics, see Latour 1997.

5 For a comparison of health and ecology see D. S. Barnes (1994), W. Coleman (1982) and R. J. Evans (1987). The anthropocentrism of the 19th-century health movement clearly distinguishes it from ecology. Nobody championed the cause of miasmas and microbes .

6 Apart from the many reasons specific to France developed in A. Roger and F. Guéry (1991). France is interesting because the idea of a nature untouched by human hands does not have the evocative strenght of what it has in the United States or Germany.

7 Bryan Wynne in England, Charis Cussins in the United States, Camille Limoges and Alberto Cambrosio in Quebec, Rémi Barbier in France, and several others, have begun to collect detailed analyses on the practical work of militant ecologists. It would be interesting to make a systematic comparison which, to my knowledge, has not be attempted. But see Western et al. (1994) for the case of "community based conservation".

8 I have used the term "political ecology" patterned out of the very well know term "political economy" to designate not the science of ecosystems -ecology-, nor the day to day political struggle -Green parties-, but the whole interesection of political philosophy of human and non-humans. In the course of this paper the meaning is going to shift from a concern for nature to a concern for a certain way of handling associations of human and non-humans that would be an alternative to modernization. Hence the rather idiosyncratic sense of the

expression. For two militant but directly opposed classifications, see M. W. Lewis (1992) and C. Merchant (1992).

9 The book offers thus a general "grammar of indignations" that accounts for one of the most puzzling features of contemporary societies: the intensity of moral disputes, the absence of one overarching principle that would include all the others, the ease with which, nonetheless, every member passes judgment as if there existed one such unique principle. The work of Boltanski and Thévenot is the first in sociology to take seriously the work of justification that is a central part of social action. But they do not simply add moral and political considerations to the study of social forces. They have found a very original and productive way to *compare* moral and political actions.

10 I was inspired by similar attempts to use the same model, by Barbier (op.cit), Lafaye & Thévenot (op. cit.) and O. Godard (1990)

11 Philippe Descola (1986 English translation 1993) and all the work carried out by the author since 1986 on the appropriation of the social world, especially his article on the non-domestication of the peccary in Latour and Lemonnier (1994) and Descola and Palsson (1996).

12 It should be remembered that the regimes model makes it posible to classify human beings, from the most lowly to the most elevated, according to a principle that is constant inside each "Cités" but which varies from one regime to the text. "Smallness" and "highness" ("petitesse" and "grandeur") are thus at once both ordered and multiple. Someone "small" in one regime maybe "high" in another. This is the source of most denunciations and what allows the grammar of indignations to be mapped out.

13 In the industrial regime highness is achieved by efficiency, and smallness by waste. Here is a typical comment by a Department of Agriculture representative concerning the treatment of the River Gardon: "The river has been completely destroyed by flood channels, which were cleared with the approval of government departments. This complete destruction serves no purpose in the event of flooding, and destabilises the river – to the point that ground sills have had to be constructed – by causing part of the water table to disappear: this is an absurd system." This high offcial does not pit the river *per se* and its interest, against the human needs for order and efficiency. On the contrary, he takes the new respect for the river's own impetus as one way to gain a *faster*, less expensive and less wasteful leverage on the other agents. The appeal to the river, is here clearly reducible to the ancient industrial order as in this excerpt with another high official –a polytechnician in charge of one of the water bassin: "Engineers only think about the *anthropic* aspect of things; they can't realize that on the long range the respect for Nature will be *beneficial*; it does not cost more to be soft or to be hard, except that the soft approach requires much more work and attention at the beginning before the companies are fully trained." This engineer adds an automat to all the automats that make up the world as in this sentence where he explains why he has been converted to the softer sustanaible development approach: "I have been converted by the aesthetic aspect of things, by the protection of the landscape, then by ecology; in term of long term management, it is better with a river that *self-regulates* itself itself than with a river that is degradating itself all the time".

14 Two opposite points of view are clearly expressed, the first by a staunchly militant ecologist, and the second by an elected – communist – representative and teacher: "Elected representatives protect their electors, we are protecting a population in its environment, in its totality, everyone else is protecting their own interests, their own particular clique, even fishermen protect their fish, *only ecologists are disinterested*." The other replies: "When you create facilities, you automatically make enemies, it's part of being a statesman, it's what politics is all

about. I am not an enemy of the ecologists, but there is a collective interest that must come *before* individual interests."

15 This is the solution explored by Godard (op. cit.). See also the classic work of E. Weiss-Brown (1989). Witness the increase in generality on the part of the mayor of a tiny village in the Côte d'Or region of France who is addressing a local meeting on water. He turns to a Cistercian monk –who is present in the local parliament of water because his monastery has been diverting water from the river since the XIIth century!– to call him to witness: "Be fruitful, and multiply and control the Earth." That's in the Bible! Father Frédéric will not say otherwise, it is essential for our grandchildren to have clean water." (We can note in passing that the theological theme of the Creation is interpreted here in a somewhat contradictory manner since, in giving freedom to his creature, God gave man a level of control that he denies himself to his fellow creatures. We only have to treat nature as our Creator treated us, to completely overturn the supposed link between Christianity and control over nature.)

16 Witness this remark by one of the few French elected representatives who is an ecologist, and who boldly combines a concern for nature with civic concern for the region and concern for the market economy: "Upstream the region Limousin wants the most natural river water and environment possible, *not for itself* but for economic development. The preserved part of the environment is *our* trump card, we cannot make up for thirty years of heavy industry, we must not oppose ecology and economy, we are not yet polluted, we have 700,000 inhabitants, *we can play the quality-of-life card*."

17 How long will it be before the self-interest anthropocentrism behind this phrase will be recognized: "The river Gardon is an umbilical cord, we are all very much attached to it, in the final analysis we have neither the right to pollute it, nor to harness it, so as not to deprive others of an element that they need, we will invitably have to work out a way of sharing"? Or behind this other phrase that gives the river free rein while at the same time draining European Community funds: "On the lower river Doubs farmers wanted to keep the river in check with stone pitching, but the policy was blocked in favor of creating a free meandering section of the river, where farmers change their crops *in order to receive subsidies* under the European Community article 19 on agro-environmental measures"?

18 Scientific knowledge continues to remain, with extremely rare exceptions, a blackbox in the ecomovements, where the social sciences rarely serve as a point of reference for opening controversies between experts. See Latour, Schwartz and Charvolin (1991).

19 For a detailed criticism of the theory of natural balance, see D. B. Botkin (1990). For its history, see J-M. Drouin (1991).

20 For a caricature of an appeal to scientism that is nonetheless unable to eliminate scientific controversies, see Ehrlich and Ehrlich (1997)

21 See P. Descola op. cit. and, for a recent analysis, M. Strathern (1995). See also Western et al. (1994) on "community based conservation" and the recent work of Charis Cussins (op.cit.).

22 A position which is particularly clear in Lewis (1992). See also Latour (1994b) on this constant involvement.

23 This is what Luc Ferry did with great efficacy, successfully killing much of the French intellectuals' interest in ecology (Ferry 1992).

24 As we will see below, deep ecology is no more part of ecology than the cartesian forms of humanism because it does close off the question that was just reopened, by stating unequivocally that "humanity is obviously part of nature".

25 In fact "nature" is merely the uncoded category that modernists oppose to "culture", in the same way that, prior to feminism, "man" was the uncoded category opposed to "woman". By

coding the category of "natural object", anthropological science loses the former nature/culture dichotomy. Here, there is obviously a close link with feminism. See D. Haraway (1991). Nothing more can be done with nature than with the older notion of Man.

26 L. Ferry (1992) rightly wanted to refer to Kant, but chose the wrong critique, opting for the aesthetics of the third rather than the morality of the second.

27 Since the classic work of C. D. Stone (1972) lawyers have gone much further than political philosophers in the invention of partial rights that turn simple means into partial ends, see for example M-A. Hermitte (1996) on the tainted blood scandal which is much more typical of "ecological" issues in France than anything related to "nature".

28 Rivers are a wonderful source of conflict between the "civic" and "green" reegimes. Since large towns and cities are usually situated on their lower reaches, the general will rapidly reaches an agreement to sub-represent the depopulated, rural upper reaches.

29 "Chevelus" is the technical term used in French to describe the network of rivulets that have the shape of dischevelled hair and are visible either in flood zones, in deltas or near the sources.

30 There is no anthropomorphism in the reference to the river taking its revenge, merely the sometimes painful revelation of a being in its own right with its own freedom and its own ends. A surprising remark from a water specialist, trained from his youth in the culture of the water-pipe and who admits: "Nobody imagined that their isolated actions would have *repercussions*, nobody thought we could dry up the river, nobody thought that removing the gravel in one place would lay bare the foundations of the bridge in the village of Crest twenty kilometres away. You have to experience extreme situations before you realize."

31 We must obviously return to the difference between necessity and freedom and invest the sciences with a role that is both more important and more anthropological. See B. Latour (1996).

32 An important advantage of this regime is that it can absorb Darwinsim which, of course, has nothing to do with social-Darwinism, that is only too well acquainted with the distinction between ends and means, as well as understanding all too easily how to create a hierarchy of the strong and the weak, a ranking that is impossible when all forms of teleology are abandoned. See S-J. Gould (1989).

33 Witness this remark by a technician: "My predecessor was very much a "harnesser"... we were technicians, we harnessed water, full stop." He adds, to emphasise the complexity of a regime that now only has mediators and can no longer simplify life by going "straight ahead": "now things have gone too far in the other direction and you can't do anything any more."

34 Ethics and law, on the other hand, are extremely well developed but leave the question of scientific objects intact. Even those who, like Stone (op. cit.), are interested in things, do not include the production of facts and the emergence of objects in their analyses. Only Serres has tried, in his own idiosyncratic way, to make the connection between the scientific status of objects and the legal status of people: M. Serres (English translation1995). Ulrich Beck (op.cit.) is one of the very few thinkers of the ecological crisis to take into account the sociology of science.

35 This is the great interest of the work developped by the German sociologist Ulrich Beck (see for example 1995) because he extends risk very far way from "nature" and makes it a whole theory of what he calls "reflexive modernity" and that I would prefer to call "non modernity".

36 This argument is developed in B. Latour (1994a).

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Michel Callon

Actor-Network Theory

– The Market Test*

Before embarking on an active and positive critique of the Actor-Network Theory (ANT), I will start by highlighting some of the results obtained by the approach, results which I do not believe we should lose sight of in any debate about what might follow ANT.

One of the shortcomings about ANT which is most often mentioned is the inadequacy of the analysis which it offers in respect of the actor. I shall consider this point at greater length in what follows. However, before proposing ways of enhancing this analysis, I wish briefly to recall a number of positive points which, in my view, should be retained. The most important is that ANT is based on no stable theory of the actor; rather it assumes the *radical indeterminacy* of the actor. For example, the actor's size, its psychological make-up, and the motivations behind its actions – none of these are predetermined. In this respect ANT is a break from the more orthodox currents of social science. This hypothesis (which Brown and Lee equate to political ultra-liberalism[1]) has, as is well known, opened the social sciences to non-humans. It has also freed them from the sterile individualism/holism dichotomy and, by using the notion of a spokesperson, has made language an *effect* of distribution and not an inherent property. My friend John Law has had the opportunity of developing this notion of distribution and of revealing its richness (Law, 1994; 1998a and 2002b).

The indeterminacy of the actor naturally entails a number of difficulties. ANT is so tolerant that it ends up presenting an actor which is an anonymous, ill-defined and indiscernible entity. Since everything is action, the ANT actor may, alternatively and indiscriminately, be a power which enrolls and dominates or, by contrast, an agent with no initiative which allows itself to be enrolled. It is certainly this aspect which has produced the most negative effects and led to the frequently

* From John Law and John Hassard (eds.). *Actor Network Theory and After*. © *Sociological Review Monograph*, 1998. Reproduced with the kind permission of *Sociological Review Monograph*.

repeated accusation of relativism. Another way of formulating the critique is to say that ANT's main shortcoming is that it is everything but a theory – which explains why it cannot explain anything!

What I would like to do in this paper is to show how ANT can explain actors' competencies, without however denying its basic hypotheses and, in particular, without calling into question the refusal to give an a priori definition of the actor or the role of non-humans in action.

In order to do this – and in order to put ANT to a test – I will offer an analysis of the economic market. The market is an institution which mixes humans and non-humans and controls their relations. What economic theory describes is, among other things, the circulation of goods and the allocation of resources between human agents. It would be worrying if ANT had nothing to say about the market when it was all along designed specifically to describe and analyse those imbroglios in which humans and non-humans alike are involved. Yet the market is a considerable challenge for ANT because it introduces a strict separation between what circulates (goods which are inert, passive and classified as non-human) and human agents who are active and capable of making complicated decisions (producers, distributors and consumers). Moreover, on the market, whether we are referring to real markets or those of economic theory, the agents involved are characterized by very specific and highly demanding competencies: they are calculating, know and pursue their own interests, and take informed decisions. In short, the market seems to undermine ANT's hypotheses. ANT was developed to analyse situations in which it is difficult to separate humans and non-humans, and in which the actors have variable forms and competencies. Whereas the market is diametrically opposed to this situation; everything is delimited and roles are perferctly defined.

The question is then: is ANT of any use to us for understanding markets? And if so, in what ways will it have to be modified?

The market as a network

What is a market? There are numerous answers to this question but Guesnerie's definition seems well-suited to our argument (Guesnerie, 1996). According to him, a market is a co-ordination device in which: a) the agents pursue their own interests and to this end perform economic calculations which can be seen as an operation of optimization and/or maximization: b) the agents generally have divergent interests, which leads them to engage in c) transactions which resolve the conflict by defining a price. Consequently, to use his words:

> a market opposes buyers and sellers, and the prices which resolve this conflict are the input but also, in a sense, the outcome of the agents' economic calculation

This definition has the merit of emphasizing the essential. That is:

- the decentralization of decision-making;
- the definition of actors as calculating agents;
- conflicts of interest which are resolved in transactions that establish an equivalence measured by prices.

The point that needs to be borne in mind is that the agents enter and leave the exchange like strangers. Once the transaction has been concluded the agents are quits; they extract themselves from anonymity for a moment only, slipping back into it immediately afterwards.

As this definition shows, the market as a method of co-ordination implies the existence of agents capable of calculation. This is confirmed by Williamson in his discussion of the notion of trust (Williamson, 1993).

> Calculativeness is the general condition that I associate with the economic approach and with the progressive extension into the related social sciences.

Let us accept this hypothesis and ask ourselves the following question: Under what conditions is calculativeness possible? Under which conditions do calculative agents emerge?

In order to write and conclude calculated contracts – that is to say, to go into the content of goods and their prices – the agents need to have information on the possible states of the world. More specifically, for calculative agents to be able to take decisions they need at lest to be able to:

1. establish a list of the possible states of the world;
2. rank these states of the world (which gives content and an object to the agent's preferences);
3. identify and describe the actions which allow for the production of each of the possible states of the world.

Thus, if market co-ordination is to succeed, there have to be not only calculative agents but also agents with information on all the possible states of the world, on the nature of the actions which can be undertaken and on the consequences of these different actions, once they have been undertaken.

Market co-ordination encounters problems when uncertainties about the states of the world, on the nature of the actions which can be undertaken, and on the expected consequences of these actions, increase. Problems are at their worst when the uncertainties turn into ignorance pure and simple. Now, such situations are the rule and not the exception. This is even more obvious with the uncertainties generated by technoscience. The general question is thus the following: how are agents able to calculate when no stable information on the future exists? (Eymard-Duvernay, 1996)

In order to maintain the possibility of co-ordination, economists have proposed several solutions which – they assure us – are, or ought to be applied in concrete market situations. The most "orthodox" solution is that of *contingent contracts*. Contingent contracts are revisable contracts; their renegotiation is planned, thus taking into account the occurrence of events specified beforehand. The greater the uncertainties, the more difficult it is to use this approach. It implies that agents spend a considerable amount of their time renegotiating their contracts, that is to say, interacting and exchanging information as it is produced. In this case market co-ordination as such disappears, leaving room for uninterrupted social interaction involving many different agents. These agents, no matter how much they wish to do so, are no longer able to become strangers; they are entangled. I shall return to this notion in a minute.

Another solution is that of a *focal point*. Here it is assumed that agents share common knowledge which guarantees their co-ordination. The nature of this knowledge is highly variable. It may pertain to a shared culture, rules, procedures, routines or conventions which guarantee the adjustments and predictability of behaviour. Socio-economics has studied these intermediate realities in detail in order to explain the co-ordination of market action. But it is easy to show that these different solutions suffer from the same limits. Whether we talk about a common culture or of shared rules or conventions, we encounter the same stumbling block: rules, conventions or cultural devices do not govern behaviour completely since they imply irreducible margins of interpretation. Here again, these margins of interpretation can be removed only during interaction, negotiation or discussion.

A third, and opposite, solution to the question of co-ordination is to assume that beneath the contracts and the rules, there is a "primitive" reality without which co-ordination would not be possible. An understanding of this ultimate basis is the purpose of the notion of a social network (Swedberg, 1994) or, more broadly, the notion of embeddedness as initially formulated by Polany (1957) and later refined by Granovetter in two brief but seminal articles (Granovetter, 1973; 1985). If agents can calculate their decisions, it is because they are entangled in a web of

relations and connections; they do not have to open up to the world because they *contain* their world. Agents are actor-worlds (Callon, 1986).

It is useful to recall these two articles for they have been the source of many misinterpretations which prevent us from seeing both the originality and the true limits, of Granovetter's solution. His solution lies in his definition of the notion of a network. Granovetter first does away with the classic opposition between *homo sociologicus* and *homo economicus*. He shows, convincingly, that beyond their often-asserted differences, they have in common the catacteristic of both being individual agents with perfectly stabilized competencies. The thesis of over-socialization and that of under-socialization, share a common hypothesis: that of the existence of a person closed in on himself – *homo clausus*, to use Elias' expression. This hypothesis precludes any solution to the problem of co-ordination in a situation of radical uncertainty.[2] For Granovetter the only possible solution is that provided by the network; not a network connecting entities which are already there, but a network which configures ontologies. The agents, their dimensions, and what they are and do, all depend on the morphology of the relations in which they are involved. For example, a very simple variable such as the length of the network, or the number of connections that an actor has with different networks, determines what the actor is, wants and can do. There is thus in Granovetter's work an emerging theory of the actor-network. We find in it the reversibility of perspectives between actor and network, as well as the variable geometry of identities (for example interests, projects, expectations and preferences).[3]

The consequence of this approach is radical. What needs to be explained is precisely that which we consider as obvious in the usual description of the market; the existence of calculative agents who sign contracts.

The break introduced by Granovetter – albeit one that he does not follow through to the end – lies in this reversal. What needs to be explained is not the fact that, despite the market and against it, person-to-person interaction has to be developed in order to produce shared information. On the contrary, we need rather to explain the possibility of this rare, artifical latecomer composed of agents which are generally individual, calculating humans, foreign to one another and engaged in the negotiation of contracts. The evidence is the flow, the circulation, the connections; the rareness is the framing. Instead of adding connections (contigent contracts, trust, rules, culture) to explain the possibility of the co-ordination and the realism of the calculation, as in the various solutions proposed by economists, we need to start out from the proliferation of relations and ask how far the bracketing of these connections – which below I call "framing" – must go to allow calculation and co-ordination through calculation.

As we shall see, to explain the emergence of calculating agents and of a great divide between agents and goods, we have to fit out and to enrich the over-social networks of Granovetter. This leads me back to some of the achievements of ANT.

Framing and disentanglement

In this section I will show that if calculations are to be performed and completed, the agents and goods involved in these calculations must be *disentangled* and *framed*. In short, a clear and precise boundary must be drawn between the relations which the agents will take into account and which will serve in their calculations, on the one hand, and the multitude of relations which will be ignored by the calculation as such, on the other.

Economic theory has already addressed this question very specifically through the notion of externality which allows the introduction of more general question of disentanglement.

Economists invented the notion of externality to denote all the connections, relations and effects which agents do not take into account in their calculations when entering into a market transaction. If, for example, a chemical plant pollutes the river into which it pumps its toxic products, it produces a *negative externality*. The interests of fishermen, bathers and other users are harmed and in order to continue their activities they will have to make investments for which they will receive no compensation. The factor calculates its decisions without taking into account the effects on the fishermen's activities. The externalities are not necessarily negative, they may also be positive. Take the case of a pharmaceutical company which wants to develop a new molecule. To project itself it files a patent. However, in so doing it divulges information which becomes freely available to competitors and can be used by them to shape their own R&D.

These examples help to explain the following definition of externalities: A, B and C are agents involved in a market transaction or, more generally, in the negotiation of a contract. During the transaction or negotiation of the contract these agents express their preferences or interests and proceed to evaluate the different possible decisions. The decision taken has positive or negative effects, called externalities, on a series of agents X, Y and Z (distinct from A, B and C) who are not involved in this transaction to promote their interests.

The notion of externalities is essential in economic theory because it enables us to underline one of the possible shortcomings of the market, one of the limits of its effectiveness. But it is also very useful for understanding the meaning of the

expression "constructing a market". This is where the joint notions of framing and overflowing fit in.

Granovetter – and on this point he is at one with ANT – reminds us that any entity is caught up in a network of relations, in a flow of intermediaries which circulate, connect, link and reconstitute identities (Callon, 1991). What the notion of externality shows, in the negative, is all the work that has to be done, all the investments that have to be made in order to make relations calculable in the network. This consists of framing the actors and their relations.

Framing is an operation used to define individual agents which are clearly distinct and dissociated from one another. It also allows for the definition of objects, goods and merchandise which are perfectly identifiable and can be separated not only from other goods, but also from the actors involved, for example in their conception, production, circulation or use. It is owing to this framing that the market can exist, that is to say, that distinct agents and distinct goods can be brought into play since all these entities are independent, unrelated and unattached to one another.

What economists say when they study externalities is precisely that this work of cleansing, of disconnection, in short, of framing, is never over and that in reality it is impossible to take it to a conclusion. There are always relations which defy framing. It is for these relations which remain outside the frame that economists reserve the term externalities. The latter denotes everything which the agents do not take into account and which enables them to conclude their calculations. But one needs to go further than that. When, after having identified them, the agents, in keeping with the predictions of Coase's famous theorem, decide to reframe them – in other words to internalize the externalities – other externalities appear. I would suggest the term "overflowing" to denote this impossibility of total framing. Any frame is necessarily subject to overflowing. It is by framing its property rights by means of a public patent that a pharmaceutical firm produces externalities and creates overflowing. It is by purifying the products that it markets that a chemical firm creates the by-products which escape its control.

The impossibility of eliminating all overflowing has, in reality, a profound cause which I shall merely point to in this piece (Callon, 1998). To ensure that a contract is not broken, to delimit the actions that can be undertaken within the framework of this contract, the agents concerned have to mobilize a whole set of elements; these are, to use Leigh Star's expression, boundary-objects (Star & Griesemer, 1989). These objects make possible the framing and stabilization of actions, while simultaneously providing an opening onto other worlds, thus constituting leakage points where overflowing can occur.

Let us take the simplest example, that of a market transaction concerning a motor car. The transaction is possible because a rigorous framing has been performed.

This framing has reduced the market transaction to three distinct components: the buyer, the producer-seller, and the car. The buyer and the seller are identified without any ambiguity, so that property rights can be exchanged. As for the car, it is because it is free from any ties with other objects or human agents, that it can change ownership. Yet even in this extreme and simple case not all ties can be cut. Something passes from the seller to the buyer: the car, which conveys with it the know-how and technology of the producer. All the property rights in the world cannot prevent this overflowing, except by eliminating the transaction itself. If the buyer is a firm, reverse engineering becomes possible. This is a general point which can be expressed as follows: the simple fact of framing the transaction leads to overflowing because it mobilizes or concerns objects or beings endowed with irreducible autonomy. Complete framing is a contradiction in terms.

The framing/overflowing duo suggests a move towards economic anthropology and more specifically towards the entangled objects of Thomas and the careers of objects of Appadurai (1986).

I shall settle for recalling Thomas's thesis, noting that it expands on and enhances Appadurai's: one is not born a commodity, one becomes it. It is also Thomas who gives the best explanation for this reconfiguration in his discussion of the distinction between market transaction and gift. His argument is fairly complex and sometimes even obscure. I think, however, that it is summed up in the following citation (Thomas, 1991):

> Commodities are here understood as objects, persons, or elements of persons which are placed in a context in which they have exchange value and can be alienated. The alienation of a thing is its dissociation from producers, former users, or prior context (p. 39).

The last sentence of this citation is obviously the important one. To construct a market transaction, that is to say to transform something into a commodity, it is necessary to cut the ties between this thing and other objects or human beings one by one. It must be decontextualized, dissociated and detached. For the car to go from the producer-seller to the customer-buyer, it has to be disentangled. It is only if this can be achieved that the calculation can be looped: that the buyer and the seller, once the transaction has been concluded, can be quits. If the thing remains entangled, the one who receives it is never quits and cannot escape from the web of relations. The framing is never over. The debt cannot be settled.

This notion of entanglement is very useful, for it is both theoretical and practical. It enables us to think and to describe the process of commoditisation which, like the process of framing or of disentanglement, implies investments and specific actions

to cut certain ties and internalize others. The advantage is that this analysis applies generally, and enables one to escape from the risk of essentialism. Anthropological studies of money are most informative from this point of view. Money seems to be the epitome of the commodity; it is pure equivalence, pure disentanglement, pure circulation. Yet as Viviana Zelizer showed so convincingly, agents are capable of constantly creating private money which embodies and conveys ties (Zelizer, 1994). This is the case of the grand-mothers who gives her grand-daughter silver coins, or supermarkets which give fidelity vouchers to their customers. To entangle or disentangle are two opposite movements which explain how we move away from or closer to the market regime. Both movements can apply to any entity. No calculation is possible without this framing, a framing which makes it possible to provide a clear list of the entities, states of the world, possible actions and expected outcome of these actions.

Framing and the construction of calculative agents

Very few studies exist in which analyse the work of framing which allows calculation. To my knowledge the best study is that of Marie-France Garcia on the transformation of the table strawberry market in the Sologne region of France (Garcia, 1986). This transformation occurred in the early 1980s and resulted in the constitution of a market with characteristics corresponding to those described in political economy manuals:

- the existence of a perfectly qualified product;
- the existence of a clearly constituted supply and demand;
- the organization of transactions allowing for the establishment of an equilibrium price.

Garcia analysed all the investments required to produce the frames allowing for the construction of this market. First material investments were needed. Un-coordinated transactions between producers and intermediaries engaged in interpersonal relationships were replaced by interactions held in a warehouse built for this purpose. The producers took their product there daily packed in baskets, and exhibited it in batches in the warehouse. Each batch had a corresponding data sheet which was immediately given to the auctioneer. The latter entered the data into his computer and compiled a catalogue which was handed out to the buyers. Producers and shippers then went into the auction room which was designed in such a way that buyers and sellers could not see one another but nevertheless had a clear view of the auctioneer and the electronic board on which prices were displayed. The display of the strawberries in

the hall and the catalogue enabled all parties concerned to have precise knowledge of the supply in terms of both quality and quantity. Moreover, the fact that the different batches were displayed side by side highlighted differences in quality and quantity between producers. The latter could compare their own production with that of their competitors, something which had not been possible formerly when collections were made locally. As Garcia notes "those growers who had been caught up in personal relationships with intermediaries and shippers entered into impersonal relationsips" (Garcia-Parpet, 1996).

All of these different elements and devices contributed to the framing of transactions by allowing for the rejection of networks of relations, and thus by constructing an arena in which each entity was disconnected from the others. This arena created a space of calculability: the technique of degressive bidding, the display of transactions on the electronic board, the relative qualification of batches of strawberries on their data slips, and knowledge of the national market all made the transactions calculable. As this example clearly shows, the crucial point is not that of the intrinsic competencies of the agent but that of the equipment and devices which give his/her actions a shape.

The importance of the introduction of such tools is starting to be well documented. It is unquestionably one of the essential contributions of science studies. The work of Peter Miller has, for example, highlighted the role of accounting tools in the construction of agents capable of calculating (Miller, 1998). What Garcia clearly shows is all the devices – material (the warehouse, the batches displayed side by side), metrological (the metre) and procedural (degressive bidding) – which give these instruments their power and effect.

Garcia's study serves moreover, to specify the respective roles of the instruments of calculation, of material investments and of economic theory in this process of framing and of constructing spaces of calculability. In the construction of the strawberry market, a young counsellor of the Regional Chamber of Agriculture played a central part. The remarkable thing is that his action was largely inspired by his training in economics received at university and his knowledge of neoclassical theory. The project, which he managed to launch through his alliances and skills, can be summed up in a single sentence; the construction of a real market on the pure model of perfect competition proposed in economics handbooks. As Garcia says, it is no coincidence that the economic practices of the strawberry producers of Sologne correspond to those in economic theory. This economic theory served as a frame of reference to create each element of the market (presentation on the market of batches which account for only a small portion of the supply; classification of strawberries in terms of criteria which are independent of the identity of their producers; unity of time and place making the market perfectly transparent;

and, finally, the freedom of wholesalers and producers alike who are not obliged to buy and sell).

This case provides an outstanding example in that it enables us to follow the birth of an organized market. Above all, it is the purest and most perfect example of market organization. The conclusion that can be drawn from it is extremely simple yet fundamental: yes, *homo economicus* does exist, but is not an ahistorical reality. It does not describe the hidden nature of the human being. It is the result of a process of configuration, and the history of the strawberry market shows what this framing consist of. Of course it mobilizes material and metrological investments, but we should not forget the essential contribution of economics in *performing* the economy (Callon, 1998). The study of this contribution constitutes a vast project for the future. ANT and, more generally, science studies, provide an invaluable resource for studying this contribution.

Conclusion

So what does ANT contribute to the understanding of economic markets?

On the whole I find the assessment positive and encouraging. ANT enables one to go further than do traditional socio-economics or analyses in terms of networks proposed by people like Granovetter. Markets are not embedded in networks. In other words, it is not a question of *adding* social, interpersonal, or informal relations in order to understand their functioning. A concrete market is the result of operations of disentanglement, framing, internalization and externalization. To understand a market it is necessary first to agree to take what it does seriously; that is to say, the construction of calculative actors who consider themselves to be quits once the transaction has been concluded. This does not mean that everything has been framed and internalized and that no relations other than market relations exist. I have suggested that complete disentanglement is impossible; framing can function and survive only if there is overflowing, and connections have not been internalized. But it is one thing to see these links and relations as having been voluntary and actively rejected from the framework of market relations, with the precise aim of locally and temporarily purifying market relations; it is quite another to say that the market is possible and functions only because these relations are present and form, in a sense, the substratum of market exchange.

The metaphor of framing and externalization (taking into account only those relations which make it possible to conclude the calculation) is not the same as that of embeddedness and of social construction (taking into account informal relations in order to account for the possibility of a calculation). In one case the configuration

of market relations and of the market is taken seriously, while in the other case all the overflowing that the market cannot prevent is highlightened. In one case we believe in *homo economicus* – although a *homo economicus* that is variable, configured, framed, etc. – and in the other case we denounce him as an abstract invention. ANT which allows entities to define and construct one another, is well suited to observing the construction of *homo economicus*. With its focus on the role of technical devices and scientific skills in the performing of the collective, ANT highlights the importance of the material devices and of natural science but also of the social sciences in general and economics in particular, in performing the economy.

A final remark regarding the actor. As I mentioned earlier, ANT has often been criticised for presenting actors guided by the quest for power and solely interested in spreading networks and their influence. We have probably sinned, although it was a venial sin. What is shown by the study of the market – and hence of the gift – but also by the exploration of other regimes such as that of political representation, is the variety of possible configurations of action and actors (Hennion, 1993). In a network of pure scientific mobilization, the actor resembles that dreadful white male enamoured of power and aligning the world aorund himself. In a market network he is calculating, selfish and impersonal. The good news is that in a network of gifts, s/he gets tangled in links and relations that s/he does not want and from which he cannot disentangle him or herself. Suddenly he is generous and altruistic. In political representation s/he makes words proliferate and renders the world talkative, which is not necessarily unpleasant. This amounts to saying that there are no model actors. The identity of the actor and the action depends precisely on these configurations, and each of them can be understood only if we agree to give humans all the non-humans which extend their action. It is precisely because human action is not only human but also unfolds, is delegated and is formatted in networks with multiple configurations, that the diversity of the action and of the actors is possible.

At the start of this paper I was ready not only to recall Actor-Network Theory, but possibly to change the model and to launch a new range. In concluding it I am more optimistic. In short, it has passed one of the most demanding tests: that of the market. And if it has passed it is because ANT is not a theory. It is this that gives it both its strength and its adaptability. Moreover, we never claimed to create a theory. In ANT the T is too much (*"de trop"*). It is a gift from our colleagues. We have to be wary of this type of consecration especially when it is the work of our best friends. *Timeo danaos et dona ferentes*: I fear our colleagues and their fascination for theory.

Notes

1 See Lee and Brown (1994).
2 Elias (1978).
3 This point is addressed by Burt in a formal manner (Burt, 1993).

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Andrew Barry

Political Invention

Revolution

In his study of the significance of engineering in the French revolution, Ken Alder notes that the relation between engineering and revolution is in one sense unsurprising. For "after all, in the broadest sense, engineering is perhaps the quintessential revolutionary activity". "In principle", he notes, "engineering operates on a simple but radical assumption: that the present is nothing more than the raw material from which to construct the future". The French revolution can itself, according to Alder, be "understood as a vast engineering project".[1]

One of the preoccupations of engineers in late 18th century France was with what Alder calls the "uniformity project". This was not just manifested in the interest of the technocratic elite in the promotion of the standardised metric system of measurement, a system which, as Alder notes elsewhere, was "deliberately crafted" in order to break the political economy of the Old Regime.[2] It was also expressed in the detailed design of technical artefacts and their process of manufacture. Alder himself focuses on one important example, the artillery cannon, and the attempt by engineers to promote novel methods of production involving the design of interchangeable parts. This was a challenge to contemporary artisanal modes of manufacture. The attempt, which long-predated the twentieth century "Fordist" system of production, failed. Technical change was resisted. The French State, which had "initiated the program of interchangeable production at the end of the eighteenth century, repudiated it in the early nineteenth century".[3]

Alder's study is a timely reminder of the critical part that has been played by technology in modern political enterprise. Technology is not merely one subdivision of government, to be studied by specialists in science and technology policy and historians of technology. Rather, government is itself a highly technical matter,

and the recognition of this character of government is a corrective to three contemporary accounts of government and politics. In one account, associated with contemporary political science, government is equated primarily with political institutions and their relations, and the development of public policy and regulation in relation to the law, public services, taxation, and the rights of citizens. Some of the best political science is particularly attentive to the specificity of contemporary forms of political regulation and the emergence of new forms of political organisation. Yet from the perspective of political science, technology barely figures except as a topic for specialists, or is simply treated as an external factor to politics. Government is considered to be the government of persons, of "society", in abstraction from a discussion of technology and science. In this way, clear demarcations are sustained and reproduced between the history of political institutions and the history of science and technology, and between political philosophy and political theory and the philosophy and sociology of science. Science and technology, which have become so central to the conduct of government for both the nation-state and the person, are rendered external to the political process.

In a second account of politics, associated with cultural studies and post-structuralist political theory and the work of writers such as Ernesto Laclau, Chantal Mouffe and Slavoj Žižek, the study of conventional political institutions is displaced from the centre of analysis. Instead, the focus of research is on the constitution of civil society and the dynamics of ideological struggles. In such a perspective, cultural politics and the politics of discourse become the objects of investigation.[4] There are strengths in this form of analysis too, not least in its awareness of the ambivalences and complexities of political identification, and its effort to think the possibility of a politics which is neither grounded in universal norms or essential identities. In such a perspective, politics is not something that should be grounded. On the contrary, a radical democratic politics is one which has to live with the fact that the grounds of politics are not given. Thomas Keenan has summarised this position thus: "We have politics because we have no grounds, no reliable standpoints - in other words, responsibility and rights, the answers and the claims we make as foundations disintegrate, are constitutive of politics". [5]

Yet if political science can too often become narrowly empirical in its focus on formal political institutions and its positivist concern with political decisions and public policy, analyses of political discourse and cultural politics can become lost in the study of ideology at the expense of attention to the conduct and tactics of politics and the specificity of institutions,[6] let alone the complexity of the role of science and technology to contemporary political life. Responding to her critics who have accused her of having no concern with the material realities of political economy, Judith Butler has rightly argued that studies of political discourse and political

identification need not and do not deal with "merely cultural" questions or reduce the study of politics to the study of political discourse. The politics of identity have quite real economic and material dimensions.[7] But it is possible to respond to those who accuse poststructuralist theory for its lack of political and economic realism in another way. For we need to rethink what is meant by politics and government not just in relation to the analysis of radical politics, but even in the study of most conventionally bureaucratic, economic and technocratic of institutions.

A third account of politics and government, which provides one way of doing this, is associated with the work of Michel Foucault and, in particular, his later work on government. One of the key strengths of Foucault's work on government was to challenge the equation of political power with a concrete object: the sovereign, the government or the state.[8] In this way, the notion of government opened a space for thinking about the historical specificity of particular forms of rule, and the ways in which they figured in political discourse. In particular, post-Foucaultian studies drew attention to the historical formation of "the individual", "community" and "society" as subjects and objects of government.[9] Yet, while the notion of government indicated the existence of a neglected field of empirical research and political analysis, there are two weaknesses in post-Foucaultian accounts. First, following Foucault's own work, there has been a lack of interest in the analysis of political conflict, and a tendency to resort, in the absence of any developed account, to the notion of "resistance" to understand such conflicts.[10] Secondly, there has been little attempt, with a few exceptions, to integrate some of insights of Foucaultian approaches to the study of government with the work of the anthropologists, sociologists and historians of science and technology.[11]

In questioning this disciplinary division of labour between the study of science and technology and studies of contemporary politics, this chapter develops three lines of argument. The first is a geographical-political one, which expands on the early work of Michel Callon and Bruno Latour.[12] This is that in thinking about the relation between science, technology and politics one cannot assume an opposition between the universal applicability of scientific knowledge and technical instrumentation, on the one hand, and the local specificities of politics, on the other. On the contrary, scientific and technical practices have come to play a critical part in the development of new spaces of circulation which may be more or less global or local, more or less continuous, and more or less subject to forms of political regulation and contestation. There is nothing necessarily global about science and technology. At the same time, political action may itself take more and less technical forms that may be replicated between different sites. Politics may itself form extended zones, despite the boundedness of the nation state and national political institutions.

The second argument is political and philosophical. It is that in thinking of the relation between politics and science one cannot assume an opposition either between a science which is rational and objective and a politics guided by passion and interest, as the work of many philosophers of science would suggest,[13] or an opposition between a science which is oriented towards instrumental control and a domain of politics oriented towards public debate, as suggested by Habermas and his followers.[14] On the one hand, many political strategies can have anti-political effects, in so far as they can close down the space for political contestation and judgment, effecting a displacement of the political.[15] On the other hand, some scientific arguments can open up the space of the political, raising questions both about matters of fact, and questions concerning the capacity of laboratories, firms and governments to determine such facts.[16] In this context, it is necessary to make a distinction between politics conceived as ways of codifying particular institutional and technical practices, and the political conceived as an indicator of the level of contestation and experiment. In this latter sense, scientific enterprise may be political or anti-political in its implications, irrespective of the extent to which it is autonomous from direct control by organised political interests.

The third argument is about technology, invention and time.[17] In the government of a technological society, technology is reckoned to be central to the invention of new political and cultural institutions. Seen in these terms, a technological society should not be understood as a stage in the evolution of society, nor a particular mode of government, but rather as a particular form of orientation to the political present. Central to this orientation is the equation of invention in general with technical innovation. Here, I argue that just as it is necessary to distinguish between politics conceived of as a set of practices associated with political institutions and the political as an index of contestability, it is also important to distinguish between technical change and invention. In part, this is because technical change can be *anti-inventive* as well as inventive in its effects. In part, it is because the distinction between technical change and invention opens up a space for thinking about forms of political and cultural invention which, although they may have novel technical elements, do not centre around the development of "new technology", or indeed forms of invention which circumvent entirely the "necessary" moment of technological change.

Zones and sites

In terms of theorizing the new forms of circulation, scientific research and technological development are widely understood to disrupt traditional political and

cultural boundaries. Concepts of networks, cyborgs, interactivity and deterritorialisation all seem to speak of a world in which the boundaries of nation-states, persons and firms are dissolved or blurred, a world in which connections are increasingly easy to make.[18] Certainly, in some cases, the boundaries between entities do seem difficult to draw, and may be more difficult to draw than hitherto. However, it is important to recognize that the development of technical artefacts and practices involves the formation, translation and contestation of new blockages and impediments as much as their dissolution.

In general terms, the development of science and technology involves the generation of two kinds of loci or space. In thinking about the spatialities of scientific and technical knowledge, the work of Harry Collins, John Law, Annemarie Mol and Bruno Latour has been particularly important. On the one hand, the production of scientific knowledge is associated with specific localised *sites of calculation*, observation, monitoring, technical practice and experiment.[19] The laboratory and the workshop are particular kinds of environments within which experimentation and monitoring can occur, and within which objects can acquire new realities. But, sites of experiment and technical invention can be established in many places: in the field, in factories, homes, bureaucracies, hospitals, prisons and museum. As Ted O'Leary and Peter Miller have argued in a discussion of innovations in work-shop practice and factory organisation:

> It is here on the shop floor, that new realities are created out of the dreams and schemes of diverse agents and experts based in a multiplicity of locales... Together these disparate devices form a complex of interrelated practices for governing economic life. To adapt a phrase of Hacking's, these various initiatives that take the factory as the locus and object of intervention entitle us to analyze it as a "space for interfering under controllable and isolable conditions with matter and energy". As such, the factory is an intrinsically theoretical and experimental space, one where phenomena are created.[20]

Such sites of experimentation may be more or less difficult to make; they may be temporary, unstable and subject to legal challenge or political contestation. They may be mediated in more or less public view, or in more or less specialised and technical forms. The "phenomena created" may include both non-human artefacts and persons. "The museum visitor", for example, can become an object of *self-experiment* through the formation of localised sites of interactivity and forms of mediation. A city street can become a well-established public site of monitoring and experimentation which served to produce the phenomenon of "air quality".[21]

A second kind of space established by scientific and technological development are what Arjun Appadurai has called technoscapes[22] and I have called technological *zones of circulation*.[23] These are spaces formed when technical devices, practices, artefacts and experimental materials are made more or less comparable or connectable. They therefore link together different sites of scientific and technical practice. Such zones take different forms. The points of access to the zones may be more or less clearly marked, with more or less well defined and functioning gateways. They may be privatised, or open to the access of many. They are variably homogeneous or stable. Attempts to unify Europe have involved, to a remarkable degree, an effort to forge a more or less uniform European technological zone.[24]

Not only do technological zones take different shapes and forms, but there may also be considerable disjunctures between the homogeneity and unity of a zone as it is represented in public discourse and its rigidities, instabilities and blockages in practice. As it is represented, "Europe" is a perfectly smooth and well-connected technological zone in which the movements of capital and labour are unimpeded by irregularities in the technical materials out of which Europe is formed. In practice, Europe's multiple technological zones are full of fractures and discontinuities and overlapping and intersecting strata. In some cases, these technological zones extend well beyond the territorial boundaries of Europe; in other cases they exist only in the minds of a few bureaucrats, politicians and economists in London, Paris and Brussels.

In analyzing the government and politics of these zones and sites it is important to consider two sets of practices. First, practices of demonstration, testing and calibration are critical to the process of augmentation by which technologies move from one scientific or technological site to generate a zone containing many such sites. The kind of extension or augmentation inherent in zones depends therefore on particular, localised forms of work which are often extraordinarily technical. In general, debates concerning these practices of demonstration and testing have not been held in public but have been contained within specialised committees and laboratories. Indeed, since the 19th century, a series of scientific and technical organisations have emerged around the problem of how to govern the formation, extension and development of transnational technological zones. In the European Union today the effort to establish an extended technological zone is manifest in the remarkable preoccupation with networking and harmonisation. In other cases, efforts to translate material artefacts and scientific and technical practices from one site to other sites can become the object of intense public political controversy. In recent years there have been protests against the testing of Genetically Modified crops in specified experimental sites in Britain and elsewhere in Europe. For firms, these sites are expected to be the first points in the

formation of transnational agricultural-technological zones. For protestors, such experimental sites are identified with the incursions of polluting artefacts and (American) multinational capital and become, therefore, sites of contestation.

A second set of practices critical to the politics and government of technology are those concerned with technical and regulatory standards and intellectual property rights. These practices play a key part in the configuration and reconfiguration of technological zones, channeling and restricting the flows of objects and persons along particular routes, forming particular lines of circulation. Claims to intellectual property appear to have particular importance in marking the ends of technological zones or the places where movement is restricted. However, such claims are often much more uncertain, problematic and unstable than they might at first appear. They imply the formation of both a connection and a separation between a subject and an object of such rights. In key areas of contemporary research and development such as information technology and biotechnology neither object nor subject may have a stable identity. Legal and political disputes over intellectual property rights and the subjects and objects of such rights are also conflicts over the configuration and reconfiguration of technological zones and the properties and capacities of the actors that produce them.[25]

If scientific and technical practices are much more localised and contained than is often imagined, then what of politics? Historically, politics has developed its own privileged, localised and highly regulated sites of action such as the party caucus or conference, the executive committee of the local party, the parliament, the photo opportunity and the radio and television studio. The occasions when political action, in the conventional sense of the term, moves outside these sites are rare. In general, these sites have been organised on a national basis and located in the capital. In response, sometimes conditioned by the centralisation of communications and the desire to attract publicity, many oppositional political actions have themselves been sited in the capital, often on the streets surrounding the buildings occupied by the central institutions of government. Thus, political circulation has been contained within a very restricted set of sites.

However, it is a characteristic feature of political conflicts over scientific and technological developments that they are *not* always directed towards the centres of political authority. To be sure, there are many political conflicts over science and technology that do involve the activities of parliaments and government bureaucracies. Most of these, however, are obscured from public view. While they may be crucial in the contemporary configuration of government, the development of technical standards, environmental regulations and intellectual property law are, with a few exceptions, conducted between technical specialists, bureaucrats and industrial lobbyists. [26] In these circumstances the oppositional politics of a

technological society are displaced elsewhere, crystallizing, often unexpectedly, at the many sites of scientific and technical practice: the factory with its automated machinery; the laboratory conducting animal experiments; the construction-site of a road or a dam; the experimental farm; the psychiatric ward; or the polluting chemical plant.[27] In a technological society, students of politics need to focus their attention not just on the formal centres of political authority but on the many sites where political action comes to circulate.

Unlike sites of scientific and technical activity, these sites of political action tend to be temporary. They emerge in restricted circumstances and make use of available energies and opportunities. But despite these conditions, sites of demonstration may also be tied together to form fluid zones of politics. For although each action is necessarily unique, it is common for those engaged in them to try to replicate some of the tactics, practices and techniques used elsewhere, and in earlier periods. Political technique has its own geography, history and memory.[28] Consider, for example, the techniques of the anti-road protestors discussed in the UK that were reproduced on a large number of potential construction sites across the UK and beyond;[29] or the tactics of *Greenpeace* which have been replicated world wide. Just as there are zones of scientific and technical practice, so there may also be more or less discontinuous, temporary, fluid and fragmented zones of oppositional political action. Extra-parliamentatry political protest is undoubtedly less formal and less standardised than conventional forms of scientific and political practice. But it also has its own characteristic tactics, sites, rhetorics and organisational forms that may be replicated in different locations and situations.

The political and the anti-political

In writing about contemporary forms of extra-parliamentary radical politics it would be a mistake to romanticise these politics or to set up an opposition between examples of political "resistance" and the "power" and "instrumental rationality" of bureaucratic and scientific institutions. First, this would not do justice to the productivity of radical forms of extra-parliamentary political actions, and the complexity of their *own* historical formations. Radical political action cannot be opposed, in any obvious way, to scientific truth. The function of action may be to reveal a truth which would otherwise be unrecognised in public. The truths such radical actions demonstrate cannot simply be proved or disproved by scientific means. They are, in a Wittgensteinian sense, simply there to be *shown*.[30] In this context, the stance of radical movements is not necessarily in opposition to scientific expertise, but to take on a political function which expertise has failed to, or cannot, fulfill.

Secondly, it is partly an empirical question whether scientific work opens up or closes down the space of political contestation. The notion that scientific practice is simply a form of instrumental rationality obscures the ways in which experiment may question, and make uncertain, assumptions about the instrumental capacities of technologies, or the effects of material objects on their environments, or the capacities and competencies of laboratories and governments. A crack in a rail track which causes an accident may have many more far-reaching political effects than any number of more overtly "political" actions.[31]

In these circumstances, it is necessary to distinguish between politics and the political. Georgio Agamben's analysis of the *irreducibility* of the political to political interests and ideologies in his book *The Coming Community* is important here.[32] Here, I take politics to be a way of marking and coding a certain cluster of historically specific practices. In this sense, politics refers to a range of forms of action and practice which include organising election campaigns, networking and lobbying, decision management, party organisation and public debating. At various historical moments, trade unions, feminists and environmentalists have all sought to broaden the institutional and discursive space of what we call politics. However, if politics is a way of coding a historically variable cluster of practices, then the *political* can, following Agamben, be understood as a space of dissensus and contestation that is not reducible to politics. Indeed, one of the key functions of established political institutions has always been to place limits on the possibilities for dissensus and restrictions on the sites in which political contestation can occur. What we generally term politics thus always has something of an anti-political impulse. The role of politics, in the first sense, is not generally to produce dissensus and controversy, but to contain and channel it in particular directions. Parliamentary politics can be extraordinarily anti-political in so far as its contours are carefully managed and defined. To say this is not to denounce parliamentary politics or to celebrate a culture of permanent political invention.

If politics, in the first sense, often has an anti-political logic, scientific practice can be politically productive in three ways. First, scientific practice can have political effects because it involves assigning tasks and competencies to the producers and audiences who are given the responsibility of judging or accepting matters of scientific fact. In many cases there is nothing controversial about this, for both the producers and audiences of scientific practice are well contained within specific specialist "communities" or "core sets".[33] Indeed, in so far as this is the case, scientific practice restricts the space of the political. However, in a technological society there is a general expectation that non-experts are also potential audiences and that matters of scientific fact have implications for them. The citizen of a technological

society is increasingly expected not just to accept the authority of experts but to understand science itself.[34]

Secondly, scientific research creates new objects and artefacts, thereby disrupting the discursive boundaries of contemporary politics, and opening up new sites of political contestation. Of particular importance today, for example, is the creation of new genetic objects and new ways of conceptualising human capacities and tendencies in the fields of brain research, genetics and molecular biology. The objects of these areas of research are not in themselves either inherently political or unpolitical. Rather, the question of whether they open up political questions depends on the forms in which they are materialised and the sites within which they circulate. When contained within a laboratory experiment, for example, a particular sample of genetic material may pass a relatively uncontroversial existence, monitored only by a handful of scientists and laboratory assistants and circulating between a small number of laboratories. However, once circulated across other sites, and materialized in other more visible forms, such material can become the centre of political contestation. Witness, for example, the way in which cloning techniques became an object of political controversy once they were applied to something as visible and as "human" as a sheep, whereas they had not been a political problem when vegetable samples were cloned in the laboratory. Political institutions have sometimes sought to close down the space of political controversy by making a clear distinction between sites and forms in which genetic material could pass an uncontroversial existence, and the sites and forms in which its existence would be either legally impossible or tightly regulated. However, given the outbreak of extra-parliamentary action in Europe over the subject of genetic modification, this attempt to restrict the space of political has only been partially successful. Instead of supposing that genetic material has inherently political properties, we could trace the ways in which it is made more or less political as it circulates and is transformed across a range of "scientific" and "political" sites.

Thirdly, scientific practices can become political in so far as they raise questions about the properties and capacities of technical objects and devices. While it is commonly thought that science is a process of discovery, many of the activities of professional scientists and engineers are not innovative in the way that many people would think of as innovative. They are about testing and measuring the properties of technologies, and demonstrating such properties to others, whether for the purposes of connecting them together, or for the purpose of regulation, or in order to market and sell them.[35] In general, the work of testing and demonstrating has anti-political effects. It is intended precisely to contain the potential space of contestation of the properties of new technologies within particular institutional and discursive limits. It is conducted prior to the release of an object or artefact into

general circulation in order to anticipate the effects of the release. However, in some cases the implications of testing and monitoring work are more complex. Indeed, in a few cases, testing and demonstration can have an immediate political effect, raising questions about the safety, security, properties or effectiveness of an artefact, a process or a device or the competence of those who use it. Consider, for example, the implications of taking measurements of pollution outside of a chemical plant, which may or may not fuel a public controversy.[36] Although there is nothing inherently unpolitical or political about a particular chemical composition of the soil, once such an object takes the discursive form of "pollution" it may become political – a site of contestation. Whether this does actually happen, depends a great deal on the spaces within which such objects circulate. Measurements of "pollution" simply recorded by a government or private laboratory are not likely to become political matters. But they can easily become political once they are found in the press release of an environmental organisation or circulated in public documents.[37]

Seen in these terms we should not speak of the *inherent* political properties of scientific objects but the ways in which objects may become more or less political. In general, scientific research is expected to disentangle an object from the complexity of the environment from which it becomes extracted. Pollution as measured by a detector is not the same as the molecules in the air, with all its interactions with people, cars, wind and other chemicals. Scientific practice disentangles an object from its relations, translating the object into a new form. Yet in doing so, it may serve to create new forms of entanglement. Suddenly, through being monitored, chemicals enter into a whole series of new relations with citizens and governments that had never previously existed. In this case, the air ceases to be something we merely breathe in. It becomes an element in an transnational political project with all the unpredictable consequences this implies.

Invention and anti-invention

In what I have called a technological society, the concept of invention is often equated with technical invention. Today, the idea of political revolution is seldom spoken of, except as an historical event. But perhaps more than ever before technology is expected to carry the promise, or the threat, of radical social and political change in the future. Technical change is reckoned to be innovative. By contrast, the social and political realm is thought to be a source of resistance, of inertia. The relation between the two is often represented using the metaphor of potential. Technologies have certain potentials. But in practice all kinds of social, cultural and economic factors prevent this potential being achieved. Skills and human capital

are poorly developed; knowledge about the capacities of technology is not sufficiently disseminated; the public understanding of science is said to be impoverished; or there is political or commercial or corporate resistance to new technologies. For a few fundamentalist defenders of the rationality of "Science", public and academic irrationality is simply opposed to the rationality of scientific and technical method.[38] Society fails to realise the potential of technology, and therefore to realise its own potential.

The contemporary equation of technology with invention and innovation is a sentiment echoed in official statistics. Whereas, in the nineteenth century and before, a measure of population was often taken to be a good indicator of a nation's vitality, today this role is more likely be taken by indicators of technical inventiveness and literacy such as the numbers of patents awarded to national laboratories by different national patent offices, research and development expenditures, or the numbers of graduate scientists and engineers and students with computer literacy skills.[39] Ironically, given the connectedness of scientific and technical activity across institutional and national boundaries, and the difficulties of defining what research and knowledge actually are, the technical problems of obtaining reliable data and making comparisons between different national sets of data on these matters are enormous. Scientific research and technical innovation does not occur only in a *national* context.[40] And technological activities are both localised and dispersed. But in Britain and North America, the activity of measuring invention and inventiveness has itself become a small industry. Governments are anxious to ensure that economies are performing technologically and that measures exist to monitor their performance, in order that it might be improved.

At the same time, technology is reckoned to be central to innovation in government and to the invention of new political forms. For the European Union, standardised technical devices have provided part of the solution to the difficulties of establishing common European institutions. If it is difficult to form European citizens or to support a European public service, there has been remarkable investment in the formation of "European" technical instruments and practices. This project has had a partial success. At the same time, for many political and cultural organisations, interactive technologies and new media are expected to provide the solution to a range of contemporary problems concerning education, economic development, citizenship and democratic empowerment.[41] Interactivity, networking and feedback are considered central to the solution of many of the problems of governing what is variously called a "knowledge-based society" or a "knowledge economy".[42]

But is the development of new technologies synonymous with invention? And can we take indicators of scientific and technical activity (such as dollars spent, patents or papers produced, or citations generated) as indicators of inventiveness,

however imperfect such indicators maybe? Drawing on certain traditions of work on technology that includes Marx, Foucault, and research in the history and anthropology of material culture, one might suggest a different account of invention; one that does not equate technical novelty with inventiveness. Within these traditions, the notion that technology can be understood as something like an isolated artefact is problematic.[43] Technology is viewed not so much as an artefact, but as a series of relations and connections between artefacts, physical and mental skills, desires and interests, concepts and information.[44] Seen in these terms, inventiveness should not be equated with the development of novel artefacts, or indeed with novelty and innovation in general. Rather, inventiveness can be viewed as an index of the degree to which an object or practice is associated with *opening up possibilities*. In this view, scientific and technical objects and practices are inventive precisely in so far as they are aligned with inventive ways of thinking and doing and configuring and reconfiguring relations with other actors. From this perspective, it is possible to identify forms of invention that are not technical, but rather involve the use of a device in more creative ways.[45] In short, just because an object or device is new does not make it an invention. *What is inventive is not the novelty of artefacts and devices in themselves, but the novelty of the arrangements with other objects and activities within which artefacts and instruments are situated, and might be situated in the future.*

Invention should not, therefore be narrowly equated with technical change. Technologies change all the time, but this does not mean that technical change is always inventive. Technical changes can be conservative in their implications, maintaining or rigidifying existing arrangements between persons, activities, devices, and habits of thought; they may restrict and displace the possibility of alternative developments. Seen in these terms, rapid technical change is not necessarily inventive, nor is it necessarily revolutionary in its implications. It may indeed be a way of enforcing or sustaining a kind of socio-technical or socio-cultural stasis. The constant upgrades of computer software and hardware packages are instances of a restrictive strategy, locking users into existing configurations producing enforced obsolescence, reproducing the contours of the existing technological zone in a trivially "new" form. And even apparently quite radical technical changes may be anti-inventive whether in their conception or their execution. More generally, there is no simple relation between the speed of technical change and inventiveness. I want to suggest the contrary hypothesis: that high levels of information production and rapid rates of technical change may occur precisely when there is a sense that inventiveness is lacking or needs to be restricted. The rapidity of the growth of information and technique may, in some circumstances, be anti-inventive. I suggest

the term *defensive innovation* to refer to the way that this kind of anti-invention can be a deliberate element of industrial or cultural strategy.[46]

The same case could be made in relation to the military field and the defence industries during the cold war, in which high rates of technical change were reckoned to be necessary in order to maintain the existing structure of confrontation in place.[47] But defensive innovation is a characteristic feature of many fields of new technology. For firms, patents are acquired in order that others may not acquire them. In thinking about the distinction between invention and the speed of technical change, Paul Rabinow's recent study of the development of biotechnology, *Making PCR*, is instructive. In this study, Rabinow unfavourably compares the bureaucratic and peer review dominated character of academia with the liberal minded freedom he encountered in his fieldwork in the Californian biotechnology industry. Rabinow is alert to the inventiveness of the development of the polymerase chain reaction (PCR): "learning and making and remaking: new variants of the instruments, practices, spaces, discourses. PCR is more than any of its specific uses – it has the distinctive quality of continuing to produce events".[48] At the same time, however, his study points to the anti-inventive logic of the industrial development in which they are engaged: the way that unconstrained development in the field is, in part, a business of laying claims to a territory in order to ensure that others do not get there and make property claims first. "Filing a patent application for an aspect of the work and subsequently publishing would serve as a means of establishing 'prior art' and consequently barring others from obtaining a patent – especially outside the US."[49.] New products are developed in order that alternatives are not given enough breathing space to emerge. Firms invest in pure research not because they need to repay their debt to universities and to scholarship, but – amongst other things – because of a sense of the need to anticipate rival movements that may threaten to destabilise their long-term competitive position. In other words: *rapid technical change may have to occur in the present for invention by others to be anticipated in advance and therefore stifled.*

So speed is not the same as invention. On the contrary, rapid technical change can be one of the best ways of making sure that there is not an *excess* of invention, with all the unpredictable consequences for economic and political life that this might bring. Moving things rapidly may increase a general state of inertia. It may fix objects and relations in place before alternatives have the chance of developing. Frenetic pseudo-innovation may not just create a sense of boredom – everything is novel, but nothing is new – but stifle creativity. Inventiveness may occur when technical change, as it is normally measured, is slow or in places and at times when it is least expected, or most difficult. Gilles Deleuze speaks of the way in which inventiveness may occur in the most difficult and the most "cramped" conditions.[50]

Certainly we should expect that the temporality of invention (conceived of in terms of the creation of possibility) is quite different from the temporality of technical innovation as it is usually conceived.

Conclusions

Since the nineteenth century, politics has generally been conceived of in terms of divisions between Left and Right, and between those who favour public ownership and state intervention and those who seek to restrict the role of public institutions. But whatever the continuing value of this traditional distinction it is possible to make another. This would distinguish between those movements, debates and actions which are politically inventive and those that are not. The notion of political invention points precisely to the way in which political action itself is a technical matter, involving the development of a series of devices and practices (from public demonstrations to parliamentary inquiries) which make it possible for particular issues or matters to be made into political ones.

The idea of political invention suggested here should not be confused with progressiveness, or even with radicalism. There is no doubt that some of the most inventive forms of political action have been performed by radical social movements at specific historical moments. Consider, for example, the political inventiveness of the suffragettes in the early twentieth century, or the work of environmentalists in developing new forms of direct action and new objects of politics in the latter part of the century. But it would be a mistake to imagine that there is a necessary relation between the conduct of radical politics and inventiveness. What is called "radical politics" can equally take very highly codified and conservative forms, for good and bad reasons. Conversely, those central political and commercial institutions which are generally regarded as conservative, bureaucratic or dominated by an economic logic may contain localized sites of political invention. Critical theorists have all too often denounced scientific and technical work as being merely instrumental, and necessarily anti-political. But scientific work can itself be politically inventive, establishing new objects and sites of political activity and creating new forms of relation between experts and non-experts.[51] In these circumstances, an analysis of political invention is an empiricist one. It must attend to the specificity of particular forms of inventive practice, their complex histories, and their dispersion across what are too often regarded as quite distinct and unconnected political territories. We can not assume that we know in advance where political invention is to be found.

Notes

1 Alder 1997, p.15.
2 Alder 1995, p.39.
3 Alder 1997, p.5.
4 See, for example, Laclau and Mouffe 1985, Butler, Laclau and Žižek 2000.
5 Keenan 1997, p.3.
6 Keith 1997, p.279.
7 Butler 1998. Indeed, Butler's own analysis of materialisation suggests a way of rethinking the distinction between the material and the social which has parallels with the work of sociologists of science such as Bruno Latour, Andy Pickering and Donna Haraway, Butler 1993, p.4-10. I am grateful to Mick Halewood for pointing out to me the parallels between the movement in Butler's work in the 1990s towards the study of the "material" and parallel shifts in the sociology of science.
8 Foucault 1977, 1991.
9 See, in particular, Burchell, Gordon and Miller 1991, Rose and Miller 1992 , Barry, Osborne and Rose 1996, Osborne and Rose 1997, Rose 1999.
10 On this point see McNay 1992, Barry, Bell and Rose 1995, O'Malley and Shearing 1997, Ashenden 1999, Rose 1999.
11 Exceptions include the work of Peter Miller and Mike Power on the study of practices of accounting Miller and O'Leary 1994, Power 1994, 1997 and Paul Rabinow's analysis of "biosociality", Rabinow 1996a, 1996b, 1999.
12 Callon and Latour 1981.
13 The idea that there was such an opposition was one of the key points of dispute in the Popper-Kuhn debates of the 1960s and 1970s. In many ways Kuhn's *Structure of Scientific Revolutions* was a very conservative book, with its assumptions about the autonomy of "scientific communities" from politics, reproducing the dominant rhetoric of post-1945 US cold war politics. Yet what was scandalous about his argument to many philosophers was that it raised questions about the distinction between rational justification and irrational commitment.
14 Habermas 1971. For an excellent critical discussion see Ashenden and Owen 1999. See also Callon, Lascoumes and Barthe 2001.
15 On the displacement of the political in political theory see Honig 1993.
16 Barry 2002.
17 Spufford and Uglow 1996.
18 The idea of the networks and cyborgs as disruptive of boundaries was developed, in particular, by Donna Haraway in her well-known "cyborg manifesto" (Haraway 1991). Here I would argue that while Haraway's essay did have a critical importance in the 1980s in marking a break with the essentialism and anti-technological orientation of contemporary socialist and feminist theory, it has to be read in this particular historical and political situation.
19 Collins 1985, Shapin and Schaffer 1985, Latour 1987, Law and Mol 1994.
20 Miller and O'Leary 1994, p.121.
21 Barry 2001.
22 Appadurai 1990.
23 Barry 2001, chapter 8.
24 Barry and Walters 2003.
25 Strathern 1999, chapter 9.

26 See, in particular, the work of Sheila Jasanoff on the role of regulatory agencies and scientific committees in containing both the social and discursive space of political controversy over scientific and technological developments, Jasanoff 1990.
27 Irwin 1996, Berglund 1998, Rose 1999, Beck 1999.
28 On the importance of thinking geographically about politics see, in particular, the work of Steve Pile, Michael Keith and Doreen Massey: Massey 1995, Pile and Keith 1997.
29 Barry 1999, 2001b, chapter 8.
30 Wittgenstein 1969. On Wittgenstein see, in particular, the work of David Owen 1995.
31 Barry 2002.
32 Agamben 1993.
33 "Core sets funnel all of their competing scientists' ambitions and favoured alliances and produce scientifically certified knowledge at the end" Collins 1985, p.142.
34 Irwin and Wynne 1996. Consider, for example, efforts to help the public understand such subjects as obesity, heart disease and global warming.
35 The distinction between innovation, on the one hand, and testing and demonstration, on the other, is certainly not clear cut. Testing and demonstration are an essential part of the process of industrial innovation, for it is only by configuring the relation between a novel technical device and its potential users, that one will be able to decide whether a device works. As Keith Grint and Steve Woolgar have argued "users" themselves have to be made or configured along with the devices that are to be used, Grint and Woolgar 1997, 74.
36 Callon 1998.
37 Barry 2002.
38 Sokal and Bricmont 1998.
39 Sherman 1996, Robson 1996.
40 For an excellent discussion of the issues involved, see Archibugi and Michie 1998.
41 Examples of a vast literature on the value of interactivity and networking for democratic empowerment include Budge 1996. Budge, along with many others, pay scant attention to the specificity of the new media imagining that their use is relatively unproblematic. For an indication of the complexity and difficulties of "virtual democracy" in reality see Tsagarousianou, Tambini and Bryan 1998.
42 Leadbetter 1999.
43 Marx 1973, Foucault 1977, Callon, Law and Rip 1986, Callon 1987, 1998, Deleuze 1988, Law 1991, 1994, Pickering 1995, Mackenzie 1996, Gell 1998, Strathern 1999. Bruno Latour makes the point succinctly: "Up to now we have believed in objects. But there are no objects, except when things go wrong or they die or turn to rust" Latour 1996, p.212.
44 As Donald Mackenzie, Nathan Rosenberg and others have argued, Marx is often wrongly accused of being a crude technological determinist. Better is to note his sense of the entanglement of machinery, human skill and ideology in the labour process. "The production process has ceased to be a labour process in the sense of a process dominated by labour as its governing entity. Labour appears, rather, merely as a conscious organ, scattered among the individual living workers at numerous points of the mechanical system" Marx [1939]1973, p.693.
45 See, for example, Deleuze's comments about "invention" in tennis, Deleuze 1995, p.131-132.
46 For a good example of an anti-inventive cultural strategy see Georgina Born's ethnographic account of musical modernism, Born 1995.
47 Including the structure of the defence industry. For an argument along these lines see the work of Mary Kaldor 1982.

48 Rabinow 1996, p.169. In pointing to the inventiveness of contemporary biotechnology, Rabinow implicitly criticises those sociologists of science who either have no interest in the objects of scientific research or who reduce such objects to their social context. This criticism is an important one. However, his ethnography remains *too* close to its object to attend to the anti-inventive implications of his research which occur elsewhere.

49 ibid., p.25.

50 "Creation takes place in choked passages...a creator who isn't grabbed around the throat by a set of impossibilities is no creator", Deleuze 1995, p.133. I am grateful to Nick Thoburn for this point and for the reference.

51 Stengers 2000, Latour 2004.

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Kristin Asdal

Re-Inventing Politics of the State

Science and the Politics of Contestation

Traditionally, the humanities and social sciences have approached "nature" by criticizing how the natural world is treated as an object or a technical matter in public and political discourse and in management practices. The argument has been that nature is simply not just a thing: Instead, it represents fundamental values that cannot be quantified or expressed in technical terms. In this way, the humanities and social sciences have claimed their own space for analyses of different attitudes to nature and its inherent or symbolic value. This approach has also been used to criticize expertise in the natural sciences, engineering or economics as technocratic and therefore as constraining the space of the political.

More recently an alternative and quite different way of thinking about nature and politics has developed. A combination of laboratory studies, actor-network–studies, and work on governmentality in the tradition of Michel Foucault treats nature in its various forms as a result or effect of technical and scientific practices. No longer the starting point for analysis, nature becomes the endpoint: an effect of various technical and scientific interventions. In this way of thinking science and technology represent new sources of power. They are seen as creative and productive rather than as forms of control and repression. This way of imagining the political is quite unlike that found within the critique of technocracy or critical theory: If new objects, issues and realities are generated in scientific practice, science is no longer a constraint on political action, but it may actually produce politics.[1]

In the last few years, the tradition of laboratory studies has started to turn "outwards" and engage in empirical studies of politics. This article is part of this movement. I present a cluster of selected stories to show how a specific form of governable nature was created in a particular set of scientific and technical practices. Through these stories I show how a new governable entity called fluorine altered established policies in Norway. I also show that this material entity "fluorine" became governable because it was quantified. This quantification helped to create a "political fluorine"

as a crucial object in real political events.[2] Thus, the article is on the significance of numerical technologies in the making of the political.

However, even if quantification is shown to be vital, quantified technoscience realities such as parts per milligram of fluorine, have no intrinsic power. Few cases are better suited to demonstrate this crucial point than cases concerning politics of pollution, or environmental politics. The reason for this is simple. A politics of pollution come into being (or not) in the encounter with other entities, such as the factory or the economy. What this implies is that entities made governable through being quantified, such as fluorine, may still be relatively weak. They do not always create immense political effects. Thus, by demonstrating the relational space through which politics of pollution emerge, I argue for a certain modesty: Numerical technologies may be powerful in shaping new governable objects, but we should not overstate their political effects.

Thus this paper is about politics of nature in its clashes and confrontations with industry, the economy or the factory. However, when analyzing these relations I have not contended myself to discuss the extent to which numerical technologies have political effects. The paper is also about the struggle between the margins and the center, and about the kinds of entities and arguments that make its headway to the state, and those that get ignored. Thus this is a paper on issue-formation as well.

In particular, I show how the coupling of scientific objects and numerical technologies may shape issues not only by increasing their size or easing their transfer to "the center", but also by severing alternative relations that might have led to a radically different outcome or a radically different issue.

To explore this I apply a relational perspective that underlies both actor-network theory and studies of governmentality, which nevertheless has not been sufficiently undertaken in practice.

A story on theory

Political theory attends too much to institutions, and too little to practices. This was Foucault's argument.[3] Through these practices, new realities are created. "We live in a world of programs", writes Colin Gordon with reference to Foucault, and connects this to the way in which the Western world in the last four hundred years has given rise to discourses that produce programs that aim to shape social reality and society. Here, Gordon points to a crucial aspect of studies of governmentality; The arts of government. These are discourses whose object domains are defined simultaneously as a target area for intervention and a functioning totality to be brought into existence.[4]

This problem has generated a substantial literature. What are the technologies of government and what do they imply? The interest in studying the significance of the technologies of statistics for the art of government springs from Foucault's work on governmentality. Inspired by Foucault there has emerged a large body of literature on the importance of numerical technologies, measurements, and quantification, for the making of modern democracies, nation-states, and the economy.

A crucial argument is that spaces such as the economy are not brought into existence by theory alone. For instance, the strategies of national economic management as they appeared in the mid 1900s were made possible not simply by the installation of new sets of concepts for thinking about the economy, but also in the construction of a vast statistical apparatus through which this domain could be inscribed, visualized, calculated and compared.[5] This new national accounting system made it possible to measure and compare the performances of national economies, year by year and country by country. This served as a condition for post-war, growth-driven, economies.[6]

This body of literature is important as it shows that science and technologies are not simply political tools, but also produce new forms of the political. "It is not just that the domain of numbers is politically composed, but also that the domain of politics is made up numerically", writes Nikolas Rose.[7] Numbers are a key condition for present forms of government because they help to produce the very objects available for political intervention. Such numerical technologies not only describe already existing realities, but also help to produce those realities in the first place.

Nikolas Rose and Peter Miller talk about "an intellectual machinery".[8] Thus discourse and concrete world transforming technologies go together. In adding actor-network theory terms such as "action at a distance" and "centers of calculation" this research tradition has highlightened the world-transforming practices of these technologies.[9]

On the other hand, there is a drawback to this approach. The temptation seems to lie in painting "the center" as all- encompassing.[10] But there are limits to the center, so what are these? What are the *in*abilities to govern? What is the significance of contestation? For Foucault, government was a point of contact, where techniques of the self interact with techniques of domination or power.[11] Government is a relationship, and not a matter of acting *on*. Strangely, however, there are few empirical investigations of this, and few studies of contestation and resistance that go beyond a focus on the individual. However, if we are interested in the politics of nature, and (as I am here) with questions of politics of pollution, it is difficult to avoid this issue. To present the fluorine story without touching on the factory is virtually impossible.

Establishing a definite link

In 1950, a telegram was sent from an impatient group of angry farmers in Årdal, a remote rural community in Norway, to the agricultural authorities in Norway's capital, Oslo. An aluminum smelter had been built in the community the previous year. Now the farmers were seeking support for their view that there was a link between the smoke from the plant and the diseases that had quickly begun to appear in their livestock:

> We hereby refer to the current research regarding the question of smoke-damage in Årdal and what was promised to us, namely that the results should have been received by now. […] We feel completely helpless with respect to our many sick animals and the plowing and sowing that should already have taken place. And since it has been two years since this issue of damages was first brought up, we are beginning to incur significant economic costs as well. Unfortunately, this has turned into a test of patience. We send this telegram to the Chief Veterinary Officer to say that our patience has reached its limits.[12]

What was happening here? The telegram from the farmers was an attempt to establish a definite link between their complaints and the village's aluminum plant. When A/S Årdal Verk had been granted its operating concession as a state-owned aluminum smelter a few years earlier, ambitions were high both in terms of the aluminum it would produce and what it represented in political terms: The plant was to be a social – or a socialist – experiment and thus help conquer new land. However, the land was transformed in a more literal way than intended as the smelter also produced an unknown quantity of fluorine. And while the aluminum from Årdal was sold on the international market, the fluorine remained in Årdal. This effect of aluminum production was not discussed in public beforehand, and the villagers had no forewarning.

But was there really a concrete link between the smelter and the sick animals? Was it really the fluorine that caused the farmers' livestock to fall ill? The farmers hoped to prove the link through scientific testing and the test results they were waiting for from the Ministry of Agriculture and the laboratory at the Norwegian School of Veterinary Science in Oslo.

The problem for which the farmers were seeking an official answer was not new. It had begun the year before, shortly after production in Årdal had begun. The problem was described in a letter to the Chief Veterinary Officer from the local veterinary officer in the area. He had been alerted that there was a mysterious illness that had begun to appear among the livestock in Utladalen, the main grazing area

in Årdal. That same day the district veterinarian had travelled to Årdal to examine the illness more closely:

"I first went to Svalheim farm in Utladalen," he writes to the Chief Veterinary officer in Oslo. It was a farm with a herd of 14 cattle. He had no doubt about what the problem was, soon realizing "that we in Upper Årdal were facing a serious case of fluorine poisoning". He described the phenomenon in greater detail:

> In ten herds, cattle, sheep and goats were affected to a greater or lesser degree. The animals seemed lethargic and preferred to remain lying down; they had difficulty getting up and walking. If they were forced to walk, they appeared to be stiff and sore. A few showed visible swelling on their ribs, and many had eye infections with marked tearing. Virtually all the animals in the herd had visible symptoms.

Afterwards he connected this diagnosis to the aluminum plant in the same village: "There is no doubt that what we are facing is chronic fluorosis as a result of the proximity to the new aluminium smelter."

Similar reports came from other sources, including the lawyer representing the farmers. In a letter to the management of Årdal Verk in Oslo the following year, he reported on his experiences and the description he had received from his clients, the farmers in Årdal:

> During my stay in Årdal, I received […] the following description of how the damage manifested itself: The smoke from the smelting ovens was noticeable in all wind directions except an easterly wind. The smoke was most pronounced in relatively calm weather with rain and haze, particularly in the summer when it lay like a blanket over the valley, and grass, plants, and the leaves on the trees, and the animals were coated with a bluish-black sticky substance. At times it was so bad that clothes that were hung out to dry, and sheep and goats, became completely dark colored. Touching the grass or leaves would leave a black film on the fingers, and laundry that was hung out to dry had to be taken down and washed again. An example was given that a goat or sheep that went out on the worst smoke days would become completely bluish-black in the course of one day. […] The creatures refused to eat grass, hay, or leaves that had this coating, and after consuming them would rapidly become sick. The effect was like a poison. It would begin with the animals getting runny eyes. Their legs then became weak, and they developed lumps the size of walnuts on the sides of their legs and experienced difficulty in standing. The effects were most evident in the horses, cows, sheep, goats,

> and hens. All of the farmers were convinced that the damages were caused by eating. After the animals were brought to the mountain pasture, the effects diminished somewhat. However, it was reported that one cow remained lying down without being able to move for 14 days after it was brought up into the mountains.. […] All of the farmers believed that they had demonstrated a high degree of patience.

The attorney's conclusion corresponded to that of the local veterinary officer's: "I cannot draw any other conclusion than that the damages incurred here clearly must be directly ascribed to the smoke from the aluminum smelter", he wrote.

The management at Årdal Verk, however, rejected the assertion that there was any connection between the production at the plant and the sick animals. Their position was clear: "We cannot see that the studies undertaken by our company in response to the received complaints support the assertion that the alleged damages can be attributed to the smoke from the smelting ovens. We therefore consider the damages reported in these complaints to be of no concern to our company."

Thus, neither firsthand descriptions nor clinical diagnoses were sufficient to establish an acknowledged link between Årdal Verk and the sick animals in Årdal. Nor were they strong enough to move the company: A/S Årdal Verk rejected the link. The Ministry of Industry, which owned and supervised the company, also remained unmoved. This was the background for the telegram from the frustrated farmers in Årdal to the Ministry of Agriculture in Oslo, to which I referred above.

Only six months after this telegram was sent, and almost two years after the local veterinary officer had made his diagnosis based on clinical examinations, the first series of quantitative results emerged from laboratory tests at the College of Veterinary Science. The conclusion was that "chemical tests […] show such a high content of fluorine that, with support from the experience and knowledge accrued both here at home and abroad about the damaging effects of fluorine, we must conclude that there is conclusive evidence of fluorine poisoning in the livestock".

This was the conclusion that the local veterinary officer and the Ministry of Agriculture had been waiting for. Now the ministry could take further action. Shortly afterwards, the conclusions were submitted to the Ministry of Industry; now it could be "assumed to be completely clear that this is a case of fluorine poisoning of the livestock as a result of contamination (of grazing land, meadows, livestock feed) by fluorine compounds, and that this is caused by the smoke from Årdal Verk". The Ministry of Agriculture now assumed that the factory would no longer contest the causal relationship between the smoke and the fluorine poisoning – and that the company would be willing to compensate for the damages.

About the same time, the issue was brought before the Norwegian Parliament: "It is evident that the smoke from Årdal Verk causes excessive damage to plants and animals. Can we assume that the Ministry of Industry will make every effort to immediately assess the damages already incurred, and that the company will immediately take steps to mitigate further damages?" it was asked.[13]

The Minister of Industry responded: "I hope that the MP's question did not give the impression that Årdal Verk is reluctant to address the problems reported. But this is a rather complicated problem, a problem that Årdal Verk is obliged to examine thoroughly before taking a position".[14] However, now they had the test results. "But I must emphasize" , the minister added, that the test-results had not been available "until May 24th of this year". Yet, he now admitted that the results suggested that there actually was a relationship between the emissions from the plant and the sick animals. "Damage to vegetation and livestock has been demonstrated", said the minister.[15]

A few days later a letter was sent from A/S Årdal Verk's owners, the Ministry of Industry, to the company's management. In this, the ministry urged the company to take immediate steps to undertake an assessment so that "compensation for the damages to vegetation and livestock in Årdal caused by the factory smoke in Årdal" could be determined.

The making of a governable space

I began the empirical part of this story with the farmers' frustrated telegram to the central authorities in Oslo. I continued with the protracted response from the political authorities. So is this a story of how the local farmers in Årdal lost all power over their own situation and were left at the mercy of a government at a distance? And when things finally happened, when the company and authorities finally acted, should this be read as an example of the hegemonic power of laboratory science, and of the ways in which political questions are depoliticized and reduced to a question of measurements, of quantities, of technique? After all, it was not until the farmers' situation was translated into numbers, when fluorine was quantified in the form of parts per milligram, that the situation that the farmers themselves had experienced from day one was established as a fact.

In line with the analytical perspective introduced earlier, I interpret the events in a rather different way. Instead of being *reduced to* numbers, I see what happened as an example of how laboratory science and technical procedures and equipment *enabled* policy. "Our images of political life are shaped by the realities of our society that numerical technologies appear to disclose".[16] Just like other "inscription

devices" numbers actually constitute the very area they appear to represent. Not only are domains of numbers politically composed, but the domain of politics is made up numerically, Nikolas Rose argues.[17] When it comes to the situation of the farmers in Årdal, this kind of analysis gives immediate meaning. Indeed, the farmers in Årdal had to wait for the results, but when these quantitative results finally emerged they established the situation as abnormal and problematic. The measurements demonstrated a definite link between the plant and the sick livestock in the vicinity. Finally the local farmers and their suffering animals became a real matter of concern to the Minstry of Industry, a political moment which simultaneously can be seen as the start of a new politics of pollution, headed by the state.

So let me follow up this line of reasoning: "Numbers function (…) as powerful 'fidelity techniques,' means for ensuring the allegiance of those who are distant to decisions in a centre," continues Rose.[18] When it comes to the company, this was indeed the case. The Ministry of Industry came to accept the numbers as facts, as did the company – eventually. On the other hand, the factory already *was* part of the center; it was a state-owned company with its headquarters in the capital. When it comes to the farmers in Årdal who were affected by the plant's fluorine emissions, it is just as relevant to restate Rose: The numbers functioned as powerful fidelity techniques – in the form of ensuring the center's liability for damages that were continually produced *locally*. The numbers helped strengthen those in the periphery, or margins, in their efforts to challenge the decisions of the center and what until then had been the hegemonic policy: to establish Norway Industry, Inc.

So why claim that the farmers and their livestock were *reduced* to numbers, to the technical? It seems far more in line with the events to state the contrary, that the numerical technologies made the fluorine-issue bigger and the farmers more powerful – to the extent that they were able to move the factory.

However, this increase in size was not created by the numbers alone. Rather, it was created as the farmers themselves pleaded for the test-results, and then later used the channels available to them to put these to work. Through these channels and arrangements, the quantified units of fluorine created a political space. The numbers helped strengthen those in the margins in their efforts to challenge the center. This occurred because the material that was collected locally – bones, urine samples, bags of straw – were *returned* to the farmers in Årdal in the form of new and relatively undisputed units: parts per milligram of fluorine.

To be made an object for technological or scientific practices is not necessarily a problematic procedure that suppresses. Instead it can be a basis for agency. However, it is crucial that the results come back, that they are returned.[19] Such was the case in the fluorine story. Sanctioned by the Ministry, the material returned from the laboratory at the College of Veterinary Science to the local actors, the

farmers, and the farmers' representatives in Årdal. Here, a year later, in 1952, an arbitration court met in the village's community center. Through this process, various kinds of past and present documentation of fluorine poisoning were drawn together to form a single coherent story. Physical damage to the livestock was described and acknowledged. These descriptions were compared with what was known from previous cases of fluorosis both in Norway and internationally.

Again, it was the chemical analyses from the grass, hay, bones and urine that had the last word. As was stated in the court proceedings, "the hay samples contain abnormally large amounts of fluorine compared to hay of normal composition. In extreme cases, the content is about 50 times higher than normal. Even samples from Vetti Gård – about 13 kilometers from the factory – contain 36–38 ppm [parts per milligram] fluorine in the dry substance (compared to a normal value of 3–5 ppm)." With respect to the bone and tooth analysis, the samples from sick animals in Øvre Årdal "showed extremely high fluorine content". And further: "The highest value for bone fluorine in the collected material is thus about 8200 ppm, compared to 162 ppm in available Norwegian comparison samples. In teeth from sick animals (goats in Øvre Årdal), the laboratory has found amounts of fluorine up to 4526 ppm compared to 264 ppm in teeth from healthy animals".

The court was convinced the sickness came from fluorosis in virtually all cases where claims for compensation were made and that the fluorosis was caused by the smoke from the aluminium smelter. As it was argued; "The analyses from the laboratory on the fluorine content in the teeth, bones, etc. of sick animals speak for themselves." Thus, the final verdict stated that the analyses provided good support for the argument that the damage was being caused by fluorine poisoning. The "abnormally high" fluorine content that was found in the bones, teeth, and urine from afflicted animals coupled with the clinical findings presented a picture of "a true fluorosis".

The disinterested and technical language of numbers had political effects – initially in the sense that the farmers were awarded compensation for their economic losses. The fluorine issue in Årdal also became a political event in the sense that the continual measurement of fluorine levels in the animals' bodies and fodder formed a source of unrest in relation to the factory[20] – a source of unrest with lasting effect.

And not only did this unrest produce an agricultural issue and a smoke-damage issue, but it subsequently re-invented state-politics by creating a new governable space. The fluorine issue in Årdal expanded beyond the local court of arbitration as the emissions that had been definitely linked with the smelter were soon to become the cornerstones of a new national and governable space of "smoke-emissions". Here, fluorine, measured in parts per milligram, was to be a crucial, but far from

the only case of the development of a vast apparatus linked to the production of a statistics of pollution.

This, then, is how numerical technologies took part in making a governable space of pollution, a governable space that then lent itself to political intervention: If the emissions could be measured and found to be too "big", then this meant that they could also be made smaller – be reduced – couldn't they? Thus, the new pollution issue could potentially grow in size and significance, to the extent that it could move the factory – the factory which stood there already, as part of another story, one of industrial policy, export income, numerous jobs and the promise of a new and prosperous land.

Limits to the politics of numbers

So far, I have argued that the fluorine issue grew big, and that the farmers' resistance and contestation re-invented political space. But as authors from Foucault's governmentality-tradition have indicated, the politics of resistance are not enunciated or practiced outside power relations.[21] Contestation and resistance do not stand in any fundamental opposition to ruling forms of governance. "Genealogy does not posit any radical heteronomy between those political, technical and ethical strategies that have made up our present and those that have opposed them, but rather an array of conflicting points of engagement and alliance." [22] In other words, we can trace our present back to logics of resistance just as much as to imperatives of control.

This is a version of the relational point I touched upon earlier: it is not a question of acting *on*, but rather a relation. My argument is that as an issue grows big, the logic of contestation is being shaped in certain ways – and not others. While room is made for *some* links and relations, *some* forms of contestation and critique, others are excluded or simply missed out. Not all forms of contestation have an equal role in shaping the issue at stake. Resistance and contestation are also shaped by their encounter with "the center". Moreover, a *lack* of links, of relations, may also shape issues and objects, the state, in certain ways. Thus issues are shaped not only through the knitting of alliances and relations, but also through exclusions, through arguments and relations that are cut off or never allowed to circulate or move beyond their local site in the first place.

Demonstrating these exclusions or processes of marginalization – the critique that does *not* work or have political effects and is cut off from any relation with "the center" – is no simple task: After all, these are traces, arguments, questions, which did *not* take part in forming "the center" or "the present". Tracing such arguments

and contestations is not only a question of available material, but also of methodology. Rather than tracing "the whole story," one must limit oneself to showing mere glimpses, specific bits and pieces, but pieces that might contribute to breaking open our political imagination about how cases, issues, and the political could have been shaped in radically different ways.

In the story I have presented so far, I have placed little emphasis on the animals' situation or the relationship between them and their owners, the farmers in Årdal. Instead, I have focused solely on the farmers' situation, the farmers as producers, as it were. This way of writing the story mirrors the way in which the controversy between Årdal Verk, the ministry, and the farmers took shape. It was shaped within a logic of compensation: Demanding and receiving financial compensation became the logic for resolving the conflict.[23] The farmers were compensated for the fact that farming and the smelter could not co-exist – as long as the factory did not change its practices. The practices of the factory changed little; in the short run, it was the farmers who had to change, to some extent radically. The stream of measurements that continued to emerge from the laboratory at the College of Veterinary Science established a kind of fluorine regime to which the farmers had to adapt – their production, their work and livelihoods – as the test-results varied from one year to the next.

Thus, for a number of years, the numerical technologies became intimately linked solely to the farmers, rather than to "the center" and forms of interventions which aimed at protecting agriculture through governing the *factory*. The practices of industry were contested and had political consequences, but only within limits. For many years it was the farmers' way of life that had to change, whereas the factory continued its production merely unchanged.

A story about care

There are traces of conceptualizing and relating to the fluorine issue in ways other than the logic of compensation. But these were not carried further as a part of institutionalized policy, as politics of the state. There were ways of acting on the course of events other than simply rectifying the farmers' *economic* losses. The point of departure for some reports was that the farmers were not alone, but were rather entwined in close relations with the animals they owned – and cared for.

"Keeping livestock in Øvre Årdal is animal cruelty," writes the local paper *Sogns Avis* in 1954. The article reported what some of the farmers had told them: "We cannot bear to see the animals suffer anymore. We should all be reported for cruelty to animals". Thus, there was protest against the "fluorine regime", the type of

detailed regulations to which the farmers were subjected. These were regulations that meant that the farmers could only slaughter the animals for a documented reason – if they were to receive compensation. The protests were based on the suffering this brought to both animals and people. "Farmers are supposed to raise animals here. That is decided. But, they say, no one who has not seen for themselves can understand how the animals are suffering, and understand how difficult it is to watch the suffering."

The newspaper article commented on how this was a dialogue that took place – only very quietly. "The farmers have not said anything about this in the public. They have not said anything about the suffering the animals have been subjected to. Yes, the animals are still suffering and dying. Yes, they are suffering so much that most farmers can no longer bear to raise animals."

Thus, there were stories about the farmers' relations with their animals, their compassion and caring for them. This was a part of the fluorine issue, but it remained small and mostly took place quietly, in local places. One story told how the animals were cared for after having been taken to the mountain pastures in trucks because they could no longer walk unassisted: "The woman who took care of them said that for a long time she had three cows lying out in the fields. They could not get up and walk, and she carried out food and water for them. They had to have fodder concentrate to stay alive, and when it rained, she had to cover them up. This is a little of what she said, in sober tones. There was no expression in her face, no inflection in her voice, when she said that no one who hadn't seen this could understand how these animals suffered."[24] This means the fluorine issue was not just about "producers", but about caring as well. The farmers were not alone, even though they were largely forced to be "alone" within the logic of compensation they had become part of.

This way of relating to the issue went no further as part of the politics of the center, even though the Society for the Prevention of Cruelty to Animals (*Foreningen for dyrenes beskyttelse*) brought it to the attention of both the police authorities and the Ministry of Agriculture. The issue was, however, brought up in the Norwegian Parliament and received coverage in one of the national newspapers as well. But the problem was rejected by the Ministry of Agriculture: Never had the veterinary authorities or representatives of the Ministry of Agriculture experienced a case where animals were so weak or suffered so much that it could be described as cruelty to animals, it was stated. Neither in this case.

A similar procedure was repeated when a completely different way of linking humans and animals together was brought up: the food connection. Was the food produced by the fluorine-contaminated animals fit for human consumption? When a slaughterhouse in Bergen wanted to test the fluorine content in the

meat from the contaminated animals, this link through food was rejected as well: Doing this kind of testing would be too costly, the College of Veterinary Science argued. Instead of performing tests, the college recommended taking certain precautions. The slaughterhouse was recommended to sell the meat to a sausage-maker who could guarantee that the meat would only be used in the production of smoked sausages. Thus, the problem was resolved by avoiding establishing a link through testing.

My point here is not to argue that such links *should* have been established. Rather I have attempted to point out some cases where possible links were severed and to show that this kind of exclusion helped shape the fluorine issue in certain ways. *Not* establishing links between humans and the animals became a key condition for the making of a new governable space of pollution, a numerically composed space which lent itself to political invention. The definite link, the precise amount of fluorine, the politically effective number, implied that a number of other links were missed and lost. Later on, this was to become an external nature, a nature "alone" as it were, as an entity "out there", cut off from a number of possible relations.

Weak versus strong links

These exclusions were not accidental. They must be seen in the context of the institutional arrangements to which the resistance and contestation were directed. Here, "definite links" was the key phrase. To be politically significant in the terms of closing a case, the resistance and contestation had to establish scientific certainty, as I have already demonstrated. Establishing as a scientific fact the link between the emissions and the sick animals was imperative for the contestation to gain strength. This shows again, when the Ministry of Agriculture had to address the charge of animal cruelty to the police authorities. The charge was rejected by the ministry, who responded that the crux of the issue was coming up with, in their own words; "a definite conclusion".

In this way it was not just the farmers, the "locals", who were forced into a logic of numerical certainty. The same was true for the Ministry of Agriculture, one "center" in its encounter with another, namely the Ministry of Industry. It was in the confrontation with the factory and the politics of industry that the fluorine issue was shaped as an issue of scientifically and numerically demonstrated certainty, as a politics of numbers.

As the issue dragged on, impatience grew and after a few years the Ministry of Agriculture pleaded with the Ministry of Industry for a "permanent solution" for the farmers: Should it or should it not be possible to raise livestock in Årdal? It

was argued that there was little point in waiting for further tests. The result would be nothing more than a detailed report that confirmed the information that the ministry had already received. Such testing should not continue ad infinitum. The definite answer, the uncontested number and conclusion was thus primarily important with respect to the Ministry of Industry. It was in this encounter that the Ministry of Agriculture worked to close the book on the issue.

In a very literal sense, these were forms of resistance and contestation that did not exclusively come about from the "outside" or "below". What I have shown is not only local practices of contestation and resistance in their encounter with "central power" – or a unitary state. Instead, what I have attempted to show is the way in which terms such as "the state" can be relaxed for the benefit of tracing relations and contestations all the way through the center.

The significance of the critique

My approach in analyzing politics of nature has been inspired by a feminist critique that has pointed out that what others, not least the male gaze, have portrayed as dead, passive matter, has been shown to be subjects with tremendous importance and power to act.[25] This is a feminist argument that has been transferred to a number of areas, to discussions of the role of the consumer, the media-user, and to the production of scientific knowledge. The critique enhances the significance of "the user", who becomes an active agent in the making and remaking of goods as well as scientific facts. Demonstrating the significance of "the user" is a crucial part of my own fluorine story. Without the active agency of the farmers the practices of the factory would never have been contested and the test-results would never have emerged or had political effects.

At the same time however, I have attempted to show how this type of critique might fall short. We should not contend ourselves with upgrading the importance of the user. The question at stake is not only *who*, or *which* groups or actors that have influence or are allowed to participate, but also how issues and objects are formed – through some relations – at the expense and exclusion of others.[26]

In the turn toward empirical studies of politics and the role of contestation in the making of "the center" – in the making of the state, – this is decisive. Here, the point should not only be to capture the possible exclusion of human actors, but the exclusion of certain relations, of certain forms of life, as well. The fluorine case in Årdal would never have turned into a real political event without the resistance, contestation, and protests from the actors within agriculture. But this encounter did not allow for all forms of contestation and resistance. Only the stream of precise

numbers that exceeded what had been established as normal was, eventually, strong enough to move the factory – somewhat.

Political and anti-political effects of science and technology

The way in which I have formulated the question of "the political", is, as I have already indicated, in opposition to both critical theory and the critique of technocracy that usually emphasizes how science and technology close off for "the political". In this tradition, the focus has predominantly been on the reductionist effects of technologies of numbers as well as science and expertise more generally.

The studies and literature to which I have linked my own story have almost the opposite point of departure. They emphasize the productive, creative and transforming, and even the politicizing effects of scientific objects and technologies. This, however, does not mean that "the political" is conceived as something that springs forth easily – or everywhere. Just as empirical studies of science have shown that producing facts takes work, it takes work to produce "the political".[27] Occasionally, however, new scientific objects may produce a new political space, produce a political event where policy was previously closed and absolute. About twenty years later, sulphur dioxide came to play much of a similar role in the emerging issue of acid rain.[28]

To draw on the work of Andrew Barry, "political fluorine" is a relevant term for describing the Årdal case: The vast amounts of precise numbers had political effects. Their very precision created a new reality that turned into a political event through the way in which this reality was put to work by a number of engaged actors.

But in framing "the political" as that which opens up, critical theory and the very literature I have drawn on for the sake of my own argument, ironically end up being much the same. Must not closing off, establishing an issue as given, be regarded as an essential part of the politics of contestation? This at least, is an issue that becomes relevant if political resistance and contestation are linked and studied in relation to "the center" or the state. For how do resistance and contestation help create a center, or put in another way, how do resistance and contestation help to create a new politics of the state? Only if politics of contestation is able *both* to open up, and then next, also to close a case will resistance have lasting political effects. When turning laboratory studies "outwards" towards empirical studies of politics, this ought to be part of the story as well.

The pollution issue I have explored in this article was intimately linked to the company, the smelter that was in place already. A/S Årdal Verk was established *before* the fluorine issue. This does not imply that problems related to fluorine were

unknown. The same year the decision was made to establish the aluminum smelter in Årdal, a report was released by the Medical Research Council to the "Fluorosis Committee" on fluorosis in connection with aluminum production in Scotland.[29] The report stated that problems associated with this industry were well-known and had existed for a long time: "Fluorosis due to man's industrial activities has been described in both men and animals during the present century." The study referred to tooth damage in sheep as well as changes in bone tissue in factory workers.

The study concluded, "in effect, this means normal dairy farming in a fluorine-contaminated area is not possible as long as the contamination continues ..., successful sheep farming is impossible in an area where there is any considerable contamination with fluorine."

But what does it imply to be "known"? The facts that were established in relation to the smelters in Scotland had no immediate impact at a new and distant site – such as Årdal in Norway. Moreover, as I have already shown, Årdal Verk initially rejected any link between the factory and its surroundings – between emissions and the resulting fluorosis. Even after external pressure was brought to bear on the factory, the factory management continued to keep the issue open: *Was* fluorine contamination really a problem? Shouldn't milk production just be resumed? Thus, part of the problem was that the fluorine issue was so hard to close. It was constantly helped to remain open, challenged and made an object of dispute. If it is laborious to open up a political space, it may be just as laborious to close an issue off, to put an end to debate, for a real political event, a decision, to take place.

The events I explore in this article are all tied to government. They all had, in different respects, effects on the politics of governing. Eventually, they changed the ways in which politics could continue. They changed the political terrain. But for this to happen it was necessary to close political debate. If not, a change would not have come about in this respect, as new politics of the state. In these negotiations, only the precisely numbered proved (sometimes) strong enough.

A governable space of pollution was brought into existence with the help of a statistical apparatus through which this new domain could be inscribed, made real and calculated. This new abstract space took part in re-inventing the state. The fluorine story, like the pollution issue more generally, exemplifies the ways in which our present can be traced back to logics of resistance just as much as to imperatives of control. The logic of contestation, however, was formed in clashes and confrontation with industry, the factory and the state. Not all forms of contestation make their way to the present or to the re-making of the state. While some forms of contestation have taken part in forming our present, others have been excluded, or cut off. These processes take part in shaping the very issue at stake. Rather than

only searching for *the* political, one should also explore which new issues and objects that are being made in these relations and confrontations.

Notes

1 Andrew Barry, *Political Machines. Governing a technological society*. The Athlone Press. London and New York 2001.
2 I here play on his notion "political chemistry".
3 Colin Gordon,"Governmental rationality: An introduction" in Burchell, Gordon and Miller (eds.), *The Foncaul Effect Studies in Governmentality*, Chicago 1991.
4 Colin Gordon, "Afterword", in Gordon (ed.), *Power/Knowledge: Selected Interviews & Other Writings 1972–1977*, New York 1980, p. 245. Michel Foucault: "Governmentality", in Burchell, Gordon and Miller (eds.) 1991, pp 87–104.
5 Nikolas Rose, *Powers of Freedom. Reframing Political Thought*, Cambridge 1999, p. 33. See also Alain Désrosières, *The Politics of Large Numbers. A History of Statistical Reasoning,* Cambridge, Mass. 1998.
6 Einar Lie and Hege Roll-Hansen, *Faktisk Talt. Statistikkens historie i Norge [The history of statistics in Norway]*, Oslo 2001: chapter on the development of the Norwegian national accounting system.
7 Nikolas Rose 1999, p.198.
8 Nikolas Rose and Peter Miller, "Political power beyond the State: Problematics of government", *The British Journal of Sociology* no. 2, vol. 43, 1992, p. 182.
9 Peter Miller, "The Invention of calculating selves and calculable spaces", in Megill (ed.), *Rethinking Objectivity*, Durham 1994.
10 One of the works that portrays this part of Foucault's work as resembling Weber's iron cage is Paul Rabinow's introduction to the book that he himself edited: *The Foucault Reader*, New York 1984. See the section entitled "The problem of government", pp. 14–23.
11 Graham Burchell, "Liberal government and techniques of the self" in Barry, Osborn, Rose, *Foucault and Political Reason*, Routledge, London and New York 1996 [2001], p. 20.
12 This telegram, as well as all the other documents referred to in this paper can be found at *The National Archives of Norway* in the *Archives of the Ministry of Agriculture*, file Air "Pollution – Fluorine 1949–1954".
13 Parliamentary records. June 11, 1951. Question from Member of Parliament Mr. Lunde about smoke damages from Årdal Verk. *Tidende S.*, p. 1598.
14 Parliamentary records. June 11, 1951. Response from Minister of Trade Mr. Brofoss. *Tidende S.*, p.1600.
15 Ibid.
16 Nikolas Rose, 1999, p.198.
17 Ibid.
18 Ibid, p. 212.
19 This is a version of the argument of Charis Cussins in her article, "Ontological Choreography: Agency for Women Patients in an Infertility Clinic" in Marc Berg and Annemarie Mol (eds.) *Differences in medicine*, Duke University Press, Durham and London 1998, p. 153. It must be added that, unlike Cussins, my starting point is not the patient per se, but the

farmers that owned the animals. However, I will come back to the relationship between the farmers and the animals as a crucial part of the argument in the latter part of this article.

20 John Law, "Transitivities" in *Environment and Planning: Society and Space* 2000, volume 18, pp. 133 – 148.

21 Andrew Barry, Vikki Bell and Nikolas Rose, "Introduction", *Economy and Society. Special Issue: Alternative Political Imaginations*. No 4, vol 4. 24 1995.

22 Ibid.

23 For this notion 'logic of compensation', see Ingunn Moser, *Road Traffic Accidents: The Ordering of Subjects, Bodies and Disability.* Oslo: Unipub, 2003.

24 The article was sent as an attachment from the Society for the Protection of Animals to the Chief Veterinary Officer at the Ministry of Agriculture.

25 See Donna Haraway *Primate Visions. Gender, Race and Nature in the World of Modern Science,* Verso, London, New York 1989 and "The Promises of Monsters: A Regenerative Politics for Innapropriate/d Others" in L. Grossberg, C. Nelson, P. Treichler (eds.), *Cultural Studies*, New York, Routledge 1992.

26 This is an issue where I draw from Donna Haraway's works, not least from her essay "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective" in *Simians, Cyborgs and Women. The Reinvention of Nature*, London, Free Association Books, 1991 and this volume. This is also inspired by the argument of Annemarie Mol on the need for a transition from the 'politics of who' to a 'politics of what'. See: *The Body Multiple: Ontology in Medical Practice*, Durham: Duke University Press, 2002.

27 Andrew Barry, 2001.

28 Kristin Asdal, *Politikkens teknologier. Produksjoner av regjerlig natur,* [*The technologies of politics. Productions of governable nature*] Oslo: Unipub, 2004. The argument that what was produced was an external nature, "out there" is further developed in K.Asdal "Enacting things through numbers: Taking nature into account/ing," *Geoforum*, in press 2007.

29 *Industrial Fluorosis. A Study of the Hazard to Man and Animals near Fort William, Scotland. A Report to the Fluorosis Committee*, Medical Research Council, Memorandum No. 22, London.

Epilogue

Ingunn Moser

Interventions in History

Maureen McNeil and John Law in Conversation on the Emergence, Trajectories and Interferences of Science and Technology Studies (STS)

The history of STS as a history of an academic field and movement has been told and reconstructed in different ways.[1] David Edge, in the introductory chapter to the *Handbook of science and technology studies* (1995), emphasises that STS was shaped in varying ways in so many locations, with different local agendas and disciplinary traditions. Similarly, Mario Biagioli in the introduction to *The Science Studies Reader* (1999) describes the field as simultaneously unified (in terms of its object of study) and strongly disunified (in terms of its methodologies, research questions, and institutional locations). It is difficult, he says, to draw the boundaries of contemporary science studies, to trace its internal subdivisions, cultural genealogies and socio-political valences, or to map its institutional ecologies. This is also the starting point for the story about STS that we present and advocate in this book, as well as for the collection in itself. It is necessarily partial, a sampler, – but with a particular direction and interventionary aim. The introduction, "The politics of interventions: A history of STS", is written as a story linking the Sociology of Scientific Knowledge with Radical Science, the feminist or women's movement, and labour process studies. This is a story that brings to the fore and assigns importance to a set of relations and contributions that have long been treated as marginal to the history of STS but which we argue have moved and shifted the field in productive and promising ways during the last decade.

This is also the motivation for asking especially Maureen McNeil and John Law to sit down and reflect upon these issues together. Law was a student of sociology in Edinburgh at the time when the Sociology of Scientific Knowledge, or SSK, was

invented. A few years later, in 1972, McNeil left Canada and her studies in history for the Department of the History and Philosophy of Science in Cambridge. Here she became a member of the Radical Science Journal and collective. In this way McNeil and Law came from different places into an emerging interdisciplinary field and movement. Indeed, different variations of science and technology studies became institutionally established in a range of locations in the academy at that time – in the late 1960s and early 1970s.

Since then, both McNeil and Law have moved and reinvented themselves along with the field, its movements and new actors. Along the way, the changing conditions of possibility for STS work, and poststructuralist and feminist interferences in particular, have brought them closer together in a shared struggle with the politics of knowing. As of today, Maureen McNeil and John Law are located in Women's Studies and Sociology at Lancaster University in the UK. They are both members of the Centre for Science Studies at Lancaster. But while sharing a long history in and with science and technology studies (STS) McNeil and Law still come from very different places and bring different resources into that collective space. It is these histories, or trajectories, as well as their interferences that we want them to speak about in this conversation.

IM: The theme we would like to see running through this conversation is the conditions of possibility for the texts which are included in this collection. This means that we invite you to reflect upon the emergence of the problems they raise, as well as the changing conditions for and trajectories of STS interventions. And we invite you to do so through your own histories in STS.

This relates to our introduction, which is a story about how STS emerged out of a heterogeneous set of concerns around science and technology, and out of the tensions and debates between these concerns and the collectives, they belonged in. In our story, however, we focus in particular on SSK, the Radical Science movement and feminism – and how feminist interventions in particular have shifted and moved the field. As said, this builds a story with emphasis on politics, social movements, and critiques of science and politics of STS as a shared concern. The STS movement, our argument goes, is heterogeneous and broad, but with an agenda and a politics related to the fact that science and technology have become problematic. To what extent do you recognise or identify with such an account?

MM: My sense is that *some* of the elements that contributed to build different ways into science studies include a critical concern about science and technology; with the positioning of science and technology in a range of social and political settings; and with science and technology as a mediator of power. The Radical Science Journal, at least, identified science and technology as a key mediator of class

relations, in the first instance. This was then examined and elaborated in many different ways, but it was certainly a clear knob for the Radical Science Journal.

In addition there were other particular issues that worked as sparks for thinking about and developing these analyses, such as the nuclear industry, and the military. And then feminism came, for me, to provide another set of both contexts and issues for thinking about science and technology. This included, then, the women's health movement, the anti-nuclear movement in the UK, and the women's peace movement, also in the UK. These were indeed crucial. But they did not appear simultaneously. The women's health movement was in the 1970s. The Greenham movement, the women's peace-movement and anti-nuclear movements came later, in the 1980s. The Radical Science movement and journal started earlier, however, restricted to a focus on class at that time.

IM: Two starting points were crucial for our story about STS. These are, first, the feminist notion of situatedness and its claim that all knowledge claims are made from somewhere and in specific relations, and, second, the STS/feminist argument that one should write agency and actors back into the stories of science. Things don't just happen, nature doesn't simply reveal itself, scientific knowledge is not simply an unmediated reflection of reality, and science doesn't "grow" or "develop" by itself. Instead, it is made in concrete and material practices. If we ask you to do this kind of situating for yourself; what were your concrete locations and institutional affiliations in this period? And what were the relations, resources and practices – in these locations, and beyond – that went into building and moving the analyses of science?

MM: I came to Cambridge in 1972, to the Department for the History and Philosophy of Science. This was where Robert Young was located at this time. He left in 1974, because he was dissatisfied with the constraints of the academic institutions, to become a freelance intellectual in London, to work in the media where he did the Crucible series,[2] and to work with psychoanalysis. The Radical Science Journal became established in 1974-75. There was a cluster of people in and around London and Cambridge that became the nucleus of the Radical Science Journal. But their backgrounds were quite diverse. They were people from very different backgrounds, partly academics, scientists, doctors, but also activists and people from the British Society for Social Responsibility in Science. It was quite an activist group. After Cambridge, I moved to London to work on a project, or programme, which was called science, technology and education, located at the Institute for Education. And then after that I moved to Manchester, to a job in Liberal Studies in Science, which was the general science studies department there – and to Birmingham, before I came to Lancaster.

IM: But where did you come from, when you moved to Cambridge and science studies?

MM: I came from nowhere! I got into science studies through history of science. And my first degree was in history and political science. But I took a seminar in religion and science in Victorian England, and that was the springboard for me to go to Cambridge. I got interested in social issues around science, and so my supervisor encouraged me to go to Cambridge, where Robert Young was seen as one of the bright young men in the history of science at that time. But I don't think my Jewish "father figure" [supervisor] professor had any idea of what he was sending me to. With him I (a lapsed catholic) had spent my time studying protestant thinking around issues to do with science in Victorian England. He had no interest in Robert Young's Marxist connections, but he sent me there. And so I went with a scholarship to Cambridge, with no idea of what I was going into. But Young's concern with class resonated for me, and with the shock of going to Cambridge. It had the effect that I discovered my class background – I was the first in my family to enter higher education.

JL: Trying to think about what made the institutional conditions of possibility for STS and SSK in the UK, what the conditions were that led to the creation of a space in Britain for doing these kinds of inquiries, I think an important incident was that the Labour government in 1965 established two committees to investigate the status and quality of science and technology education. The occasion was a concern with the "swing from science" and the narrowness in the curriculum in science and engineering – but in a broader frame also with industrial competitiveness and the scientific basis of formation of values and modernisation. The reports these committees delivered, the Dainton and Swann reports respectively, argued that science and technology education had to be reshaped, and that an important element of this should be the introduction of, and reflection on, social and human aspects, as well as the social consequences, of science and technology. In one sense, this was an echo from C.P. Snow (1959), his argument about the two cultures, and a kind of renaissance-man ideal of the whole human as educated in the arts as well as the sciences. Following these reports, a small amount of money was allocated for the broadening of these curricula. These resources were given to three or four locations in the British academic system, and generated units that in one way or another contributed to this aim. These included The Liberal Studies in Science unit in Manchester, the Science Studies Unit in Edinburgh, and the Science Policy Research Unit, or SPRU, in Sussex. But courses which in one way or another addressed the relations between science and society were also developed and offered at a range of other universities.

At any rate, this had the consequence that it became possible to look at science in a "broad" way. Obviously there had been history of science and also philosophy of science before, but what was new I think was that it became institutionally possible to look at science in a "broad manner" – whatever that meant. Probably it was very unclear what it meant! Anyway, it produced a variety of approaches to science, including some that were more straightforward and functional, indeed policy-oriented.

IM: So this means that what is today sometimes differentiated as science, technology and innovation studies (STI); science and technology policy studies (STP); and science, technology and society studies (STS) all emerged from the same – or same kind of – initiatives. And also that it was quite unclear and open what the content and outcome of these new investments would be. The idea that there was a need for a form of "science of science", then, was motivated by such different concerns as industrial growth and competitiveness; a scientific basis of modernisation, government and policy; failed technology transfer projects; an alleged crisis in science education; the social responsibility of science; and the role of science and expertise in power relations. This is often left unnoticed, if not silenced, in the histories of the field.[3]

JL: Yes. These were the UK conditions for both SSK and the science studies tradition on the one hand and the Radical Science and a critical project on the other. I think it was small, this initiative, but it was significant.

I myself was a PhD student in sociology at Edinburgh at that time, and became involved in the new Science Studies Unit there. David Edge had just been appointed Director, and the Unit had been given three new lectureships; one was meant to be in policy, one in philosophy, and one in sociology. But in Edinburgh the policy part of this never worked. The approach adopted in Edinburgh was more academic or scholarly, than policy oriented. So after a couple of years the policy position was converted into a history oriented post which was occupied first by Gary Werskey and later Steven Shapin. Then there was David Bloor, who was hired as a philosopher, and Barry Barnes who was appointed as a sociologist.

So that was an intellectual space. And the character and trajectory of that space, was quite unlike what Maureen has described. There was a superficial interest in politics. This was in 1968! But SSK imagined itself as an intellectual project and endeavour: it was intellectually motivated. It imagined itself as the systematic, rigorous analysis of scientific culture, from a new sociological and philosophical basis. Not as critical, or criticism, but as a matter-of-fact inquiry into how science works – in a "scientific" way, and within a "scientific" frame. As a scientific endeavour to find out how science really works.

And the particular input to that was Thomas Kuhn. I guess we could discuss how it was that the SSK scholars started reading Hanson's (1958) and Kuhn's (1962) contexting and historical inquiry into science, instead of Whig versions of the history of science. I don't know the details of this move, but certainly the reading of Kuhn, and a particular sociological reading of Kuhn, became most crucial to what emerged as SSK. So it became, I think, a very creative moment, intellectually. In SSK, Kuhn was read as allowing us to think of and read science as culture, and as a set of practices, rather than a purely intellectual exercise. In this it broke away from the Mertonian tradition. And what it meant was that science ceased to be special, or privileged. That was the kind of interest that motivated SSK. But I don't think that politics had much to do with it.

So this is definitely a difference in our starting points and locations.

IM: Does this mean, then, that there were no links and connections between SSK and Radical Science – that they lived in separate worlds, so to say, with no relations between them? Or would you subscribe to our version of the story about STS as emerging from tensions, debates and so relations between – as well as within – SSK and Radical Science?

MM: This is interesting. In the Radical Science Journal there were always dialogues, tensions, clashes, and interferences between the more strictly academic project and the political activism. Particularly when John mentioned Gary Werskey this became clear to me, that there were indeed connections between SSK and Radical Science, and also similar tensions both in SSK and in Radical Science. And that there were people who mediated between these. Gary Werskey was one of them. He was affiliated with the Radical Science Journal. And people like Robert Young. Just think of his scholarship, his work on the history of the sciences of mind and brain and his Darwinian work! His interests led him out of the academy, but he remained very academic. He related to the group of people around the British Society for Social Responsibility in Science, which was an activist group, but he was never an activist in the traditional, political sense in the UK.

But also in relation to the repertoire and resources, there were lots of points of intersection between SSK and Radical Science. I mean, I could tell a story, too, about the people who were important to me. In the department where I was, History and Philosophy of Science in Cambridge, it was the group of graduate students that were significant to me. We certainly also related ourselves to some of the staff such as Robert Young and Karl Figlio and, for some people, but not everyone, Mary Hesse. The group of graduate students included Roy Porter, Ludmilla Jordanova, John Forester, John Durant, Edward Yoxen and Lorraine Daston. To me, that was absolutely crucial. We had various reading groups that were diverse, and broad, and

covered everything from art history to anthropology and psychoanalysis. And that group was crucial in key conferences, too.

So that group was somewhat my equivalent to what you described, John. But of these people, I guess Edward Yoxen and myself were the only ones who came into the Radical Science Journal. The Radical Science Journal made a different cluster. There was, then, as you were describing, that interference between academic work and political activism always going on.

But I think that John is also absolutely right about the institutional conditions for these inquiries. What happened then was that these spaces subsequently became closed down. As teaching units, however, they remained important, since scientists and engineers had to take these courses.

JL: It is perhaps interesting to note that in Edinburgh, unlike the places you were situated in, science studies was located in the science faculty.

MM: I am really not sure of this – and I think that the units at Cambridge and Manchester may have been located within science faculties, but they did operate quite distinctively.

JL: To be sure, it took some while to formulate this program of studying science as culture. But it worked, and one reason was because Barnes and Bloor (along with a handful of others, notably Michael Mulkay and R.G.A Dolby) were convinced that Kuhn's history of science offered a way of getting into content, and seeing science as culture. Merton, as I said already, was concerned with scientific institutions, not content. In addition, Barry Barnes was convinced that scientists are active and creative agents, and puzzle-solvers. This was also a reaction against the Mertonian tradition. Agents, Barnes claimed, and here he was influenced by symbolic interactionism, are shaped by culture, but they use it as a resource. They are not programmed, over-socialised or over-determined by it. The question then was: if science is culture, how did the culture get shaped in the way it did?

This was where the notion of social interests became important. This was the next move. Indeed, the trajectory of SSK can be seen as an attempt to extend and explore the way in which interests operated. It started out with professional interests, but fairly quickly it also tried to see how class interests might be shaping scientific knowledge. An example here is Donald McKenzie's early work on statistics. Though gender, or gender interests, were not, so far as I can remember, discussed at the beginning of SSK. The program then was to try and explore how social interests, of a macro kind, could be seen at work, operating in highly esoteric knowledge. And so, for Harry Collins in particular, it was important to investigate how social interests could be seen to be operating in and through micro interactions and negotiations – even in the most removed and remote locations of science, such as physics.

That was the way in which the relation between context, or society, and science got built in this programme. And how we worked at how it is that scientific facts and truths are created or constructed through social negotiations and interactions. One way in which SSK perhaps differed from Radical Science, was in the way it saw knowledge as ideologically determined, but not as inherently ideological. I think Barry Barnes was most clear about this. He didn't use the term "ideology". You could never say that knowledge had an inherently ideological character. He used terms such as "ideological determination", suggesting that overt legitimate or concealed illegitimate interests were at work, shaping knowledge. Once it was created, however, whatever its origins knowledge became a resource that could be used, in different ways, for different purposes, in different contexts and circumstances, and one could never really know how things would turn out. As such it was not inherently ideological, even if it could be used for ideological purposes.

IM: You both mention Mary Hesse and Mary Douglas, in addition to Thomas Kuhn, as key inspirational sources in the development of new approaches to science. It is striking that the contributions of these "foremothers" of STS are seldom given prominence. However they offered tools and resources for approaching science as culture that were distinctively alternative to the notions of interest and ideology. Is it possible to say something more about what specifically you took from Hesse and Douglas?

JL: In Edinburgh's SSK Mary Hesse's analogical and relational view of scientific knowledge was understood as being largely consistent with Kuhn's pragmatism: knowledge was a network or a grid of conventional relations of similarity and difference, thrown over and responding to the indefinitely complex sense-data arriving from the world; a *selection* within the indefinite number of possible similarities and differences offered by the world. Certainly this way of thinking was important for David Bloor and Barry Barnes as they started to think about science as a culture for handling the world.

The importance of Mary Douglas's writing was a little different. Her work on "grid" and "group" offered a strong theory about how different social structures, or people located in different social locations within a society, might respond to anomalies: by embracing them willingly, by refusing them as abominations, or elaborating some kind of additional class within a large taxonomy. In contrast to the "interest" theory of social shaping, which obviously traces its genealogy back to Marx' theory of ideology, this was a Durkheimian and anthropologically inspired account of why (for instance) some groups (environmentalists?) were committed to pollution rhetoric, whereas others (many experts?) were much more pragmatic in their approach to knowledge and its problems.

MM: Before I respond, let me just note that what happens now is precisely that we constitute the history of science studies as a history of names and heads again. Very quickly we do. Anyway, I am not denying that this intellectual history is important to trace. However. I would like to stress that on the issue of ideological interests, there was in Radical Science a lot of contestation of the meaning of ideology. There were different views. And a significant part of the Radical Science Journal took a rather libertarian Marxist understanding of ideology, which was taken from Lukacs. In this we used the term in a rather different way than other people in the group, including interesting people like Hilary Rose and Steven Rose, who took a more traditional and conventional Marxist view of ideology as distortion.

I think that difference was really important to how the analyses developed. And that then became moderated in the work of Robert Young, and his view of science as social relations. This was a much more diffused view, and a libertarian view, of ideology.

This was really crucial. It implied that you moved from ideology as distortion in the direction John is describing towards culture, and science as culture. This is much more open, not at all looking to identify aberrations but more interested in the elements of it, and the relations. I would like to add that Robert Young – partly for political reasons, and his Marxist affiliations – always was longing to push outside of a history of ideas version of this. Nevertheless he always ended up with a history of ideas kind of analysis. My explanation is that he did not have the tools to move outside.

I should however return specifically to Mary Hess' and Mary Douglas' work which was important for those of us working within the Radical Science circle, although there was some scepticism about conservative elements and orientations within and around their ideas. Certainly there was a lot of interest in various aspects of Hess' work, particularly her work on metaphors which seemed to open up science and to suggest broader cultural connections. Douglas was associated with an anthropological tradition which amongst other things promised a way of looking at the specificity and idiosyncratic features of Western science.

But if I could step outside that intellectual trajectory: what distinguished the Radical Science Journal from the trajectory that John was describing, I would say, was that in Radical Science there was a constant foregrounding of power relations. There was an interest in power relations, but also, and specifically, in their mediation through science and technology. And in order to do such analyses, we had endless reading and discussion groups, of Marx, and of different parts of Marx' works, trying to find resources there. This, then, sometimes, led to a more general analysis than what was provided by SSK in that it was less focused on the knowledge itself;

an analysis that was more interested in the social relations and power. But as said, there were many moves between.

JL: Yes, there are examples of work that could have belonged to either. Just to be clear about that. And on power: I don't know whether there was a science studies line on power as such, but I know that the person who really wrote about it, in that tradition, is Barry Barnes. He saw power as essentially an enabling phenomenon, and not primarily as a matter of inequality or distribution. He insisted on the productive character of power – like Foucault, though the inspiration was not primarily from Foucault. Anyway, out of this line of Edinburgh work, in the end we get Steven Shapin and Simon Schaeffer's study of the formation of modern science. So the argument about shaping is creatively extended from a concern with the *content* of science to the production of the *institutions* that define what we might think of as the division of labour between science and politics. And the conditions for the kind of division of labour between science and politics within which modern science makes sense. And that was incredibly important, and indeed dealing with content *and* with power and politics.

Nevertheless, I do think that politics was kept on an arm's length in SSK. It saw itself as a kind of science of science even if it did not use that phrase, which, as if obvious, rings many of the wrong kinds of bells. But it saw itself as just as systematic, rigorous, rational, and methodical as the sciences it studied. Now this is not a position that I would now personally take, but it certainly defines one part of its conditions of possibility. And that made some questions explorable and discussable – and others unthinkable, inappropriate, or uninteresting.

MM: Yes, I remember I was writing a review of Bloor's (1976) *Knowledge and Social Imagery*, in which I was animated by the elements of science that were recreated in it, and in the mode of work of SSK. The scientism of SSK, that is. I remember I was very frustrated by the lack of reflection on those issues. But on the other hand I think it is important to say that there were also similar tensions in the Radical Science Journal. There were tensions, always!, about the academic nature of that work – in contrast with, and encounters with, activists.

IM: But a difference between SSK and Radical Science was perhaps the very strong division of labour between academic work and politics in SSK? That the politics and activism that people were actually engaged in, were conceived as a different thing altogether? A different life, so to say, outside or unconnected with their professional work and interests?

JL: Yes, there was a sharp division. And this was sometimes uncomfortable with no continuity of purpose of the kind you describe, Maureen.

MM: But this also played into Radical Science Journal. Radical Science Journal also had a strong tradition of scientific Marxism which had pretty rigid distinctions

itself, and that was constant. And I think a lot of people in Britain have it, especially, because of the history of the communist party, and other left Marxist identified groups of that legacy. They came out of that with a very different attitude, a reverence for science which was unheard of in other places, and which was reconstructed and reinterpreted and adapted after the Second World War. In this tradition, one saved the rationality of science by reserving the notion of ideology for the wrong kind of interests, the "bad" interests.

JL: This was of course very different from SSK, which was perhaps not critical, but neither was it reverent of Marxism. I don't think any of its authors came from a position such as scientific Marxism. It was more matter of fact. Even if there was, as I said, also a strong scientism in parts of SSK. And here David Bloor was perhaps the most outspoken, coming from a background in mathematics and psychology. But the divisions of labour that this work created between science, or academic work, on the one hand and politics on the other, was not exceptional either. Indeed I think it fitted with the institutional conventions.

And still there were other ways of working at and around it. The other thing that came out of SSK and led into politics was the line of work that later became known as the Public Understanding of Science, or the Public Interpretation of Science as Brian Wynne would put it. In this there was a different awareness and concern about the politics of science studies, which also led to an extension of SSK. And he was another person who went to Edinburgh. From the beginning his work was shaped by environmental concerns and his engagements with the movements in this field, for instance around Sellafield. And so his work came to be interested in the different cultures, and also different knowledge cultures, with experts, lay people, and public debate, and their relations.

MM: But it also needs mention that Brian Wynne definitely belonged, and belongs, to the critical wing of this tradition. His work is not to be identified with the body of work circulated by the journal with the same name; *Public Understanding of Science*.

JL: I completely agree. And this is another context. In the early 1980s there was another initiative in the UK to support the so-called public understanding of science. The dominant idea was that if the public was worrying about new scientific and technological innovations, it was because they misunderstood the science. If only they would understand, they would stop worrying. Here lay people are constituted as irrational and misunderstanding scientific facts and knowledge. So I completely agree with Maureen on this. Brian and his colleagues have always questioned that old model in which the authority of science is seen as "above" and "trickling down" into the public and into politics.

IM: So we have touched upon a series of elements that made possible and went into the shaping of STS in the UK, its interventions and politics. Perhaps we should move on, to how the conditions have changed since then, what this has made possible and not, and the more recent developments in science and technology studies?

JL: A new set of actors came into STS. How to characterise this change, and the conditions that led to it I am not sure. But one thing that happened was the emergence and introduction of what came to be called actor-network-theory, or the sociology of translation. For me, this change took place around 1980. But what made this space possible? Certainly, in France poststructuralism was inventing itself. But, then, how did *that* become possible, what were the conditions of possibility of poststructuralism? What was clear to me, was that this opened a whole new set of possibilities.

Perhaps one can trace the emergence of the new conditions of poststructuralism in structuralist Marxism and particularly in the work of Louis Althusser. At least for British social science, and British sociology. Perhaps we can say that the poststructuralist struggle is an effect of these Marxist traditions, and in particular their struggles with scientism and structuralism, which no one was any longer very happy with. Perhaps Althusser can be seen as the first in that move?

MM: Or perhaps he was rather the epitome of the old, of the structuralism and scientism – but also the turning point? Anyway it all happened rapidly.

JL: Yes, and to me the introduction to semiotics and poststructuralism meant that an entirely different set of conditions of possibility were made available for science and technology studies.

IM: But weren't there other elements of it, to use Maureen's vocabulary?

MM: One important condition was the *New Left Review*, which did an enormous job to translate into English and print and so make available "continental'(as they are called in the UK) theories. This was a crucial element of making the conditions of possibility for this in the UK. And as we said, it was taken up remarkably quickly.

IM: But why, do you think, did it happen so quickly?

MM: I think there was, on the left, a hunger for something beyond British empiricism. People were looking for something else. We, in the Radical Science Journal and collective, were for instance reading Mary Douglas at that time – this was perhaps the closest British resource?

There seemed to be a reaching for new ways of conceptualising and analysing the social and political sphere and a great wealth of richness in these "imported" theories.

JL: Anyhow, it affected science studies in varying and different ways: For me, it completely transformed what I could do. Sure, one lost a few things, for instance the social as explanation, or the macro, and culture, but one was given, or opened for, a whole new world. With the work of Michel Foucault, power became a different kind of thing – which is relationally produced, and runs all through everything. This implied – or promised – a complete transformation of science studies for me.

IM: But why did this French connection become so important to you in particular?

JL: It was in part a contingency – I spoke and read French. And so I was contacted by Bruno Latour, who also invited me to Paris. And it was also Bruno who introduced me to Michel Callon. And we just got on, both intellectually and personally. And then after we met I went to Paris on research leave in 1980-81. It was like a conversion-experience, I have to say. It moved me from seeing actors as active but shaped by the social, and culture as a resource, to seeing it all as relational effects. It just made sense. I really had the feeling that I had to go one way or the other, that it was an either-or, and so constituted a choice.

MM: As for me, and how things shifted me from the Radical Science Journal-direction, I want to mention three areas that were of importance. They all happened within a short period of time in the early 1980s. First, there was feminism. I was more and more involved in politics as a feminist. I want to mention one incident in particular, because this was so significant to my future trajectory. This was the science studies conference in Bath in 1980 – on "New perspectives on historical and social studies of science". There were only three women as full participants in this conference. And I just had to raise that as an issue, and speak about it. So I used the few minutes allocated to me, to present my paper and the argument I had made in it, to speak about the gender relations of the conference. The person who was discussant on my paper, totally ignored me and my interference and spoke as if it had not happened. And afterwards I was treated as if I had a contagious disease.

About the same time, when I moved to Manchester, I decided to set up MA options around gender relations of science and technology. I developed two courses. And third, was my increasing engagement with cultural studies that moved me further away from Radical Science and on to something new. My turn to cultural studies came in part through my thesis, which had been on cultural aspects of the industrial revolution. Crucial to me were particularly Raymond Williams and Edward P. Thompson who had been my thesis examiners. This background made possible my move into the cultural studies department at the University of Birmingham. And it was the interaction with resources from cultural studies to think about science and technology that was crucial. Moreover, the work of

Raymond Williams, on ideas of nature on the one hand and on media and television on the other, were particularly influential.

These were the motivations and movements that shifted me and many others too. And part of what this meant was that the privileged focus on class was shaken. By feminism, and by the interest in culture. On the other hand, however, there was also, for quite other reasons, a process of fragmentation going on in the Radical Science Journal. Some members of the Radical Science Collective moved into psychoanalysis. The result was, first, the establishment of the Free Association Press and the psychoanalytical journal, *Free Associations*. And the other outcome of it was *Science as Culture*, the journal. So Radical Science ceased to function as a collective. This was in the late 1980s and early 1990s.

JL: It strikes me that in SSK there was no such notion of a common political project, and no such notion of a collective either. Only a group of people. That was how people saw themselves around the program of SSK.

MM: Another important influence for me was Donna Haraway. I met her through Robert Young. She had acted as a kind of "foreign correspondent" to Radical Science Journal through many years. I also edited a special issue of Radical Science Journal on gender and expertise to which Donna contributed. And then in 1989 and 1990 I went to California and stayed with her. It was just when *Primate Visions* came out. Donna Haraway had also become more and more feminist in her politics and concerns.

Yes, poststructuralism. It was as if it had been nascent, always. There had been the *New Left Review* translations, but also, I would like to add, Stuart Hall's work. And like John, I also think that Althusser was a turning point from structuralism into poststructuralism. It just flushed into cultural studies in the mid-1980s. I remember that very well, when that happened. I also remember another conference, it was in fact the follow up conference in science studies after the one in Bath in 1980. It took place in 1984. Here Michel Foucault was the big presence. It was a huge controversy. And I was incredibly sceptical – because of the political implications.

Personally I was wrestling with Michel Foucault for a long, long time. In Cultural Studies at the University of Birmingham we used to do these mapping exercises, which we called "mapping the field". And so, for instance with semiotics, we'd review the theories and resources in relation to what could be used. So when I contributed to the collection edited by Caroline Ramazanoglu – *Up Against Foucault: Explorations of Some Tensions Between Foucault and Feminism* (1993) – I had to think through Foucault as a resource for feminism. I really worked through it carefully for that. I was very ambivalent, yes. I also ended my article with ambivalence. And it is also still my position. I think Michel Foucault and his work is incredibly important and useful, but I still have reservations.

IM: Perhaps you could expand a bit on this? What are these reservations about?

MM: I think that I worry about ways in which versions of poststructuralism contribute to or resonate with some political positions now that trouble me, and also contribute to positioning the actor in a way that evades political responsibility. And a kind of distancing that I see. It has to do with the position of the analyst. That is the question for me. I think Michel Foucault and feminism come together – and go apart.

I am animated in my work by a passion about social injustice. That makes an animated relation to work for me. I see a world with a need to do a lot – in terms of social justice. But I cannot always see that in some Foucauldian and poststructuralist work. The disappearance of that passion is crucial to my ambivalence and reservation.

JL: But anyhow the space today has become entirely reconfigured. And by that I mean that other conditions of possibility have been opened up, including political possibilities. For me, the actor-network version of poststructuralism, or what has become known as ANT, which is a material version of poststructuralism, and the work of Donna Haraway, belong together. They both say that the world is built in a materially relational way. And of course there are differences and tensions. I don't want to underplay these. But for me they have made something available which was not available earlier. In particular, the work of Foucault, along with post-Foucauldian work, opened some new political possibilities. These have to do with the acknowledgement of the productive character of power, as well as the exclusions and silences of power.

And going back to ANT: This set off in earlier versions as a kind of constructivism, an argument about how things were put together. It was a relational ontology which saw things as originally quite open, but an openness that closed down as certain kinds of shapes were produced. And so it gave an image or impression of a production or construction of the world. This then moved to a space, which is now, the present, in which one has a somewhat different sense of the world as multiple and enacted – in so many ways. This builds on feminism.

And with differences and multiplicities, politics comes into the woodwork of institutions, as we say in English. In which case it becomes important to explore differences, also in politics, and interfering in productive ways. As said, this builds very much on the work of Donna Haraway. Not that I want to claim identity between ANT and Haraway's writing – there are samenesses and differences. But personally, I must admit that I am much more comfortable now, much more comfortable when politics have come back in. And for sure I have learned this in various ways, but feminism has indeed been important to it. I learned for instance that everything is inherently political, and that we build worlds in ontological politics.

This is for instance from Annemarie Mol as well as Donna Haraway. And this opens up a post-Foucauldian politics, which is not an essentialist politics.

MM: I am still ambivalent. But that old world no longer exists for me either. For one thing; the movements and collectives outside are no longer there. And secondly, the forms of politics and the understandings of politics have also changed, in the ways just described by John. And certainly these are the conditions of possibility for working together now, the two of us, John and I.

And as for my reservations, before, there is also another concern, which makes a difference now – which is that I find myself more located in the academy than I would like. It absorbs me – the academy, I mean. And so it is that I am very concerned about some of the forms that this beast that constitutes STS now, takes. What I see is a move back to the academy. This has, I think, very much to do with funding, and the way this is pulling people in directions towards the "latest news" and "latest developments" in science and technology. We are led, or social science is led, by research programs and funding opportunities for instance on genomics, or "health innovation". And we are so absorbed that there is no critical space left. The pressure on academic workers is so heavy there is no space to think about it critically. And so, notwithstanding how much I also admire the work of many of my colleagues, it is also caught up in that. It has to do with the intensification of academic work, and the accountability that is thrown upon us. In Lancaster we are still relatively privileged. There is still a certain form of openness, and also exchange, which is not there in other places. They are indeed ominous, the new pressures, including the pressure to get funding.

IM: This is, I guess, an experience that STS researchers in most places share these days, however with local variations. But aren't there other things going on, too? Other interesting and promising movements in the field of STS? Wouldn't you, for instance, see feminism as having interfered with and moved SSK or STS? As having made a contribution, and a significant one, to how the field has changed and developed? Especially for a move to new engagements – of a variety of kinds! – with politics, and perhaps in particular, the politics and interventions of STS?

MM: Well, I guess what I'd say is that it has and it hasn't…? There are indeed elements that have been significant, and which has had impact, like Donna Haraway's work. This signals a change. But otherwise, I think John here is exceptional. I am still, and continuously, surprised to see how "great bodies of work" in STS do not register or make reference to feminist work at all. There is a continued blindness to feminist work that is conspicuous. And an example of that, or a sign of that, is in the exchanges between Bruno Latour and Donna Haraway on the refusal to take feminist work seriously in so much SSK and STS work.

On the other hand, I think there is always and will always be a tension at the heart of feminism in relation to the position in the academy as well as with the developments around postmodernism and poststructuralism. And this has to do with the fact that feminism is a modernist movement, with a teleology, for instance.

And then there are the constant enactments – to use your term – of gender relations. These enactments go on in so many ways, in so many guises, and so many places, in the field, even by key people. Which mean that the gender analysis can still go on. It has made a mark, but. Gender is also continuously being enacted and re-enacted in the field. Strangely, I am still surprised by it.

But it is not only that, it goes beyond that to the concerns about funding opportunism, and how we are letting ourselves be led by programs and opportunities for funding on "innovations in science". This has perhaps even more of an impact. I wish we would be more critical. But I do not see much challenging of it. And this is also what I see as the possible implication of appreciating poststructuralism and its focus on specificities, the local and enactment. It is that it produces silence about certain topics. That it can contribute to, or be used to legitimate lack of activity in other spheres.

IM: Would you, John, like to get in and add to this? According to what you already said, poststructuralism and feminism opened up a whole new set of possibilities, also political possibilities, for you. But what do you think are the exclusions, the marginalisations and the silences of STS today?

JL: On the one hand, there are, as already voiced by Maureen, the concerns with the macro, history and structure. And I share the view that these are locations where we need to do more work. What is the successor-project, so to say, to these "larger" concerns? How to think about them, and rethink them?

On the other hand, I am also concerned with another set of questions and marginalisations. These have to do with the limits to knowing, to language, and to representation. It has to do with other kinds of objects, and subjects in relation. With various versions of "in-hereness" and "out-thereness", and with the limits to conventional modes of representation. With for instance how science is conceived of as an "in-hereness" in which one can represent, make representations, of "out-thereness". And it has to do with silence, the non-verbal, and non-conventional modes of apprehending and appreciating realities. Which constitute a set of impossibilities, which produce silences, and omissions, in science, or in scientific modes of knowing and representing. I very much admire the work of Helen Verran, for instance, and her way of tackling the postcolonial situation and its differences. I think it is incredibly important.

MM: I agree. For me it has to do with finding a link, the link, between the critical register in STS now, which is incredibly sophisticated and elaborated, and what

is going on in the world of technoscientific development. I fear that science studies have come so far into it, into science and for instance genomics, that they have almost become implicit in its hype. That it is becoming collusive. To find a way out is the question and one of my concerns.

IM: But isn't this related to different conditions of possibility for both conceiving of and doing politics in different locations? These are notably different in Norway, the UK, France, The USA, or the Netherlands. Still, in this collection we have tried to bring out and support what we see as a movement "outwards" again, towards politics, in STS. Partly in the form of studies that work and imagine themselves in terms of "modest interventions", but also in the form of capital P Politics. For instance in attempts to look at the technologies of the political, as in Andrew Barry's work, or in Bruno Latour's work on the politics of nature. But also in the turn to markets and economics. This work turns to Politics again, then, but then also addresses politics with science studies tools and approaches and arguments. In our view, this is "not only" an academic endeavour, not only an academic interest, but engaging with and participating in new ways in scientific and political experiments. This is different from the picture and story you just gave. What is your reaction and response to this way of setting it up?

JL: Yes, I also agree with this. Perhaps Maureen and I are getting too tired and, dare I say it, old! However, I do worry constantly about the topics we discussed in our moment of relative pessimism. I also worry that the specificities of the material semiotics get transmitted in an anodyne form into other adjacent contexts. This, of course, has happened to actor network theory, which is considerably less managerial and smooth, even in its earlier versions, than the kinds of reductionisms that are often peddled in its name. The stress is on transportability and smoothness. As you know, I imagine the world as being densely textured, rough, messy, filled with specific and often unjust distributions. These specificities get lost in the quicker narratives. This is also related to the issue about the macro and the historical. How to talk about sizes, or big things, without losing specificities?

IM: Allow me to return one more time to the issue of whether things have changed, and whether feminism and or science studies have had any impact or not. I am a bit puzzled by this. From our point of view, things have indeed changed, and the feminist work in STS has also had important impacts and has even turned and moved the field in significant ways. That is the story we want to support and tell. What we are thinking of is the work on situated and partial knowledges; the situatedness, involvement and positioning of the analyst/researcher; the implicatedness of academic work with what we study; the politics of academic enactments and interventions; and the politics of referencing. To us, this body of work has opened up

a set of new possibilities, or conditions of possibilities. It has made and still makes things possible that were and are otherwise not possible.

JL: I am glad that it seems this way! That is encouraging. Because, of course, writing, a body of writing such as STS, a body of writing in tension as Maureen notes, is a public property. It moves. But where does it move? Straightforwardly, one can see STS tropes and theories (for instance that of actor-network theory) being used in a range of contexts: geography; CSCW, organisation theory; sociology of health and medicine; education; health-care planning; social work. STS – or perhaps it is STS in the context of other versions of "post-modern" little narratives and forms of scepticism – has made a difference. Sometimes that difference has been disastrous. For instance STS practitioners have been subpoenaed in US courts to show that findings of technoscience inconvenient to powerful interests can be "deconstructed" and are therefore discredited. But sometimes its movements have been much more progressive. Contested but encouraging. With Bruno Latour's "matters of concern" (precisely intended to argue against cheap deconstruction). With Donna Haraway's well-known tropic interferences and cyborgs. With Karen Barad's elegant talk of "mattering". With Annemarie Mol's "ontological politics' and its interventions in health care. Or with or Helen Verran's "ontic/epistemic imaginaries" in the context of post-colonial relations of knowledge and practice.

IM: Perhaps one way of thinking about this is that it has to do with how one imagines change and politics. The kinds of stories that say that nothing has changed, really – as one might say on a bad day? – relies upon a form (and politics) of drawing things together, and making singular what is really much more complex — isn't it? A form of politics that is based on a need and ability to say that "This is how it is!"? Which is perhaps implied in the commentary about feminism as being a modernist movement, and so necessarily in tension with or ambivalent about poststructuralist arguments and politics?

But if we – for a moment at least – take the (poststucturalist) arguments about multiplicity and complexity seriously, doesn't this then have consequences for how we think about matters like change, "progress", politics? My view is that we need to be more subtle also to bring out what has changed, the important changes, impacts? At least that is the interference that we want to make with this book!

JL: Yes! It would be possible to make the argument that not only is this right, but that politics has always been messy, impure, heterogeneous, Foucauldian, and all the rest, and that the appearance of big stories, big centres of power, and all the rest, are consequences of all this messy and impure work. Perhaps this is the lesson we should be drawing from Latour in the

Pasteurisastion of France. Or certainly, of course, from Andrew Barry's book. That these big things are all being done in multiple ways, messily! In which case,

arguably, we may be making a difference, but it simply appears, in the push to purification, that we do not. But what would the implications of this be, politically? Do we want to say that politics should re-imagine itself as multiple and messy? If so, then we need to respond to the argument that this is a conservative "post-modern" response. And, I guess, and this is an opening, to the challenge of imagining messy institutional forms rather than in Euclidean or regional versions of representation and accountability.

MM: I think that I am worried about some recent features of science studies that I might characterise as a loss of critical edge or voice. It feels to me as if a number of different elements have created a bit of a vortex that makes many science studies researchers wary of explicit political evaluation or engagement. Some elements that have pulled in this direction are very important both intellectually and politically, including: the move away from ideological critique as the primary mode of analysis; awareness of the "othering" of science, technology and medicine (and of scientists, technologists and doctors); emphasis on fluidity, multiplicity and complexity; scepticism about human-centeredness and the very boundaries between human, animals, machines, etc.; and the shift from constructivism to performativity. I fully appreciate and would personally advocate all of these moves. Moreover, there is no doubt that they have contributed to more sophisticated understandings of science, technology and medicine. My worry is that, taken together, in the current context, these orientations make it very difficult to think about social and political change and that the sophistication of STS analyses seems in effect, to contribute to endorsements of the status quo. I fear that there is a kind of quietism within STS as technoscientific developments and investment steam ahead (to invoke a very C19 metaphor).

It is very difficult to articulate this and I do not want to invoke spurious evaluations about what counts as politics, with a capital P. I am just worried that, in the context of the increasing commercialisation of academic work, the pressures for science studies to ride *with* techno-scientific developments and the intense individualisation which has made collectivist positionings very difficult in Western societies, it seems important that STS does have a critical edge.

Notes

1 See for instance Sismondo, S. 2004. *An Introduction to Science and Technology Studies*, London: Blackwell Publishers, Biagioli, M. (ed.) 1999. *The Science Studies Reader*, London: Routledge, Hess, D. 1997. *Science Studies. An advanced introduction*, NY: New York University Press, Jasanoff, S. et al (eds.) 1995. *Handbook of Science and Technology Studies*, London: Sage Publications, Cronberg, T. and Sørensen, K. (eds.) *Similar Concerns, Different Styles?*

Technology Studies in Western Europe, Cost A4, bd.4, European Commission, Luxembourg, Traweek, S. 1993. "An Introduction to Cultural, Gender, and Social Studies of Science and Technologies" in *Culture, Medicine and Psychiatry* 17, Dierkes, M. and Hoffman, U. (eds.) 1992. *New Technology at the Outset: Social Forces in the Shaping of Technological Innovations*, Frankfurt: Campus, Westview, Rose, H. 1992. "Feminist/Gender Studies of Science: An Overview of the Field", in *Genus, Teknik och Naturvetenskap – En introduction till Kvinnoforskning i Naturvetenskap og Teknik*, Stockholm: FRN.

2 "Crucible: Science in Society", a series of 12 1 hour television documentaries on the cultural relations of science, technology, medicine and ideas of human nature. The series started up in 1976.

3 Important exceptions are Edge's (1995) contribution in the Handbook of Science and Technology Studies, Traweek (1993), and Williams and Edge (1995) and (1992). It is also discussed in Enebakk, V. 2005. *Mellom de to kulturer. Oppkomsten av vitenskapsstudier og etableringen av Edinburgh-skolen 1966-76* [Between the two cultures. The emergence of science studies and the establishment of the Edinburgh school 1966-76], PhD dissertation, Faculty of Arts and Humanities, University of Oslo, and Oslo: Unipub forlag. This interview has also greatly benefited from comments by and discussions with Vidar Enebakk. Many thanks!

List of contributors

Asdal, Kristin, Centre for Technology, Innovation and Culture (TIK), University of Oslo, Norway

Barry, Andrew, School of Geography, University of Oxford, UK

Brenna, Brita, Centre for Technology, Innovation and Culture (TIK), University of Oslo, Norway

Callon, Michel, Centre de Sociologie de l'Innovation, Ecole des Mines, Paris, France

de Laet, Marianne, Harvey Mudd College, Claremont, California, USA

Haraway, Donna, History of Consciousness Program at the University of California, Santa Cruz, United States

Heath, Deborah, Department of Sociology/Anthropology, Lewis and Clark College, Portland, Oregon, USA.

Latour, Bruno, Sciences Po, Paris, France

Law, John, Sociology /Centre for Science Studies, University of Lancaster, Lancaster, UK

McNeil, Maureen, Sociology /Centre for Women's Studies and Centre for Science Studies, University of Lancaster, UK

Mol, Annemarie, Department of Philosophy, University of Twente, The Netherlands

Moser, Ingunn, Centre for Technology, Innovation and Culture (TIK),University of Oslo, Norway

Singleton, Vicky, Sociology/Centre for Science Studies and Centre for Women's Studies, University of Lancaster, UK

Star, Susan Leigh, Center for Science, Technology and Society, Santa Clara University, USA.