

Memory Practices in the Sciences

By Geoffrey Bowker

"Mr Swivett, approaching a facial lividity that would alarm a Physician, were one present, now proclaims, 'Not only did they insult the God-given structure of the Year, they also put us on Catholic Time. French Time. We've been fighting France all our Lives, all our Fathers' Lives, France is the Enemy eternal, - why be rul'd by their Calendar?'"

"Because their Philosophers and ours," explains Mr. Hailstone, "are all in League, with those in other States of Europe, and the Jesuits too, among them possessing Machines, Powders, Rays, Elixirs and such, none less than remarkable, -- one, now and then, so daunting that even the Agents of Kings must stay their Hands."

"Time, ye see," says the Landlord, "is the money of Science, isn't it. The Philosophers need a Time, common to all, as Traders do a common Coinage."

"Suggesting as well an Interest, in those Events which would occur in several Parts of the Globe at the same Instant." (Pynchon 1997: 192)

"Facts are but the Play-things of lawyers, --Tops and Hoops, forever a-spin... . Alas, the Historian may indulge no such idle Rotating. History is no Chronology, for that is left to lawyers, -- nor is it Remembrance, for Remembrance belongs to the People. History can as little pretend to the Veracity of the one, as claim the Power of the other, -- her Practitioners, to survive, 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 day, 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. The Revd Wicks Cherrycoke, Christ and History" (Pynchon 1997: 349)

In the course of human (and non-human) history, it is rare enough for a significant new regime of memory practices to develop. M.T. Clanchy explores one such in England a millenium or so ago, arguing that:

the shift from habitually memorizing things to writing them down and keeping records was necessarily prior to the shift from script to print, and was as profound a change in its effects on the individual intellect and on society. {Clanchy, 1993 #1255: 3}

Looking out from the year 1000, then, one can go back to the invention of writing and a subsequent uneven shift to organizational reliance on written records over several thousand years up to the turn of the first millenium after the Christian era. One can also look forward to the propagation of print culture some few hundred years further on {Eisenstein, 1979 #269} and then several centuries after that to the development of the Internet. This book is offers a reading of the ways in which information technology in all its forms has become imbricated in nature and production of knowledge over the past two hundred years.

The starting point will be the industrial revolution in England, with the development of new archival forms consequent on the expanded scope of the British state and

accompanying new scientific memory practices – for example in the then central science of geology. The culmination will be a new form of scientific product, the digital database, within a current central scientific arena: biodiversity science.

The story I tell is not a linear, chronological narrative – that artefact of a previous memory regime. My story weaves a path between the Landlord's time and the Reverend Wicks Cherrycoke's mnemonic deep; between the social and political work of creating an explicit, indexical memory for science and knowledge and variety of ways in which we continually reconfigure, lose and regain the past. The interest in the Landlord's expostulation goes beyond its brute equation of time and money. The Landlord is talking about how infrastructures form.

The mnemonic deep. At the extremes sit, dance and play two ways of reading it, and on the plateau wander an infinite number of ways of writing it. One way of reading it is to see ourselves as at any one moment completely able to escape our history, thanks to that little piece of time which is the present, together with motive force, emergence. Hope, desire, creativity, will are projected onto this little piece of time stuff, the present (ever present, never in reach). This little object, the numinous present, holds our dreams. The past is a thing that you escape at all costs. It has a heavy hand. A hand with a long reach, as many a politician has found – the politician being the concentrated symbol of the person whose past is completely knowable: prurience combined with moral fervor set up a powerful continuing (and ever incomplete) inquisition into the politician's past, the same inquisition that we carry out daily on confessional shows on daytime television with its smorgasbord of choices for redemption. Our past explains who we are; we stand here publicly before you to receive absolution for that past and to follow emergence into a spangly future The other way of reading it is as a palimpsest, as in Proust's description of Albertine's face as a palimpsest. The infinite faces of the past can be read off the present face. The mnemonic deep lies deep in the eyes of the beloved. We should remember the past and celebrate it. For how else will we savor, texture, explore, adore the real? Evoking the past is a joy and a solace in the present – through it we constitute a narrative ideal present. The timeless present – every felt more richly, ever receding into the past. For how can we know the present without taking time over it, mortgaging the present to savor the past? In this reading, we learn from the past, seeing the multiple ways it can lead, and observe ourselves choosing some of those ways (never a single decision; rarely consciously a decision). This numinous present will lead us to the question of money. As Michel Serres (Serres 1982) has noted, money is the degree zero of information. It circulates in an ever more ideal space and time (we have gone from gold to silver to base metals to paper to digits) and is exchanged, duly laundered, as something which is without history. Money is the ultimate token of emergence.

Within this metaphorical economy, time as the money of science is constituted of both the mnemonick deep and the numinous present. The time that scientists create has three main features. First is the time of the experiment/field study itself. Scientists play with much longer time scales than most of us (going back billions of years); with much shorter time scales (down to divisions of the nanosecond, to quantum units of time); and with time series and cycles of great complexity – registering, for example, patterns in time

series analyses of proxy measures for past climate (tree rings; peat mosses; fossil seeds; astronomical cycles ranging over tens of thousands of years up to millions of years). Agreements about time and timing are fundamental to all science, so a good time standard operates as a gold standard. Second is the time of the scientific enterprise. Much writing in science is historical – opening a scientific paper with an account of the recent relevant history of one’s subdiscipline; continuing with what happened in a particular day at a given laboratory. Particular constellations of historiographical stances which are shared among sets of disciplines, or between practitioners of a given discipline. Finally, there is the ultimate product – the law of nature. All contingency has been removed from the law of nature – it is true over all time and in any place. The common time that the Landlord refers to is used to create a universe in which the constructed fact is eternally true¹. In this sense, the past which scientists create can be read as an eternal present.

The institution of the sciences is one very few modern institutions that claim a perfect memory of the past (law – through precedents; and theology – through heresies are others). Even tax records decay over time. This book is about the work that goes into creating this avowedly perfect memory – about its textures and discontinuities; about the technologies and techniques that subtend it and about ways of thinking about it with a view to designing robust scientific databases that contain traces of the past which are currently cast into oblivion. But to get from here to there – or rather from now to then – we will first look at the array of traces that we leave of the past.

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What is memory, that a person may practice one?

Memory is often, and wrongly, conceived as an act of consciousness and associated with what can be called to mind. By this light, it is often seen as the act of deciphering traces from the past. We don’t analyze the movements of icebergs by studying the bit that appears above the surface of the sea; nor should we study memory in terms of that which fires a certain set of neurons at a determinate time. We as social and technical creatures engage in a vast span of memory practices, from the entirely non-conscious to the hyperaware.

Consider the total institution. Mary Douglas argues that: “when everything is institutionalized, no history or other storage devices are necessary” (Douglas 1986: 48). If I get processed into a prison, I can survive there as just a number (as the Count of Monte Cristo discovered). There is no need for the institution to hold any information about me other than that I exist and that I am subject to its regulations for such and such a time period; there is no need for me to remember anything about my own past, or any sets of skills beyond a fairly simple motor set. Why I am there and who I am just don’t matter to the institution itself – it ‘remembers’ all it needs to know through the complex set of

¹ This is the double nature that Latour Latour, Bruno. 1996b. *Petite Réflexion sur le Culte Moderne des Dieux Faitiches*. Paris: Les Empecheurs de Penser en Rond. explores.

procedures that it puts into place. Sima Qin, Chinese historian, made a similar observation about the burning of the books in 213BCE. Qin writes:

Approving his proposals, the First Emperor collected up and got rid of the *Songs*, the *Documents*, and the saying of the hundred schools in order to make the people stupid and ensure that in all under Heaven there should be no rejection of the present by using the past. The clarification of laws and regulations and the settling of statutes and ordinances all started with the First Emperor. He standardized documents (Qian 1994: 31). (The translator notes that this refers to the standardization of bureaucratic practices, not of the script).

This replacement of memory by procedures extends to a formal information processing argument that Ross Ashby made about closed systems all kinds. He argued that if we completely know a system in the present, and we know its rules of change (how a given input leads to a given output) then we don't need to bring to mind anything about the past. Memory, he said, is a metaphor needed by a 'handicapped' observer who cannot see a complete system, and "the appeal to memory is a substitute for his inability to observe ..." (Ashby 1956: 115). Now no institution is ever total, nor is any system totally closed. However, it remains true that there are modes of remembering that have very little to do with consciousness. These modes tend to abstract away individuality (extension of a person back in time) by substituting rules and constraints on the behavior of types of people for active recall.

At the other end of the spectrum is the hypermemory of Funes, the Memorious, discussed by Jorge Luis Borges. Consequent on a riding accident, Funes had a perfect memory, however it was so good that it took him far longer to recall an instant than it had to experience it:

Funes remembered not only every leaf on every tree of every wood, but every one of the times he had perceived or imagined it. He determined to reduce all of his experience to some seventy thousand recollections, which he would later define numerically. Two considerations dissuaded him: the thought that the task was interminable and the thought that it was useless. He knew that at the hour of his death he would scarcely have finished classifying even all the memories of his childhood. [cite]

Funes' memory repeats the past; it is sequential; in this way it is like the memory of Luria's mnemonist. He has no random access to different parts of his youth, though he tries to create the same by classifying and enumerating his experiences. This is a fractal memory – each act of remembering calls up worlds of experience, and each world calls up new acts as complex as the first. Operating socially, this non-discriminatory memory is often a political tool; Baudrillard writes that the deluge of information about the Gulf War was: “to produce consensus by flat encephalogram” (Baudrillard 1995: 68). At this end of the spectrum we get total individuality – there is no such thing as a generalized bin in which to store selected past data; with the only possible redemptive act being classification.

Across this span from no active recall to hyperawareness there are a dazzling array of memory practices that we engage in on a daily basis; there are few censuses of these practices. What is really interesting is not so much the individual practices and how they

articulate a given set of memory technologies. Rather it is how sets of memory practices get articulated into memory regimes, which articulate technologies and practices into relatively historically constant sets of memory practices which permit both the creation of a continuous, useful past and the transmission *sub rosa* of information, stories and practices from our wild, discontinuous, ever-changing past.

This possible object of interest (and obscure object of my desire), memory practices, extends in space into a unit I will call the Archive and into time in units I will call the epochs of memory.

BREAK IN TEXT

The Place of the Archive

In a wonderful passage of his Principles of Geology, Charles Lyell discusses the earth as an archive commissioner. He was working from the position that there was no sign of the origin of the earth, nor any portent of its end – what we have access to is a set of records in the landscape which leave the impression of massive upheaval and discontinuity in the past. This was strongly at odds with his picture of the earth as being subject now to the same forces as ever – with the appearance of massive change being wrought by a vast increase of the amount of time afforded the geologist to account for the face of the earth. The gap between appearance and reality was the record-keeping process:

Let the mortality of the population of a large country represent the successive extinction of species, and the births of new individuals the introduction of new species. While these fluctuations are gradually taking place everywhere, suppose commissioners to be appointed to visit each province of the country in succession, taking an exact account of the number, names, and individual peculiarities of all the inhabitants, and leaving in each district a register containing a record of this information. If, after the completion of one census, another is immediately made after the same plan, and then another, there will, at last, be a series of statistical documents in each province. ... the commissioners are supposed to visit the different provinces in rotation, whereas the commemorating process by which organic remains become fossilized, although they are always shifting from one area to another, are yet very irregular in their movements [so that]... the want of continuity in the series may become indefinitely great (Lyell 1837: 31-32).

This passage prefigures a major theme of this book: the tools which 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 organizing 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). However, we will not dwell on that for the nonce. Rather, let us look at what this text says about record keeping.

First and foremost, Lyell is saying that the earth itself is a sort of record-keeper. Not perhaps a very good one, but a record keeper nonetheless. Geologists today have

expanded this record-keeping function enormously, seeing traces of the distance past (beyond revolutions in the earth's surface and even before the creation of the earth) in various isotope ratios. Our earth weaves its own history into its texture. Similarly, life itself writes its history into the earth. The very oxygen that we breathe has been freed through the metabolic processes of cyano-bacteria to enter the atmosphere. Massive hard sea floors have been created by the disaggregated exo-skeletons of planktons; these floors have fostered the development of new forms of life. Without life, the earth would be an inhospitable place for life: with the positive feedback loop in place, it has become more and more livable for an increasingly complex set of organisms². The lesson here is that, with the introduction of life, the traces that we leave of the past are neither other from us or passive: they render life more livable.

This brings us to the parable of the ants on the beach, adumbrated by Simon and commented by Ed Hutchins. Simon's original story runs that if we look at ants moving on a beach, one might impute their complex trajectories to internal programming, rather than being a fact about the beach. Hutchins invites us to go outside of the normal time constraints of the psychologist (shades of the exclusionary principle above) and look at the beach over a several month period:

Generations of ants comb the beach. They leave behind them short-lived chemical trails, and where they go they inadvertently move grains of sand as they pass. Over months, paths to likely food sources develop as they are visited again and again by ants following first the short-lived chemical trails of their fellows and later the longer-lived roads produced by a history of heavy ant traffic. After months of watching, we decide to follow a particular ant on an outing. We may be impressed by how cleverly it visits every high-likelihood food location. This ant seems to work so much more efficiently than did its ancestors of weeks ago. Is this a smart ant? Is it perhaps smarter than its ancestors? No, it is just the same dumb sort of ant, reacting to its environment in the same ways its ancestors did. But the environment is not the same. (Hutchins 1995: 169)

This seems to me a good reading; it evokes the generalization that one of the things that all life does is to transform its environment by leaving memory traces in it, thereby increasing its chances for success. Further, Hutchins suggests, a snapshot view of this complex will have a given organism reacting relatively intelligently against a passive backdrop, whereas the complex {environment + entity}, mediated by archival practice, is in fact the seat of intelligence. Bruno Latour has playfully suggested that a difference between people and animals is that the former accrete memories from the past in technology (Latour 1996): this is how he distinguishes between the perpetual reassertion of rank among baboons and the more placid acceptance of a given social order among humans. To the contrary, it is a characteristic of life itself to leverage its work practices through engineering its archive.

Let us move from the ridiculous to the mundane. Maurice Halbwachs put it beautifully: "... most groups ... engrave their form in some way upon the soil and retrieve their

² Inversely, without the earth as it is life might well be simpler – the current relative peak of biodiversity (abstracting away anthropogenic extinction) is sometimes argued to be a feature of the more complex geology of the shattered supercontinent Pangea.

collective remembrances within the spatial framework thus defined” (Halbwachs 1968). James Walsh and Gerardo Ungson spoke of ‘ecology’, or physical design, being one of five ‘storage bins’ for organizational memory – the other four being individuals; culture; transformations (procedures); structures (roles) (Ungson 1991: 65-66). A few examples of such engraving will help. Imagine you are alone in a forest – take the Forêt de Fontainebleau outside of Paris. You want to go on a walk through the wilderness. You could get a map, and rely on the paper archive to provide your trail through the area. On the other hand, you might equally well choose a color (yellow for the easy walks, and black for the difficult ones, where you have to scramble) and follow the ribbons attached to trees and the streaks painted on rocks full circle. And if a few of the ribbons or streaks are missing, you just follow the track of the footprints (you would be wise to do so where they indicate that the majority of the people have gone off the trail for a distance – possibly to avoid an obstacle). Simon Schama writes at length about this reworking of the Fontainebleau wilds as the first set of guided walks in Europe (Schama 1995: 546-560), though of course from Hansel and Gretel on into historical time we have reworked our natural landscape to leave a memory trace. We often don’t think of such trails in memory terms, because it is not our own personal memory that is being engraved – it is the collective memory of our culture. We operate such changes *a fortiori* in the built environment. If you visit a Catholic church, you don’t have to remember the order of the stations of the cross – they are laid out for you in a standard fashion. Our reorderings can be evanescent. I constantly litter my morning path with objects that I want to remember to take to work – books to go to work in a pile next to the bathroom; clothes for dry cleaning on the bonnet of my car; things I really must do today on my computer keyboard. The generic trick I am using here is putting matter out of place as a form of aide-mémoire. (I have given here a trio of somewhat functional examples: the memory that we hold in the built environment is by no means necessarily useful memory – as indicated by the well known saga of the carriages on Roman roads making ruts of a certain size that propagate through to the nineteenth century since a non-standard axle will always be straddling ruts then hop technology onto trains, since that is the axle size that smiths were used to building).

On this wide reading of the Archive, I am folding distributed, diffuse archival practice into the sets of specialized archival technologies: the list, the file folder, the computer database and so forth. These latter constitute one small subset of an extremely large set of memory practices that we engage in from day to day, from century to century.

BREAK IN TEXT

We return here to the central aporia spelled out above; but this time with an understanding that it is characteristic of memory practices in the current epoch across a wide range of activities: from science, to politics to business... .

Conclusion

Discussing the daily life of the Greek gods, Sissa and Détienne (Sissa and Detienne 1989) write that the mythographers conjured a divine existence in which: “Time does not pass, it is frozen and collected into an eternal present”. For, they argue, any external influence from events, people and so forth would pose the gods as incomplete. And yet, they note, poets such as Hesiod had no difficulty imagining densely packed works and days for the gods. One of the founding myths of scientific practice is that science is carried out in an eternal present, from which all external influence has been banished. For, it is said, if a cat walks by a machine designed to detect gravity waves, then the measurement is invalid (Collins). And yet this present is an outcome of densely packed daily practice by scientists – a practice which has its chroniclers in the sociology of science.

The time which is the coin of the philosopher is in Tanaka’s term a time ‘synchronized’ over many disciplines and practices. It is the outcome of a massive work of building organizations, 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 (Burchfield 1990). However, in a messy, sprawling, gargantuan sort of a way it is a towering achievement. An achievement which beetles over its own particular mnemonic deep. The memory practices which are the subject of this book require an analysis of the textures of this time and of that deep. These practices constitute a space out of which the former and the latter are generated in all their generality and idiosyncrasy.

This book constitutes an attempt to chart out that space. The first two chapters deal with the nineteenth century and with synchronization. The first analyzes the work of synchronization then being carried out in terms of information – where information provided the ‘coin’ which allowed multiple endeavors – social and natural – to be synchronized one with the other. The second chronicles the archival technology which underwrote, wrote and filed this synchronization work – comparing this nineteenth century technology with its twentieth century counterpart. The second two chapters deal with the mid-twentieth century, with cybernetics and with synchronization. The third chapter looks at the synchronization then being carried in terms, again, of information – however an information that propagated along a different material substrate than nineteenth century information. The fourth chapter explores the kinds of memory of one’s own personal, species or disciplinary past produced by this particular kind of information based synchronization. The final chapter propels us into the mnemonic deep in the twenty first century. It evokes the spaces, entities and times which are excluded from this synchronization effort in the sciences of biodiversity today. The basic argument there is that this mnemonic deep is a textured mnemonic deep; the hope is (following Michel Serres) that my contribution will be to open up other possible spaces and times for human enquiry. A concluding chapter consigns this book to oblivion.

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» A practical flowsensitive and contextsensitive C and C memory leak detector. » Selfrefreshing memory in artificial neural networks learning temporal sequences without ca » Learning Games as a Platform for Simulated Science Practice. » eScience Experiences Software Engineering Practice and the EU DataGrid. » Practical FaultTolerant Framework for eScience Infrastructure. » The Application of Earth Science Findings to the Practical Problems of Growing Winegrapes. » Machine Science in Biomedicine Practicalities Pitfalls and Potential. » Ethics Review Practical Suggestions for Enabling Inclusi Science has not yet solved the puzzle of human memory (though great strides have been made). Some advice is presented on this site because I know it works, from having tried it myself. » Seventy healthy adults practiced a difficult memory exercise called "dual n-back training" on the computer for 8, 12, 17, or 19 days, five days a week. Those who trained increased their working memory and fluid intelligence significantly compared to controls who did not train. The more days trained, the larger the increase. » Meditation is an ancient mental discipline little practiced in Western countries until recently. While at first glance it appears those Tibetan monks aren't doing anything, they are engaged in a brain plasticity exercise that literally reshapes their brain in ways that improve memory and attention span.