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REVIEW SYMPOSIUM

TAKING A NON-LINEAR PLUNGE INTO THE MNEMONICK DEEP

Geoffrey C. Bowker, *Memory Practices in the Sciences*. Cambridge, MA and London: The MIT Press, 2005. Pp. 256. US$34.95 £22.95 HB.

By Claire Waterton

Introduction

With this book Geoffrey Bowker leads us on a fascinating, fast-moving tour into memory, technology, and the sciences and the way that memory practices and technologies have intertwined through human efforts to know and record the past. This is a rich and exciting history, in part a history of the way that societies deal with time: yet it is designed as much to make us wide-eyed and questioning about the present and future as it is to open a vista onto the memory practices of the past. An overall achievement of the book is that it manages to sensitise the reader to time and what Bowker calls 'memory practices'. The book ultimately gives us the sense, felt quite viscerally by the end of the book, that we are suspended in a past-making-present with deep implications for the future.

But the book is also specifically about the natural sciences and the way that selected sciences (namely geology, cybernetics, biodiversity) construct time and memory. It taps into a by-now familiar preoccupation within science studies – to make visible the considerable work that scientists do to make facts about the past, or as Bowker prefers it, a ''perfect memory of the past'' (p. 4). At the beginning of the book, he sets out his ambitious goal: to look at the textures of the supposedly perfect memory belonging to science,

to look at its discontinuities, the ways that it breaks up and fragments, and to look at the technologies and techniques that underpin it. In this way the book sets out to reveal the past not as a series of singular events occurring in the world, but as the outcome of a process of creating, making marks, leaving traces, and, in the case of natural scientists, carrying out an active editing of these traces. Bowker also highlights the ways in which social scientists and humanities scholars might add to these traces.

An important theme throughout the book is the insight (woven in from a major source of inspiration, Derrida's *Archive Fever* 1998 [1995]) that the technologies, theories, and methodologies used for ordering memory are both 'sequential' and 'jussive'. Sequential, in that all forms of archive determine what can be remembered 'from this moment on'. In this sense they are instruments of erasure as well as recall. Archives are also jussive, suggests Bowker, in that they determine *what* can be remembered: "[t]he archive, by remembering all and only a certain set of facts/discoveries/observations consistently and actively engages in the forgetting of other sets" (p. 12). Although Bowker does not refer in any sustained way to the 'co-productive' or 'performative' aspects of memory practices, science studies scholars familiar with theories of co-production (e.g. Jasanoff and Wynne 1998) or with performance (e.g. Szerszynski et al., 2003) will see the resonances these have with the sequential and jussive characteristics of the cases that Bowker deals with.

The book is ordered along three major shifts that have taken place in our dominant memory practice 'regimes' in the nineteenth, twentieth and twenty-first centuries. The first concerns the development of new scientific ways of understanding the past within the science of geology in the nineteenth century. Taking a broad sweep through time and memory, industrial regular space/time, Cartesian space/time, the 1830s, and the memory of the earth, we are led to look in particular at the then-new record-keeping practices of geologist Charles Lyell and the impact that Lyell's re-working of the theory, methods, and discipline of geology had on understandings of the world's past. In a classic case of the co-production of science and society, Bowker shows how "Lyell inscribed the same time scientifically onto the earth as others inscribed socially onto industrial society" (p. 70). Lyell's new theories and methods for understanding the history of the

earth meant that it was no longer necessary for geologists to look for singular sites and events to give us clues about the earth's history: the past could be accounted for, in the present, through a meticulous book-keeping outlook that would also bear effects upon the division of labour, the place of the scriptures and the handling of information within the geological sciences.

The second memory epoch traces the development of systems theory and the cybernetics movement of the 1960s. Cybernetics, it is argued, did away with memory. Representing the world in a series of black boxes, cybernetics did not need the conscious holding of the past in mind; rather, it needed rules, as seen in the mantra "remember the process, not the specifics" (Ashby, 1978, cited on p. 104). Throughout this second chapter, as in the first, Bowker shows how the sciences draw on underlying social and cultural symbols, metaphors, and discourses: cybernetics swept these up into a new universal language, shoving the past into virtual, programable, black-boxable units that played into the circumstances of the new availability of information technologies combined with the political climate of the 1960s in which large-scale global change was taken for granted as both doable and often desirable.

The third *époque* – that of the 1990s onwards – remains our historical period for the remainder of the text. In Chapters 3–5, the reader is presented with a tour in and around the memory practices of biodiversity and the technologies employed in 'inventorising' life on earth. Looking initially at databases, not as memory machines, but as '*dispositifs techniques*' (Foucault, 1975), once again Bowker makes links between biodiversity databases and scientific and state control (p. 108). This chapter opens out the question of the technological framing of memory ("technology as record keeper", p. 135) through attention to the classifications, infrastructures, norms and beliefs associated with the technological ideals wrapped into material and symbolic human-computer relationships. Bowker deals subtly with the question of technological determinism, highlighting the veritable multiplicity of technologies currently used in the databasing of life. He warns of traps for analysts, suggesting of the technologies used, "their technical substrate links strongly with their interior development, to give at any one epoch a picture of inevitability; and between epochs a set of radical discontinuities" (p. 136). One of the most interesting aspects of this chapter is the

way that Bowker brings to the fore an advocacy for a science studies understanding of the infrastructure of databases – a commitment to accompanying data-bases with ontologically and politically sensitive understandings of their data and metadata (more on this subsequently).

Chapter 4 sees a continuation of the theme of how scientists make traces of the natural world, examining in more detail issues of naming, the context of data, the integration of data, bootstrapping and reverse bootstrapping (neglect) of data, the problem of the singularity of data, the unclassified, the performance of data structures, the question of stability, the question of 'perfect data'. These are thorny contemporary issues and problems within the biodiversity sciences and Bowker once again looks practically at the options for the creation of 'robust' systems, arguing against the goal of a global panopticon of data for the biodiversity sciences: biodiversity data, he suggests, are best understood as 'partial objects' (Deleuze, 1996) agonistically trying to assert their own orderings of space, time, and matter in the world (p. 197).

Bowker's treatment of the three *époques* of course reveals his own memory practices. The book uses numerous examples and refers to a wealth of interesting sources, although there seem to be some surprising gaps (key texts within the history of geology, for example), begging the question as to whom Bowker's own memory practices are offered (historians, science studies scholars, biodiversity scientists?). It is perhaps indicative of the structure and scope of the book that, having got to the end of Chapter 4, I found myself thirsting for synthesis. Chapters 5 and the Conclusion, however, do provide a more synthetic argument, in the form of an essay on what Bowker calls the 'globalising ethnos'. In a text that looks at scientific practices for revealing the Past (with a capital P) it would seem inevitable that the book would come to address what Bowker deftly terms the 'Scylla and Charabdis of local knowledge', 'the Scylla being that its space cannot be recognised as socially performed and it cannot be historically constructed if it is to be knowledge, and the Charabdis being that if *it* does not conform to (or overly complicates) traditional rules of intellectual property, then it will be ignored or worked around. So *it* can only be knowledge at the price of denying its very nature' (pp. 220–221). Related to this is the sense that the sciences are spectacularly good at 'disappearing tricks': at conjuring in the present to make the past

simultaneously disappear and become newly visible. What Bowker has done, in a way that brings the different memory *époques* and chapters together, is to show how these 'disappearing tricks' thrive simultaneously and for mutual gain in both scientific and bureaucratic settings: "the great trick, with respect to the past, has been to project present entities and processes back into the past – leaving the present as the natural and timeless outcome of a teleological process. The memory practices that we have examined are globally about producing this frozen, perfect productive present as integrally spiritual epiphany and political reality" (p. 227). Despite enjoying the book immensely, I find this – as one of its fundamental insights – almost overwhelmingly depressing. In suggesting below why this is so, I hope to lay out what I perceive to be the relative strengths and weaknesses of the book into a wider perspective.

WHAT BOWKER CONTRIBUTES – THEORETICALLY AND IN TERMS OF PRACTICE

It is clear right from the start of the book that Bowker is leading us into a work that takes a deliberately "wide reading of the archive" (p. 20). His early advice is that "if we want to understand memory practices in the sciences or in other spheres . . then we need to look elsewhere" (ibid.). This insistence on 'folding' the archive into "sets of actions in the present and in the built and shaped environment" (ibid.) represents a fantastic invitation to see databases and other memory devices not as instruments, remembrances, sites, containers, and so on, but as current *culture* (again, give a 'wide reading'), or even something as vast as currently held *ontologies* discursively and materially present in the world.

I cannot stress enough what a relief this perspective can offer for researchers of both historical and contemporary scientific databases or archives. This feeling of relief is similar to that which I felt when I first read Derrida's *Archive Fever* (1998, [1995]), which made me feel as though I were understanding database technologies in a totally different – but altogether more appropriate – way, not simply as a technology but as the delicately, humanly wrought relationship between our presents, pasts and futures. Derrida wrote of the archive as, "a pledge, and like every pledge, a token of the future" (1998, [1995], p. 18).

One of the strange aspects of Bowker's book is that he manages at one instance to convey this very open, temporally and spatially distributed, and overwhelmingly *cultural* reading of the archive. In other parts of the book, the archive is portrayed as something much more manipulable and static, a technical layering of data for which there are significant and identifiable problems. Bowker suggests, for example, that "[w]e need to historicise our data and its organisation in order to create flexible databases that are as rich ontologically as the social and natural worlds they map, and that might help us gain long-term purchase on questions of planetary management" (p. 121). In navigating these two conceptions of the archive as a reader, I felt the need to dwell more on the tension between the idea of archives as deeply embedded human culture and the idea of an archive as a manipulable set of data that science-studies researchers can influence and play into.

It will be clear by now that, in part, this book is really quite practical. It holds within it recommendations for making data more interoperable, for the making of good and comprehensive metadata (inclusive of history, politics and even science-studies insights) as well as pleas to hold in tandem a multiplicity of data sources and memories. At times Bowker seems sure that certain conventions and practices should be upheld. Take, for example, that of species naming. Here I want to contrast the writing of Bowker with that of another science studies researcher, David Turnbull, also working on questions of biodiversity and databases. Species, according to Turnbull, are built around a necessary but basic contradiction in which diversity and stability are in a kind of chronic tension. The concept of a species is nothing more than an assemblage of diversity, a temporary achievement of sameness within a flow of difference/diversity. Turnbull challenges us: "can we imagine a database that does not reduce cultural [and biological] diversity by submitting different knowledge traditions to a one size fits all, lowest common denominator regime?" (2003, p. 20). Bowker, according to my reading, is concerned about the same issue – how to render 'biodiversity' in databases – but the differences between the two authors' approaches are revealing.

Bowker is concerned that if biodiversity is not inventoried through the use of species concepts, let alone through ideas of process, then it will get deleted from significance in public policy. If species are not named they will not be represented. Naming

conventions should be upheld. As he puts it, ''to keep track of results in the sciences, you need to be sure of what you are dealing with – a rose should be a rose, whether in seventeenth-century Leipzig or twentieth century Pesotum'' (p. 158). Turnbull, on the other hand, is concerned that if species names are allowed to represent biodiversity 'other' conceivable categories, such as those relating to process and emergence (inherent to biodiversity), will be omitted. As both Bowker and Turnbull recognise, the pragmatism of Bowker ('to keep track of results in the sciences, you need to be sure of what you are dealing with') and the challenges set by Turnbull illustrate some of the fundamental differences in ontology that co-exist within sub-disciplines of biology (e.g. ecology and systematics). But whilst Bowker settles for the idea that this situation is what life is like, that each set of concepts can be seen as 'partial objects' (Deleuze, 1996), that each sub-discipline can act as an effective spokesperson (Latour, 1987), and that ''in a biodiverse world, we need to be able to manipulate ontologically diverse sets of data'' (p. 199), Turnbull is an actor or spokesperson who wants to exploit whatever technical potential exists and radically reshape the idea of the database to allow for emergent structures of life to flourish therein.

In the light of Turnbull's conceptual, if not yet practical, strivings, Bowker's research begins to look somewhat conservative. Turnbull (along with other science-studies scholars such as Helen Verran and Michael Christie, see http://www.cdu.edu.au/centres/ik/index.html for example, but there are more!) wants to play around with the representational power of databases and archives, to exploit the material/epistemic/ontological relationships caught up within them in a self-consciously post-colonial fashion and to recognise them as something like the 'mimetically capacious machines' that Taussig describes in *Mimesis and Alterity* (1993, xiv). As I see it, Turnbull, Verran and Christie have been doing some deliberate material/epistemic/ontological tinkering, exploiting what Taussig calls 'the border' between that which is represented and those that are representing – a border that Taussig suggests has been ''diffused to cosmic proportion'', that has become ''phantasmic reality'', ''unreal, micromental and elusive'' through the presence of new and ever present prosthetic technologies (1993, p. 251).

Something that I feel is underplayed in Bowker's book is a discussion of what it means for the sciences today to dwell within

the 'unlimited upheaval' in archival technology going on, where a proliferation of technologies (Derrida, back in 1995, listed telephonic credit cards, portable tape recorders, computers, printers, faxes, televisions, teleconferences, and E-mail (1998 [1995], pp.17–18)) are infusing our practices and our lives and are all somehow constituting ways of archiving the world.

Contrast this sense of unlimited upheaval, which also doubles as an exciting potential for creativity with data/memory (perhaps the arts are doing more on this than science studies?), with the sense of claustrophobic teleology seen in the statement that "the memory practices that we have examined are globally about producing this frozen, perfect productive present as integrally spiritual epiphany and political reality" (p. 227). Bowker's text towards the end of the book is full of suffocating images, closing in: "there is really but one line into the mnemonic deep" (p. 228); "we have a restricted set of stories that we tell and can tell about the past' (ibid.)"; "because we package the past into these bundles, we can only distinguish stories that operate within these highly coupled registers" (p. 229). Bowker depressingly suggests that this is an ineluctable state of affairs (p. 229). And he gives the reader only a small hope of redemption, only the slightest room for manoeuvre – first, in the sense that there could be wider acknowledgement that memory practices are sites where ideology and knowledge fuse; second, in that this would mean nurturing a greater modesty around the stories we tell of the past; and third, that there could be attempts to proliferate stories, to create multiple stories rather than singular narratives.

To conclude, in this book, Bowker liberates our conceptions of the archive and of memory practices, freeing us to look far outside their more conventional foci within the sciences. He enables us to see the tropes of particular sciences, and their memory practices, as enmeshed within the discourses and metaphors of their time, enabling us to see how biodiversity, for example, is framed by the ways in which we create its key data through the twin discourses of coin (value) and list. To my knowledge there are few authors that have done this with such intimate knowledge of the sciences in question and such attention to the nuances of the scientific as well as the social scientific/humanities literatures. Bowker has, in this respect, done a huge service to the science-studies communities that are interested in the 'archiving of the world' and what it means for

the future within the natural sciences and beyond. At the same time, however, he seems almost to have focused too strongly on particular memory practices within certain sciences, and has featured too lightly (especially towards the end of the book, which deals with the twenty-first century where it really matters) the chaotic fecundity that is ripping through the archival sciences, already creating a massively increased sense of possibility, multiplicity, and openness. This book does, however, give the hope that he, among others, might reap the benefit of the present work, by leaping a few steps forward into the dizzyingly fast changes occurring within the data-basing and archival sciences and grasping the theoretical, methodological, and practical challenges that lie ahead for science studies, humanities and natural science scholars alike.

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How do the sciences memorise? How do they conceptualise what is there to memorise? These two questions apparently function on disjoint levels. The first has to do with material practice (scientists use books, charts, filing systems, and databases); whereas the latter would have to do with epistemology and perhaps ontology (dealing with the kinds of traces the material world leaves for the sciences to investigate). One of the primary strategies of Bowker's fascinating but difficult *Memory Practices in the Sciences*, however, is to conjoin these levels through what he refers to as a thesis of *convergence*:

> [T]he tools that we have to think about the past with are the tools of our own archive – so that we generally project onto nature our modes of organising our own affairs (just as we tend to understand the brain in terms of the dominant infrastructural technology of the day – from nineteenth-century hydraulics in Freud to the telephone switchboard in the 1920s to network infrastructure today) (p. 18).

Through three dense chapters Bowker discusses how such synchronisation has occurred, respectively in the case of Lyell's geology in the 1830s, cybernetics in the 1960s and finally in contemporary biodiversity and data-basing towards the '2107s'. These

analyses continue Bowker's long-standing interest in tying together themes of science, infrastructure, bureaucracy and classification, begun with *Science on the Run* and most recently explored with Susan Leigh Star in *Sorting Things Out: Classification and its Consequences*. All of this work shares the interest in convergence, which, most broadly stated, shows how seemingly mundane infrastructural technologies are thoroughly and constitutively *intermingled with* scientific knowledge production and never only an external and neutral *prop for* such production.

Bowker retrieves a metaphor from the mouth of the Reverend Wicks Cherrycoke from Thomas Pynchon's *Mason & Dixon* in order to elucidate the historical strategy adapted in *Memory Practices in the Sciences*. As the reverend explains, those who wish to understand history must:

> soon learn the arts of the quidnunc, spy, and Taproom Wit, – that there may ever continue more than one life-line back into a Past we risk, each days, losing our forebears in forever, – not a Chain of single Links, for one broken Link could lose us All, – rather, a great disorderly Tangle of Lines, long and short, weak and strong, vanishing into the Mnemonick Deep, with only their destination in common (cited, p. 1)

Not a chain of single links, for one broken link could lose us all; rather a tangle of lines, taking us into the Mnemonick Deep. This vision is what draws Bowker into history's "unruly past" and tempts him to write not a "linear, chronological narrative – that artifact of a previous memory regime" (p. 2) but rather trace a path "between the social and political work of creating an explicit, indexical memory for science and knowledge and the variety of ways in which we continually reconfigure, lose and regain the past" (p. 2).

The keen interest in 'tangled lines' is evident throughout the book. It is revealed not only in the way in which the chapters move between historical periods and scientific disciplines but also in the way in which the conceptual set-up of the book is organised in the first introductory chapter and throughout. Aside from the notion of the 'mnemonick deep', Bowker retrieves Derrida's work on *Archive Fever*, especially his discussion of the archive as a black box simultaneously producing and emitting a time and a law. The notion of the black box indicates another set of key influences on Bowker, namely the philosophy of Michel Serres and science-studies literature inspired by Bruno Latour – and, of course, the cyberneticians who originally developed the term.

Juggling the sometimes harmonious, sometimes incongruent ideas of these scholars and disciplines is quite a task. Bowker, however, does not stop there. In the introductory chapter he invokes an astonishing range of scholars and research spanning a wide range of disciplines. We are introduced to the notion of palimpsest "as in Proust's description of Albertine's face" (p. 3) and to Boswell, Tolstoy, Lacan and Jung (in the context of considering traces left by old friends on the web). We are presented to ideas formulated by Mary Douglas, by the Chinese historian Sima Qan (145–86 BCE) and cybernetician Ross Ashby and continue to Funes, the Memorius, whose story was narrated by Jorge Luis Borges (p. 9). Later we encounter English historian Eric Hobsbawm who wrote *The Invention of Tradition*, Canadian philosopher of science Ian Hacking's *memoro-politics*, Sigmund Freud and Marcel Proust (again).

To make my critical points immediately, this 'tangle' functions for better and worse. I strongly support Bowker's attempt to write a non-linear history, just as I do his refusal to adhere to standard epistemological police operations (as he calls them, following Latour) according to which ideas, concepts, and methods from different disciplines should not mix. Due, however, to the enormous breadth of references and ideas put in play, less time, space and energy go into explaining how Bowker encourages us to think about the relations between all these scholars, histories and concepts, and how he sees them (all) as complementary (or not). This is a shame because a number of themes, notably about convergence and synchronisation deserve to be spelled out with as great clarity as possible; not least given their considerable importance in relation to the politics of biodiversity, which is discussed later on.

The introduction also leaves untouched the crucial question about the relationship between Bowker's non-linear history and its politics. This theme decidedly deserves a more detailed consideration in the light of the book's subsequent discussions. On the one hand, the agenda of accessing the 'mnemonick deep' seems to obviate the search for single lines of historical causation, for as 'the Reverend' said "there is not a Chain of Single Links"; and, as Bowker recapitulates at the end of the book, with a stab at Ranke: "[j]ust because the past is over doesn't mean that there is a truth about "wie es eigentlich gewesen ist" (p. 230). It is, indeed, the great merit of *Memory Practices* to show that we live in a historically and infrastructurally complex world, and as Bowker explains

the aim of the work is to "open up other possible spaces and times for human enquiry" (p. 34). On the other hand, stating the point of the summary Chapter 5 on "The Local Knowledge of a Globalizing Ethnos" as "baldly as possible", Bowker claims that "the stories we tell about the past through our dizzying array of scientific practices are simultaneously a representation of our political economy through the prism of our information technology and a denial of that representation in an attempt to universalise as we globalise" (p. 34).

Yet the argument is also made that: "[a] significant part of the setup work for networked information infrastructures is putting into place a set of agreements, which should be remembered *from that moment on* – the jussive aspect of Derrida's archive" (p. 23, emphasis added). According to this formulation, memory practices emerge in different periods and different sciences, and it is through *the event* ('from that moment on') instantiated by such emergence that new 'agreements' on how to think about knowledge and memory are established: 'from that moment on'. So are we witnessing a representation of a given political economy or an unpredictable ontological transformation? The main thread of the argument leaves no doubt that the latter is the case, for Bowker makes clear that new configurations of scientific, technical, and administrative practice are *active shapers* of political economy. As he notes: "ontologies flow from these agreements" (p. 23). The book never resolves how to fit these claims and, indeed, they appear epistemologically, ontologically as well as politically incompatible.

Since articulating the ways in which new configurations of memory, knowledge, and power flow from these constellations is such an important analytical point, it is the more surprising that Bowker chooses at times to present them as following from a political economy somehow left outside the ontological flow. Furthermore, the points at which this slippage occurs are not random. To be precise the themes of non-linearity and multiple causation, stressed in order to open spaces for new enquiry, give way to an (updated) version of political economy just when it comes to spelling out the practical implications of the work. Such reduction of non-linear themes, in the final instance, to simpler claims is symptomatic for STS research, which worries about normative implications. Yet I think it is unnecessary (e.g. Jensen, 2004; Smith, 2005). Indeed, I believe that Bowker's study offers analytical options enabling one

to stay 'non-linear' while retaining an interventionist stance, for example with regard to the biodiversity debates of today.

Memory Practices operates its own version of convergence. Chapter 1 depicts how Lyell's geology mapped "both the social and the natural world into a single time package" (p. 33) while the following chapter describes how cybernetics constructed a quite different mapping "through the evacuation of memory" (p. 33). The convergence is established from Chapter 3 "Databasing the World and the 2107's" and forward, which shows how both of these memory regimes are of continuing importance in present day biodiversity mapping exercises:

> Lyell and the cyberneticians have given us two very material modes of memory practice: acting as archives commissioners or conjuring the world into a form that can be represented as a universal Turing machine whose past has been evacuated in order to render its future completely controllable (p. 109)

As Bowker documents, the fact that these modes of memory practice are in important ways incongruent in terms of their epistemologies and ontologies gives rise to seemingly insoluble practical problems in contemporary data-basing efforts. However, in spite of these deep-seated differences they share the ambition to archive biodiversity by means of advanced information technologies. To describe this situation, Bowker updates Derrida's notion of the archive drive to "the drive to database" (p. 109). Now, data-basing is often presented as a simple matter of compiling data and organising it efficiently but this is the kind of misunderstanding that Bowker is uniquely equipped to dispel, a task he carries out with great efficiency. He describes enough infrastructural complications to make one's head spin. Of standardisation: "the process and creation of standards for infrastructures is a long, tortuous, contingent one" (p. 112). Of meta-data: "you always need to think about how much information you need to give in order to make your information maximally useful over time. And here we circle back to the first difficulty in developing an information infrastructure: the more information you provide in order to make the data useful to the widest community and over the longest time, the more work you have to do" (p. 116). Of ownership: "With the increasing privatisation of knowledge . . . it is unclear to what extent the vaunted openness of the scientific community will last" (p. 118). Of old data: "a current locally generated database, for example, might stay on one's hard drive for a while then make it to a zip disk;

then when the zip technology is superseded, it will probably become for all intents and purposes unreadable until one changes jobs or retires and throws away the disk'' (p. 121). And of interdisciplinary work: ''scientists are not trained to share information across disciplinary divides. And computer scientists cannot do the work of translating between disciplines. Indeed, one of the major difficulties with developing new scientific infrastructures using computers is that the work that is interesting for the computer scientists is often very high-end: involving, say, the latest object-oriented programming and visualization techniques'' (p. 123).

The situation is further complicated because these different dimensions interact in unpredictable ways. And, of course, by the fact – certainly not negligible from the point of view of the non-linear theorist and historian – that ''in practice, the sciences use many different 'filing systems' and philosophies of archival practice'' (p. 122). These are challenges that need to be met in order to nurture the knowledge ecology of biodiversity and Bowker pays painstaking historical and theoretical attention to these issues. Precisely for that reason, however, the advice he offers to alleviate them seems less than adequate: we need to develop new career paths ''more in tune with the needs of technoscience'' and we need to ''put maintenance of the information infrastructure high on the agenda'' (p. 123). Who are 'we' here? Are 'we' the same readers who indulge in Sima Qan, Derrida, and Proust references, or rather an entirely different intended audience of policy makers? And even if 'we' were to implement those changes, how exactly would we know what is in tune with the needs of technoscience? These programmatic statements appear strangely at odds with the historical agenda following from the arguments by the Reverend Wicks Cherrycoke and Michel Serres. I would file a similar complaint about the claim that ''the policy implications are clear. Great attention must be paid to the social and organisational setting of technoscientific work in order to take full advantage of the possibilities for faster research and publication cycles'' (p. 126). Aside from the question of audience, it appears to me that the policy implications of this suggestion are not at all clear: if only we (or anyone) *knew* how to take full advantage . . . . But, of course, no one does.

Furthermore, it should be said, in a world of avowed non-linearity, it is unclear what it could mean 'to know', in such a sense that the

policy implications would immediately follow. Bowker himself says as much, emphasising that "the infrastructure is performative (in that it shapes the forms that technoscience will take) and it is diffuse (there is no central control)" (p. 126)

Entering the mnemonic deep Bowker discusses the "importance of an unruly past," or rather, the importance of paying attention to this unruliness when databasing biodiversity since "naming practices within the field of biodiversity have complex historiographies attached to them" (p. 137). While everybody seems to agree that biodiversity is a good thing, there is little consensus about what the term covers: "For example, there is significant cleavage between views of biodiversity as being about the number of species in a given locale (more species = more biodiversity) or about the amount of genetic information being held" (p. 138). This cleavage is reproduced at the policy level, where it gives rise to controversy about what to protect and it illustrates differences among the scientific communities involved in biodiversity. As noted, it also creates serious problems for those attempting to name biodiversity in database structures. Bowker exemplifies numerous classification conundrums having to do with "things that are hard to classify" (p. 140), "things that do not get classified" (p. 146) and "things that get classified in multiple ways" (p. 154), concluding that "the activity of naming is fundamental to shaping our databases of biodiversity information, but it cannot be carried out effectively without the construction and maintenance of a series of organisational procedures" (p. 173). The point, once again, is that memory practices are both theoretically and institutionally shaped, just as they help to shape both theories and institutions.

Consequently "raw data is both an oxymoron and a bad idea; to the contrary, data should be cooked with care" (p. 184). Recognising the constitutional intertwinement of technologies, sciences, and institutions in shaping memory practices allows Bowker to define something of an analytic strategy: instead of following the cybernetic dream of constructing a universal database language, we might "instead begin to look at the machines that are productive of local orderings and alignments of data sets" (pp. 196–197) to understand the *partial objects* produced there: a Deleuzian term Bowker translates to mean the "objects plus spatial and temporal units it produces". Again, however, I do not think this strategy is anywhere close to what Bowker in the same breath refers to as "a

straightforward institutional reading'', (p. 197) according to which the understanding of biodiversity data simply 'reflects' the power games of scientific sub-disciplines. Bowker's attention to the 'unruly past', on the contrary, offers us access to a much more open-ended and unpredictable story than that, as must surely be the point of diving into the infrastructural depths of memory practices.

In the final chapter ''The Local Knowledge of a Globalizing Ethnos'', Bowker argues that there are ''two dramatically different modalities for dealing with the question of biodiversity'' (p. 202). The first he approaches through comparison with the money economy. It ''tries to accord every category of living thing a single biodiversity value, so that the policymakers can start the work of determining what should be protected and what should not'' (p. 203). This ''modality of implosion'' (from Donna Haraway) characterises, for example, ecological economy. The second approach has learned from the technology of the list. It aims at listing ''every last living thing – a frenzy of naming that is reaching its apogee with several multi-billion dollar international efforts to record just what is out there'' (p. 203). In spite of differences, however, the two approaches share in a temporality. As Bowker notes:

> much biodiversity discourse centers on preserving that which is – a current set of species, our current climate conditions, and so forth. We talk about preservation and conservation, not potentiating dynamic change (p. 208).

To me this suggestion, the implications of which are not spelled out in detail, is among the richest in the book. It has clearly Deleuzian overtones: the problem is to be solved not just at the level of the real but also at the level of the virtual; we need to think not just about how to preserve this species or this ecosystem here and now but about enabling ecologies to continue their dynamic transformations in the long run.

A number of themes come together in this suggestion. Obliquely the argument is made that a better constructed information infrastructure and a richer set of memory practices, facilitating our access to the mnemonic deep and to the non-linear, unruly past, would help us envision biodiversity in terms of potentiating dynamic change rather than preserving an ecological status quo (in any case an unlikely scenario).

This would require a transformation at (what are usually thought of as) multiple scales: in memory practices in the sciences (technical, institutional and epistemological at once), in the public and

political understanding of what science is and does (not prediction and control but enabling continual variation), and a concurrent change in the relationship between science and politics – perhaps not quite as envisioned in Bruno Latour's *Politics of Nature* but of a similar broad scope. Perhaps this sounds out of scope for *realistic* intervention. And yet, if this time of biodiversity degradation is not the time to try to come up with seriously different and ambitious dreams and schemes which time could be? Here memory practices have a crucial role to play as *Memory Practices in the Sciences* documents. As Bowker says in conclusion: ''If we want the future to be other than it seems to be turning out, we must create a past that is other than it seems to have turned out . . . . Only an open past can unlock the present and free the future'' (p. 230).

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By David Turnbull

Geof Bowker is now one of a select group of writers at the peak of science studies. This is his third book in MIT Press' Inside Technology series, which makes him their most published author and puts him up there with Harry Collins, Wiebe Bijker and Donald McKenzie. These slightly hagiographical remarks are by way of explaining that Bowker is in a prime position to get away with what is essentially a set of meditations on how we know time. Meditations that coruscate and beguile in a manner deliberately redolent of Serres and Pynchon, but which are firmly based in his earlier work on dating the earth, information management, and classification (his previous books were Bowker, 1994 and Bowker and Star, 1999. But this book draws especially on his classic articles: Bowker, 1995 and 2000). But meditations they are, because unlike his previous work this is no carefully and finely observed case study. It dives in and out of three major subjects; geology, cybernetics and biodiversity, and a host of minor ones from the distant past to the present day, in pursuit of the ways we order time to construct memory – the condition for the possibility of directed action in the proximate future. He is firmly located in the 'co-production thesis', which these days is near to being theoretical

orthodoxy in science studies. The ways we know the world are shaped by the ways we relate to each other and vice versa. In and out of this warp he threads a 'heterodoxic' weft of fleeting apperçus and contradictions that he perceives in the ways we measure time and use it to coordinate our understandings and practices. Some are so fleeting but striking that you wish he would linger long enough to explore them, like the notions of dynamic uncompromise, convergence, and potential memory.

Bowker's overarching thesis has two facets; each epoch is a co-production between its forms of memory practices and the engaged activities of the people concerned, producing a particular time and space in which humans and their information technologies are synchcronised. But, just as importantly, below the temporally integrated superstructure is the 'mnemonic deep', a motley substructure.

The temporal synchronisation of the world is, however, for Bowker neither simple nor smooth: it is

> the outcome of a massive work of building organisations, classifying the world and its inhabitants and integrating material from multiple domains. The resulting eternal present and linear chronology are imperfect products. The time of mitochondrial DNA has at times conflicted with that of evolutionary theory, the time of physics has clashed with the time of geology . . . in a messy sprawling gargantuan sort of way it is a towering achievement. An achievement that beetles over its own mnemonic deep (p. 33).

The chapters on biodiversity are I think the best. Here Bowker examines two different ways of creating what he neatly calls 'second nature' – that is a smoothed, ahistorical, nature, free of emergence events and processes, and a nature that is regular, law-abiding, and ordered, a manipulable nature convergently coproduced with a similarly regularised society. The two modalities he perceives are 'implosion' and 'particularity', betokened by the 'coin' and the 'list'.

The 'coin' is exemplified by the efforts to value ecosystems, and the 'list' by the tree of life that attempts to name every species in a temporal order. Setting up a common currency for ecosystem services as a way to coordinate equivalences in biodiversity renders "the present eternal – moving ourselves and our planet out of the flow of history". Bowker identifies the central problem here as one of "trying to collapse multiple registers into a single currency with just the necessary information" but finds "the resulting units of analysis will be riven with contradictions" (p. 209).

An example of this 'hollowing out' of history into an eternal present in which events, complex interactions, and contingencies are airbrushed out to leave a single unified human species as the pinnacle of a seamless second nature is the genetic mapping of history (Olson, 2002). This presentation of a seemingly incontrovertible timeline gives an immaculate emergence, in a mere 50,000 years, to humans from the Olduvai Gorge that completely overlooks the massive simplification of human diversity through plagues and wars and obliterates the vast depth of archaeological evidence.

What Bowker gives us is a mapping of the complex space that is in a process of continuous emergence out of the interactions, contradictions, and complexities of these temporal modalities. A mapping which, of necessity, must also be messy, heterotopical, and incomplete. In the period in which I was reading this book there were some perfect examples in the press of Bowker's 'mnemonic deep' erupting and disrupting. Dolphins sing their own songs, have names and identities. Organ utangs develop innovative tool use in schools. Some of the great universal constants evolve with historical and temporal dimensions. So now humans are not the only creatures that have memory practices, identity, learning, and plans: the Universe is an historical construct and the timelessness of physics continuously collapses.

In some ways I wish Bowker's account were even more messy and complex. As each epoch develops its own technologies of information assemblage and associated forms of disremembering thus producing differing ways of synchronising time and practising memory, other temporal modalities are not lost or eliminated. Rather they are co-present and we move seamlessly from one to another, from 'proper' time to genealogical time to cosmological time to virtual time and back again. Humans have been factoring time according to Marshack (1972) since we first scratched bones at least 40,000BC, but so perhaps have dolphins. Equally, much of what Bowker finds about the coordination of commensurability in time goes, of necessity, hand in hand with space. It is frequently claimed these days that space has replaced time where in the previous epoch it was claimed that time had replaced space. What seems closer to the processes Bowker examines is that in pursuit of the 'eternal present' and synchronous atemporality, people, practices and places have to be aligned – essentially a spatial ordering. While at the same time the processes of abstraction in science and the

economy 'empty out' space, and order our understandings and exchanges temporally. So our memory practices are jointly temporal and spatial.

But, of course, Bowker is well aware of all these interactions and chooses to allow them to pop in and out of view as he plays so insightfully with archives, coins, lists, and databases. This is the strength of the book, it is both ludic and multiplicitous. But sadly, it is way too short. I wanted to know what he might say about the medieval 'topokinetic' memory practices that Mary Carruthers discusses so beautifully in *The Craft of Thought*, or about the multiply coded modalities of the Inca now becoming visible in the work of Urton and Salomon ('topokinetic memory' is Berthoz' term; see Berthoz, 2000; Carruthers, 1998; Urton, 2003; and Salomon, 2004). The consolation for the brevity is the wit and the many analytic insights that set both a new standard of writing and new waymarkers for spatiotemporal explorers of the mnemonic deep. A space which, as Bowker points out, is best kept 'othered', open and explorable, by adopting the multiplicitous messiness of the harlequin's coat. Though he steers clear of the terms, he has opened up a performative space of temporal becoming which celebrates unity and disunity and brilliantly weaves together stories from across the history of humanity.

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Author's response

Jack (né Ernest) Worthing: ''I have lost both my parents''.
Lady Bracknell: ''To lose one parent, Mr. Worthing, may be regarded as a misfortune; to lose both looks like carelessness''.
(Oscar Wilde, *The Importance of Being Ernest*)

I am honoured to have received three such creative, generous and careful readings of my book. One thread which crossed all three reviews was that they would like me to be somewhat more complex and messy – so I'll try to answer that call in my response . . . .

I did have a Jack Worthing moment as I was reading these pieces. I had thought that I was writing a radical political text, but Wateron finds my work "almost overwhelmingly depressing" and somewhat conservative in its non-recognition of "chaotic fecundity" whilst Jensen argues that I slip from politics into relatively simplistic policy recommendations as the work progresses. I had thought that I was writing a work of radical ontology, but Jensen sees me as picturing a political economy: "somehow left outside of the ontological flow" and Turnbull wishes that I had been open to ontological diversity. Accordingly, I will lay out my political and ontological positions as clearly as I can. I recognised myself, and my carelessness with respect to these roots, in all the critiques – this is repair work.

I have frequently been asked about how I can bear to do biodiversity work – it's so darned depressing. Sure it's depressing what we are doing to species (whether or not they exist) – not to mention to each other in this phase of global war. My standard response has always been the Rosa Luxemburg mantra: "If I can't dance, I don't want to be part of your revolution". Getting lost down the rabbit hole of depression is precisely the worst thing to do in the face of global disaster – you just end up slipping into mournful passivity. That was my reaction when I first read Foucault (and nothing since has convinced me otherwise on him) and also when I first read Derrida (I'll come back to him). I tried in *Memory Practices* to be as clear as I could about the downsides of our current work on biodiversity and ecology. We are already in the sixth great extinction crisis in the history of the world. This is not a particularly bad thing for biodiversity in general at the small scale or over the long term – indeed microbial biodiversity is flourishing at the moment and climate warming promises a much more diverse planet in the future; but it is not great for things at the human level nor for the continued existence of *our* species. This is being caused by an increasingly hegemonic world order undergirded by patriarchy, fundamentalisms and dedicated to economic inequality and short-term environmental thinking.

So what to do? How to dance? Many have noted that those who write what is called postmodern literature (non-linear histories in Jensen's terms) do not have an interesting political position. They mask a lack of commitment with a celebration of the 'unruly', the 'wild', the manifold 'sites of resistance' – as if this act of recognition was itself a political rather than a fashion statement. In *Memory Practices*, I tried to avoid both the celebration and the depression. This left me in a position much like the nurses I wrote about with Leigh Star some ten years ago. On the one hand, they didn't believe in the classification system they were being forced to adopt – it turned process work into punctual intervention. Many of them started reading and writing some fairly wild process ontology. On the other hand, if they just resisted, the accountants were on track to have their way regardless – better, many argued, a flawed system in which we are represented than one in which we are lumped in with the price of a room and so remain low status and invisible. My attitude on this has always been both/and. Sure it's contradictory. How can you argue to ameliorate that which is fundamentally flawed? But it's fun – hence the dance – to keep both balls up in the air simultaneously, to tack between one line and the other. In my book, this took the form of letting some fairly pedestrian (though I hope useful) policy recommendations sit cheek by jowl with some fairly outrageous ontological claims.

Which brings me to Jensen's question about who the 'we' are that are reading this. Policy makers in general won't read stuff unless in comes in the form of an executive summary with key recommendations followed by a detailed elaboration of and justification of same. Not the way that I was writing. Nor will science-studies folk who worship at the temple of Symmetry and espouse the Principle of Anthropological Strangeness much appreciate my making policy and design judgments about the information infrastructures I was discussing. That was made very clear to me at a talk I gave a few months back before some of the current keepers of STS orthodoxy. For them I was not doing science studies because I made value judgements – I was an information scientist. When, I wondered, would they realise that science studies is not and never should be a discipline around which one can build methodological barriers – science and technology are too vital politically and philosophically for that. I am aware of not writing too well for either the policy maker or the neo-SCOTists. My real goal was to write for a very

general audience. My model here is Michel Serres, who has written very complex philosophical arguments, which weave together the humanities, mathematics, and the physical sciences and yet has managed to build a broad general readership in France. Not, it must be said, that he outsells Gérard de Villier's SAS novels; but still. Here I think *Memory Practices* did not work. I tried to make it funny – I got a chuckle out of it every few pages while I was writing; but none of the reviewers picked up on this. I tried to be both complex and approachable,but maybe wasn't. I've always looked on this as an apprenticeship rather than a profession – and I'm not where I want to be yet in terms of writing style.

So on to the ontological question, which I shall reduce for the purposes of brevity to the question of whether or not species exist. Of the many things which I don't particularly think exist, let me count species, money, and nation states – at least not in any trans-historical sort of a way. One of my principal purposes in writing this book was to say that there are no transhistorical, transcultural concepts. You just cannot remove things from the flow of time and space without traducing them politically and ontologically. The 'eternal present', which haunts the book, is a scientific and political nightmare. However, I also ascribe to the William and Dorothy Thomas position – 'that thing is real which is real in its consequences'. Sure they don't exist – in much the same way as most Gods don't – but they sure do have consequences. And I think tracking these latter is a worthy endeavour.

However, I did seem to go one step beyond this in arguing that we need some constancy in language so that scientists (or other folk for that matter) can talk to each other across time and space. There I seem to be saying that though we murder to transect, we need to do it (where, as I did try to make clear in the latter part of the book, 'we' oscillates deliberately between the globalising 'we' which I am ineluctably a member of and the critical 'we', to which I aspire). I do believe that there are genuinely new ways of talking about and being in the world – and that David Turnbull's and Helen Verran's work are rich models for other ways of knowing. I don't believe that writing about it is an answer – there is a sense in which writing as we know it enrols me in a 'phallogocentric' (to borrow Derrida's awkward term) programme – the key is in our set of activities, our ways of being in the world. We will generate new ways of knowing as we create a new political economy. I hope I

am part of this movement. I did possibly err in my imagination in not capturing some new emergent forms, but to be quite honest almost all that I've seen touted as a radical new form of representation has proven to be pretty rooted in old values. The World Wide Web is less a rhizome than a hierarchical database.

There is a lot more to say in response to these deep readings. I am working now on an overly ambitious history of life on earth and of the earth itself. Hopefully I'll get to say some of it there.

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