

**Invention, Technology or History:
what is the Historiography of Technology about? ¹**

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Our brief in this session is to look at ‘both the continuing significance of some long-lived patterns in the scholarship of this field, and the importance of newer emergent trends and themes’, particularly in relation to ‘big questions that scholars – not just historians – might ask about technology, culture, and the world’. We were further asked for ‘insights about where historians of technology and the Society should be directing their scholarship and activities in the years ahead’. This is a tall and problematic order: what exactly is the field we should be considering, since the study of technology is clearly not confined to self-proclaimed historians of technology? How can we even begin to give a picture even of a field defined by membership of a learned body, let alone to suggest future directions, not just for historians of technology, but other sorts of students of technology? Indeed, one of my themes will be that we ought to distrust narratives of where the historiography of technology (and other studies of technology) has been, is, and is going. There are any number of questions that have been researched by many types of scholar, and there are perhaps even more to be researched and methods to be used. The exhortations that fields are or ought to shift to a particular method, problem or period, often seem to me to be to repress innovation rather than stimulate novelty.

Consider this: are there not many papers which assume a crude model of intellectual progress in the field doing the studying? Have not introductions to papers been (things are changing) replete with invocations of a field darkly ignorant in the past, enlightened in ‘recent years’ (embellished with a citation to a work *decades* old), and participating in a contemporary revolution? Oddly enough the targets of such introductions were typically demolished years ago: ‘whig history’, ‘technological determinism’, and ‘linear models’, and have not been taken seriously by anyone serious for a very long time, if ever. Yet, for example, in 2003 technological determinism could still be described as a ‘fast dying horse’, when it was surely either long dead, or the slowest dying horse in the

¹ This paper draws together arguments from ‘What Difference Does The History of Technology Make? Taking Low Things Seriously in an Age of High Theory’, which I gave to the 2004 Amsterdam meeting; a paper on ‘The uses of things: towards a global history of twentieth-century technology’, at the Big Issues and the future of HSTM Conference, Manchester, 23-25 June 2005; ‘Creole technologies and global histories: rethinking how things travel in space and time’, *HOST: journal of the history of Science and Technology*, Vol 1 No 1 (2007), pp. 75-112, [online](#), and *The Shock of the Old: technology and global history since 1900* (New York: Oxford University Press, 2007). See also my ‘De l’innovation aux usages. Dix thèses éclectiques sur l’histoire des techniques’, *Annales H.S.S.*, iv-v (1998), 815-37 (the English version is ‘From innovation to use: ten (eclectic) theses on the history of technology’, *History and Technology*, xvi (1999), 1-26, and [online](#)). My analysis here and in *Shock of the Old* goes further in that in 1998 I did not explain clearly enough that innovation-centric studies were not typically studies of innovation or invention as such.

annals of veterinary science.² The post-modernism turn, while in theory eclectic, playful about time and open to the marginal, in practice, often produced unconscious parodies of modernism, where we are enjoined to believe in a new age (determined by new technology), which demands new theory (which has been advancing toward the present) which is exemplified by particular heroic theorists, working towards a new One Best Way.³ In the 1980s historians of technology, so long objecting to the linear model view that technology was merely applied science, were being invited to accept as a significant theoretical novelty *applied sociology of scientific knowledge*, even though SSK was interesting because it applied to science what was *already* known about technology/politics/history. SCOT and ANT did open up new questions for some historians of technology, but as historians of technology we should be alert to alternatives, to paths not taken, and to the fact that not all change is progress, in thinking about technology as in technology itself.

Referring to Theory is not necessarily a sign of methodological sophistication, as the cultural historian Peter Mandler has noted.⁴ But, the prestige of Culture and (literary) Theory in the academy of the 1980s has to be factored into reflections on our conditions of knowledge production; for with it went an at best indifference to the economic, the institutional, the social.⁵ ‘Material history’ could hardly compete with ‘cultural history’; ‘material culture’ was much more cultural than material, as a browse through the ‘thing studies’ literature will quickly confirm. Studies of ‘consumption’ have been in fashion, while investigation of ‘production’ is passé. In this context it does not come as a surprise that the standard text on technological determinism of recent years *Does Technology Drive History?* was mainly neither about technology or history, but about beliefs in technological determinism.⁶ Another indicator is the extreme culturalism of Paul Forman’s recent reflection on the place of technology and science in modernity and post-modernity.⁷

² Michael G. Gordin, ‘A modernisation of “peerless homogeneity”: the creation of Russian smokeless gunpowder’, *Technology and Culture* (2003), p. 677

³ As an example see, Mark Poster, *Cultural History + Postmodernity: Disciplinary Readings and Challenges* (New York: Columbia University Press, 1997). While this tone is evident in programmatic statements, it is not generally noted that this reflects a profoundly modernist mode of thought. An exception is Richard Evans in his *In Defence of History* (London: Granta, 1997), pp.201-2, where he cites William Reddy noting ‘postmodernism’s replication of the eternally recurring pretension of absolute originality characteristic of intellectual debate since the Enlightenment’ (p. 278, note 15).

⁴ ‘The idea seems to be that if our findings or our arguments fit neatly into some widely accepted theoretical framework, then that will satisfy all the conceivable methodological concerns: theory provides that common language of argument ... and it also provides as much social science as we might need to ensure that our statements are anchored in a plausible understanding of human nature and social being’. Peter Mandler, ‘The Problem with Cultural History’, *Cultural and Social History*, Vol. 1, (2004), pp. 94-117

⁵ See the following reviews of John Law, *Aircraft Stories: decentering the object in technoscience* (London and Durham. Duke University Press, 2002): Eric Schatzberg, ‘On Attempting to Construct Alternative Narratives’, *Technology and Culture* Vol. 45 (2004), pp. 406-412 and David Edgerton in *Metascience* Vol. 12 (2003), pp. 85-7.

⁶ Merritt Roe Smith and Leo Marx (eds), *Does Technology Drive History? The dilemma of technological determinism* (Cambridge, MA: MIT Press, 1994)

⁷ Paul Forman, ‘The Primacy of Science in Modernity, of Technology in Postmodernity, and of Ideology in the History of Technology’, *History and Technology*, Vol. 23, (2007), pp. 1 – 152.

There is room, a need indeed, for a very different account of the field – one based on the critical examination of what historians concerned with technology have actually done over recent years. This workshop and indeed the classics revisited pages of *Technology and Culture* are to be very warmly welcomed as sites where a broader and richer picture is emerging. In this paper I do not pretend even to begin to survey recent work in a field so large and varied as the history of modern, largely twentieth century technology. I will instead confine myself to what seems to me to be the implicit and explicit big pictures which dominate *today's academic* histories, since for all the rhetorical decentring, deconstructing, incredulity towards meta-narratives, there is a usually implicit credulity towards *some* meta-narratives which we could usefully be explicit about. We need to be aware of these models and their power, so that we can ask and more importantly, answer, new and old historical questions of technology, and most importantly of all, seek to change our understanding of history in general through a fresh understanding of technology and its place in history.

What is the history of technology about?

My main interest here is not historiographical method, but substantive content: what has the historiography of technology been about? What has it been a history of? This question, it seems to me, is asked much less than what methods are used. To get a concise picture of a field is of course to very difficult, especially if one wants to highlight variety, complexity and quirkiness, to pick up and celebrate dissent. Yet we need to look to the dominant uniformities, the unspoken assumptions, the structuring stories that a field tells. A classic way of doing that is looking at textbooks and big-picture accounts meant for general audiences. We are fortunate that the history of technology now has a number of texts done by the best in the field in self-conscious attempts to bring together the scholarly output of the last few decades for students and the general public.⁸ It might be objected that the very attempt to create big picture accounts cuts against the grain of recent developments – towards the local and particular and so on, yet local and particular studies as often as not are located within familiar big pictures, at least implicitly. Very particular big pictures are everywhere in professional history of science, technology and

⁸ Thomas P. Hughes, *American Genesis: a century of invention and technological enthusiasm* (New York: Viking, 1989); Arnold Pacey, *Technology in World Civilisation: a thousand year history* (Oxford: Blackwell, 1990); R.A. Buchanan, *The Power of the Machine: the impact of technology from 1700 to the present* (London: Viking, 1992); Donald Cardwell, *Fontana History of Technology* (London: Fontana, 1994) known in the US as the *Norton History of Technology*, and more recently as *Wheels, Clocks and Rockets: a history of technology*; Carroll Pursell, *White Heat: People and Technology* (University of California Press, 1994); Carroll Pursell, *The Machine in America: a social history of technology* (Baltimore: Johns Hopkins University Press, 1995); Ruth Schwartz Cowan, *A Social History of American Technology* (New York: Oxford University Press, 1997); Thomas P. Hughes, *Human-Built World: How to Think About Technology and Culture* (Chicago: University of Chicago Press, 2004); Thomas J. Misa, *From Leonardo to the Internet: technology and culture from the Renaissance to the present* (Baltimore: Johns Hopkins University Press, 2004); Mikael Hård and Andrew Jamison, *Hubris and Hybrids : a Cultural History of Technology and Science* (London: Routledge, 2005); David Nye, *Technology Matters: Questions to Live With* (MIT Press 2006); Robert Friedel, *A Culture of Improvement: Technology and the Western Millennium* (Cambridge, MA: MIT Press, 2007)

medicine though, because research has focussed on the local, perhaps insufficient critical attention has been given to implicit big pictures and big arguments which shape the choice, context and argument of local studies. There is a risk that a local study is fitted into to very standard stories of how science, technology and medicine changed the world, a sophisticated account of the laboratory feeds into crude and more often than not very familiar accounts of a world the laboratory has supposedly made. If there is a major difference between local and big pictures (as I think there ought to be!) that would certainly be worth highlighting and discussing, perhaps at this meeting.

My crude and rash conclusion, which I shall attempt to justify empirically in a moment, is that big-picture accounts of technology in history are neither concerned with invention, nor with technology, nor yet with history. Instead the focus of interpretation is on the historical illustration of the nature of technological change, taking selected technologies at early stages of their lives, placing them in a familiar historical context. That the difference between these two statements is not at all obvious is another way of making my point: that the history of technology uses very particular definitions of technology and history. This is not a criticism, for it shares these conceptions with, and is thus in touch with, a much broader scholarly and public community, for example STS, history of science, and much of the rest of history, as well as many of the understandings of technology and history found in the wider public sphere. That in itself is a controversial point, since historians of technology have (rightly) stressed fundamental differences in approach in their work from that of historians of science, or the understanding of the general public: my point is that we have overlooked crucial similarities.

Reviewing the Derry and Williams' *Short History of Technology* the 1961 condensation of the multi-volume *History of Technology* published by Oxford University Press, Thomas P. Hughes lamented that 'influenced by prior scholarship they have generally written of the history of technology as if it were identical with the history of invention', and this despite their very broad definition of technology, which was not restricted to invention.⁹ Despite Hughes' complaint, the identification of technology with *successful* invention/innovation and the early histories of particular technologies lives on powerfully, and is well exemplified in most modern as well as older textbooks and big-pictures. Let us start with Robert Friedel's new *Culture of Improvement* which will go to the top of the list as the as the standard text for an introductory Charlemagne-to-George-Bush course in the history of technology. The introduction tells us the subject matter is the "nature of technological change", why and how technological change has changed, and how the changes have changed. It promises to be a history of invention and innovation, and most particularly and interestingly of 'improvement' in technology. The term is well chosen, for it avoids the usually misleading, and almost always post-hoc distinctions between radical and incremental inventions, and such-like distinctions. Improvements can be small or large, and apply to all technologies, whether old or new. Yet the book does not systematically address improvement, but is instead a familiar account of selected western technologies at early points in their history. Agriculture thus appears in a chapter on medieval heavy plough, the horse, and three-course rotation and

⁹ Thomas P. Hughes, *Isis*, Vol. 54, (1963), pp. 417-418, review of T. K. Derry and Trevor I. Williams, *A Short History of Technology: From the Earliest Times to A. D. 1900* (1961) [Stable URL](#):

again in the nineteenth century with mechanisation and fertiliser being applied. But, the greatest ever age of agricultural improvement in the rich ‘west’, the late twentieth century, is not discussed. The subjects of the four chapters on the twentieth century are the early histories of strategic bombing, the nuclear bomb, dams and electrification, computers, the internet, jets and supersonic airliners, eugenics, television and radio with bicycles as nearly the only small scale machine.

The choice of technology and of the period they are important in is in no way eccentric. Thus in Tom Misa’s recent *From Leonardo to the Internet*, 1870-1930 is discussed in terms of research and invention in electricity and chemicals; 1936-1990 in terms of the *wartime* history of the atomic bomb, electronics and computing; and 1970-2001 in terms of the fax, hamburgers and the internet.¹⁰ Unusually and interestingly 1900-1950 is also dealt with in terms of modern architecture, but otherwise, apart from the hamburger, the technologies and periodisations are very similar to the choice of technology in works on the history of US technology in their coverage of the twentieth century: the interwar period tends to have electricity, motor cars, and aviation, and the period of Second World War and later is deemed to be the age of nuclear power, computers, space rockets, and the internet. Writing of the USA, Ruth Schwartz Cowan claims explicitly that ‘four technological systems have dominated twentieth century history: automobiles, and their attendant roads and fuel sources; aircraft, spacecraft and also rockets; electronic communication devices; from wireless telegraphy to personal computers; and finally, biotechnologies, new foodstuffs, medications, and contraceptives’, an argument which has the virtue of insisting on the simultaneous existence of these systems.¹¹ The innovation-centredness of history of technology is still present when a serious attempt is made to engage with broader history. Thomas Hughes has, after all, written a famous book called: *American Genesis: a century of invention and technological enthusiasm* (1989), which is focussed on early stages of a similar range of familiar technologies. More recently Pauline Maeir, and Merritt Roe Smith, Alexander Kayssar and Daniel Kevles have written a textbook of American history which includes much material on *innovation* in science, technology and medicine: the book is called, *Inventing America: a history of the United States*, but it is the usual suspects, for example the atom bomb in the second world war.¹²

For all that they concentrate on early history, such studies are not histories of invention or innovation; they are not concerned with the analysis of invention and innovation in particular historical periods. For where they do so they would be largely histories of failure, and would be much more broad-ranging in the technologies they covered.¹³ Nor are they histories of technology in the sense of studies of technologies which were in use in particular historical periods. The history of technology-in-use is radically different

¹⁰ Thomas J. Misa, *Leonardo to the Internet: technology and culture from the Renaissance to the present* (Baltimore: Johns Hopkins University Press, 2004).

¹¹ Ruth Schwartz Cowan, *A Social History of American Technology* (New York: Oxford University Press, 1997), p. 221.

¹² (New York: Norton, 2003), 2 vols.

¹³ Ian Inkster, “Patents as Indicators of Technological Change and Innovation –An Historical Analysis of the Patent Data”, *Transactions of the Newcomen Society*, Vol. 73, (2003), pp. 179-208.

from these accounts of early history both in its chronology and range of technologies that are significant. What we have is a *conflation* of particular stories of invention/innovation/use. And that is partly because the term ‘technology’ has itself come to represent such a conflation. Eric Schatzberg shows, ‘technology’ is a much changing, fluid and recent concept, and indeed that ‘technology’ became identified with technological novelty only recently.¹⁴ That ‘technology’ is immediately associated with developing, changing, new, technology is clear from an analysis of the way in which it is studied in other contexts. It is revealing that the key concept of ‘technological determinism’ has been routinely defined as something along the lines of ‘technical change causing social change’ rather than in terms of technology shaping society, the old, standard definition. It is also significant that in STS and history of technology circles it was primarily criticised as a theory of technology, rather than what it classically was: a theory of society and history.¹⁵ The innovation-centric definition of technology is central to most work in the social construction of technology (SCOT) and actor-network theory (ANT) traditions.¹⁶ It is also there, despite immediate appearances, in Ruth Schwartz Cowan’s call for the study of the ‘consumption junction’, and in Ruth Oldenzeit’s subsequent arguments that studying users shows women active in the *shaping* of technology.¹⁷ Studies of *users* and innovation, going back to the 1970s, and later developed under the SCOT tradition, and recently extended, are similarly primarily concerned with users and changing technologies.¹⁸ Of course, there is nothing wrong with focussing on the history of early use of new technologies. It is indeed a very interesting topic. The danger comes when this particular topic becomes conflated with the study of technologies in use, or indeed the history of invention.

There are of course many studies of technology-in-use, indeed many studies by economic, military, business historians are exactly of this sort. Although it should be noted that very many accounts involving technology written by economic historians, especially those of a Schumpeterian inclination, tend to be very innovation-centric, for example, the works of David Landes and Joel Mokyr. Among self-proclaimed historians of technology such studies are rarer, though they are becoming more common. In its focus on technologies-in-use it has distinguished predecessors, including the work of feminist historians like Ruth Schwartz Cowan,¹⁹ historians concerned with the

¹⁴ Ruth Oldenzeit, *Making Technology Masculine: men, women and modern machines in America, 1870-1945* Amsterdam University Press, 1999; Eric Scharzberg, ‘Technik Comes to America: Changing Meanings of Technology before 1930’, *Technology and Culture*, Vol. 47, (2006), pp. 486-512.

¹⁵ For examples see Edgerton, ‘From innovation to use’.

¹⁶ A criticism made by Langdon Winner, who had long been concerned with use, in "Upon Opening the Black Box and Finding it Empty: Social Constructivism and the Philosophy of Technology" in *Science Technology & Human Values* Vol. 18, no 3 (Summer 1993): 362-378.

¹⁷ Ruth Schwartz Cowan, ‘The Consumption Junction: A Proposal for Research Strategies in the Sociology of Technology’, in Wiebe E. Bijker, et al., eds., *The Social Construction of Technological Systems* (Cambridge: MIT Press, 1987), pp. 261-280

¹⁸ Ruth Oldenzeit, ‘Man the Maker, Woman the Consumer: The Consumption Junction Revisited’ in Londa Schiebinger et al, *Feminism in the Twentieth Century. Science, Technology and Medicine* (Chicago: Chicago University Press, 2001); Trevor Pinch and Nelly Oudshoorn (eds), *How Users Matter: The Co-Construction of Users and Technologies* (Cambridge, MA: MIT Press 2003).

¹⁹ Siegfried Giedion, *Mechanization takes command : a contribution to anonymous history* (Oxford University Press, 1948); Ruth Schwartz Cowan, *More work for mother : the ironies of household*

environment, and historians of technology, for example a pioneering paper by Svante Lindqvist, and recent texts on contraception and 'brute force technologies'.²⁰ At the level of textbooks, the works of Arnold Pacey notably *The Maze of Ingenuity* (1974 and 1992) and Carroll Pursell (eg *White Heat: people and technology* (1994)) have been much less innovation-centric than the norm. Yet, we don't have anything like an adequate picture of the technological constitution of the world even in the much-studied twentieth century.

If there is a conflation of innovation and use resulting in a history of the early history of widely-used technologies being the central focus (rather than either the history of invention or the history of use) it is clear that very particular technologies come up again and again and in much the same period. There is enough consistency of choice of supposedly central technologies to suggest a common understanding, yet enough variation in dates and arguments to suggest no detailed analysis of significance. All the technologies chosen have certain features in common, and that is that they have long had high cultural visibility and have long been claimed to be central to the history. They have long been embedded in political discussion, in museums, in books for adults and children. I asked a group of students starting a course on the history of twentieth century technology, and thus interested in such matters, what the important technologies were, and when were they most important. They answered quickly, and showed how well-informed they were by saying: flight (1903); nuclear (1945), contraception (1955); internet (1965).²¹

The choices of the historians follow, broadly speaking, the claims made by all sorts of earlier analysts, which themselves follow contemporary claims at innovation for the importance of particular technologies, in particular periods. In *Technics and Civilization* Lewis Mumford celebrated the *neotechnic* revolution (the term was coined by Patrick

technology from the open hearth to the microwave (New York : Basic Books, 1983), C. Fischer, *America Calling: A Social History of the Telephone to 1940* (Berkeley: University of California Press, 1992); K. Jellison, *Entitled to Power: Farm Women and American Technology* (Chapel Hill: Duke University Press, 1993); Cynthia Cockburn and Susan Ormrod, *Gender and Technology in the Making* (London, 1993); Stewart Brand, *How buildings learn : what happens after they're built* (London: Viking, 1994). See also Carroll Pursell, 'Seeing the invisible: new perceptions in the history of technology', in *ICON* Vol. 1 (1995): 9-15.

²⁰ Svante Lindqvist, 'Changes in the Technological Landscape: The Temporal Dimension in the Growth and Decline of Large Technological Systems', in O. Granstrand, ed., *Economics of Technology* (Amsterdam: Elsevier, 1994); Vaclav Smil, *Energy in World History* (Boulder: Westview Press, 1994); Ronald Kline, *Consumers in the country : technology and social change in rural America* (Baltimore, MD ; London : Johns Hopkins University Press, 2000); John McNeill, *Something New under the sun: an environmental history of the twentieth century* (London: Penguin, 2000); Andrea Tone, *Devices and desires : a history of contraceptives in America* (New York : Hill and Wang, 2001); Paul Josephson, *Industrialized nature : brute force technology and the transformation of the natural world* (Washington, DC : Island Press, 2002). An excellent recent example is Kenneth Lipartito and Orville R. Butler, *History of the Kennedy Space Center* (University Press of Florida, 2007).

²¹ To make clear that this is not just a problem with technology we need to think about texts, syllabi, embedded assumptions on the history of twentieth century *science*. Do not *research* in molecular biology, and physics dominate, or more accurately, certain branches of academic biology and physics? Nuclear weapons are very big, and computers/information, again often around the second world war, making a good deal of headway. Leave out computers and students will want to know where it is; leave out chemistry and no-one even notices.

Geddes, but rendered into the English *new technology* makes its meaning and significance clearer) being brought about by electricity and new alloys, which would replace the technics of the *paleotechnic* age. Mumford was not the first or the last to think in this way. For example, Harry Elmer Barnes, a noted US historical sociologist (and as it happens a pioneering Holocaust denier), thought in 1948 that the world had gone through three industrial revolutions, the first of iron, steam and textiles; the second of chemistry and large industries, steel, and new communications; and the third, still occurring in 1948, was ‘the age of electrification, automatic machinery, electric control over manufacturing processes, air transport, radios and so on’. A fourth was on the way: ‘with the coming of intra-atomic energy and supersonic stratospheric aviation we face an even more staggering fourth Industrial Revolution’.²² The left too thought in these terms. For Ernest Mandel, writing in the 1960s, the first industrial revolution had been based on the steam engine, the second on the electric motor and the internal combustion engine, and the third, of which the ‘warning signs’ appeared in the 1940s, was based on the nuclear energy and electronically-control automation.²³ A British communist historian writing in the mid-1960s, and one who believed in only one industrial revolution, treated the period since the war in terms of atomic power, computers, automation and space exploration.²⁴ In the Soviet Union the idea of a ‘Scientific-Technical Revolution’, centred on automation, became Communist party doctrine from the mid-1960s. In the 1950s many believed that there had been a ‘scientific revolution’ in the early to mid 20th century, associated with aeroplanes, electronics, and atomic power, which followed on the industrial revolution of the early nineteenth century. Others later transferred the idea of a scientific revolution back to what became the ‘second industrial revolution’ based on ‘science-based’ electricity and chemicals in the late nineteenth century, and took this to be the key revolution which affected the twentieth century. More recently, we have tended to move back to a one industrial revolution model, which does away with the details of development of industrial society. The alleged point is that the revolution now underway is much more radical: it is moving us from an industrial society to an information or knowledge society, through the actions of the digital computer and the internet. Yet multiple-revolution theories have remained in play. Take the so-called ‘long-wave’ theories, which see the world economy going through fifty year cycles of activity were in vogue from the late 1970s into the 1980s.²⁵ A particularly popular variant of these accounts claimed that each up-swing corresponded to a particular set of growth-generating technologies. A recent list by the doyen of such studies, Christopher Freeman, is revealing for its detail, the tangles this kind of thinking gets one into, and the awful familiarity of the chosen technologies. The key changes are as follows: 1895-1940 - *electrification* for which the key technologies are steel and heavy engineering, and heavy electrical engineering and heavy chemicals; the core inputs are steel, copper, and metal alloys; communications are achieved by railway, ship and telephone, and industry is organised in giant firms, and work through ‘Taylorism’. From 1941 to some unspecified

²² Harry Elmer Barnes, *Historical Sociology: its origins and development. Theories of Social Evolution from Cave Life to Atomic Bombing* (New York: Philosophical Library, 1948), p. 145

²³ Ernest Mandel, *Marxist Economic Theory* (London: Merlin Press, 1968), p. 605

²⁴ Samuel Lilley, *Men Machines and History* second edition (London: Lawrence & Wishart, 1965)

²⁵ Chris Freeman and Francisco Louçã, *As Time goes by: from the industrial revolutions to the information revolution* (Oxford: Oxford University Press, 2002)

date in the late twentieth century, *motorisation* was central, the key technologies were automobiles, trucks, tanks, tractors, diesel engines, aircraft, and oil refineries; the key inputs were oil, gas and synthetic materials, the means of communication radio, motorways, airports and airlines; the forms of production were mass production and consumption, ‘Fordism’ and ‘hierarchy’. The third twentieth century wave, of unspecified dates, was the *computerisation* of the entire economy, the key technologies were computers, software, telecommunications equipment and biotechnology; the core input was the integrated circuit; the key mode of communication the ‘information highways’; the key organisational form, the ‘network’.²⁶ In the most recent book in this tradition the dates change: there has been a wave lasting from 1908 to 1971 associated with a ‘techno-economic paradigm’ of Oil, the Automobile and Mass Production, followed by the usual computer/internet wave.²⁷

My point is not necessarily that the technologies studied are not the most important, it is that there is no need to show this, to compare, or to be specific and time and place. We have such confidence in the standard narratives that we don’t, typically, ask these basic historical questions. We should.

The Question of History

In his review of Derry and Williams, Hughes lamented their failure to integrate the history of technology into history, despite claiming that they did.²⁸ The focus on history, of placing technology within its historical context, has been central to US history of technology for decades, evident in for example the work of Hughes and his students, and in the American Historical Association/SHOT pamphlet series.²⁹ It is one of, perhaps the greatest of, SHOT’s high ambitions for the history of technology. Yet that engagement with history must necessarily be a partial one where the focus is on a small group of technologies at an early stage in their history. More importantly, in general, though not always, putting technology into history has not meant starting with history. As the SHOT constitution rather oddly, it might seem, puts it: ‘The purpose of the Society shall be to foster interest in the development of technology and its relations with society and culture, and to promote scholarly study of the documents and artifacts of the history of technology’. Most SHOT sessions are organised by technology and theme, not historical period, nor historical question (though of course some are). Very often even the explicit

²⁶ Chris Freeman and Francisco Louçã, *As Time goes by: from the industrial revolutions to the information revolution* (Oxford: Oxford University Press, 2002), passim, but see summary table p. 141.

²⁷ Carlota Perez, *Technological Revolutions and Financial Capital: the dynamics of Bubbles and Golden Ages* (Cheltenham: Edward Elgar, 2002). Nathan Rosenberg and Claudio Frischtak wrote a devastating critique of such writings as they first appeared see their ‘Technological Innovation and Long Waves’, *Cambridge Journal of Economics* (1984); reprinted in Nathan Rosenberg, *Exploring the Black Box* (Cambridge: Cambridge University Press, 1994). Of course it did not stop production of such work. The key long -wave innovator was the East German Gerhard Mensch, who published in German in 1975.

²⁸ Thomas P. Hughes, *Isis*, Vol. 54, (1963), p.417.

²⁹ Hughes has, after all, written a famous book called: *American Genesis: a century of invention and technological enthusiasm* (1989). For Hecht, ‘The history of the [early] French nuclear program is ... both a history of technology and a history of France’ Hecht, *Radiance of France* (1998), p. 4. See also Pauline Maier, and Merritt Roe Smith, Alexander Kayssar and Daniel Kevles *Inventing America: a history of the United States*(New York: Norton, 2003), 2 vols

aim is to contribute not the history of technology, but to say something about the nature of technology, with what, for example, Tom Misa calls in his big picture account, after Martin Heidegger, ‘the question of technology’.³⁰ The subject of Friedel’s book is, as we have noted, ‘technological change’. Revealingly too the reader of Friedel’s book is invited to think of the ‘moral’ questions around technology. The recent works of Hughes and David Nye are concerned explicitly with the nature of technology and its relations to wider culture, not with history.³¹

The apparent primacy of the question of technology helps explain what to someone like myself who has worked a great deal addressing the historiography of twentieth-century Britain, is an oddity. While political and economic historiography will routinely seek to engage *critically* with the work of other historians, if one attends SHOT meetings, or reads articles in the history of technology, it is surprising how few and far between are the *critical* references to *specific* historical arguments about technology or about history more generally. Indeed, it is striking just how rare criticism of good positions, or even debate between them, is in the pages of say, *Technology and Culture*.³² Where it does exist, it tends to be over methodological issues, and not over substantive interpretations of the history of particular technologies in particular periods. So a provocation: understanding what is wrong with, say, the great work of Tom Hughes is of more consequence for the development of the field than what is right with some approach to the study of technology, and infinitely better than inventing new flogging technologies that require the reviving of long dead horses like whig history, technological determinism, linear models to show their power. What deserves criticism is our own academic work, not straw men.³³ Of course the standard mode is understandable, even necessary: historians of technology teach non-specialists; the public interested in the history of technology is a public primarily interested in technology.³⁴ In terms of academic audiences too, historians of technology address non-specialists in history – the common interests are much more likely to be science and technology or indeed particular theoretical approaches to the study of science and technology, rather than history.

³⁰ Thomas J. Misa, *Leonardo to the Internet: technology and culture from the Renaissance to the present* (Baltimore: Johns Hopkins University Press, 2004). My assessment thus differs in this respect from that of Eda Kranakis who hailed the book in that ‘it puts technology back into mainstream history’. *Technology and Culture* Vol. 46, (2005), p. 812, an interesting comment in that it suggests that previous attempts had not succeeded in this!

³¹ David Nye. *Technology Matters: Questions to Live With* (MIT Press 2006); Thomas P. Hughes, *Human-Built World: How to Think About Technology and Culture* (Chicago: University of Chicago Press, 2004).

³² There are partial exceptions for example the exchange between Ken Alder and Charles Gillespie in *Technology and Culture* Vol. 39 (1998), pp. 733-754.

³³ Paul Forman, “Independence, Not Transcendence, for the Historian of Science,” vol. 82 *Isis* (1991), 71–86; “British Scientists and the relations of Science and War in Twentieth Century Britain,” in *National Military Establishments and the Advancement of Science: Studies in Twentieth Century History*, Paul Forman and J.M. Sanchez Ron eds. (Dordrecht: Kluwer, 1996).

³⁴ This has become particularly clear to me in surveying responses to my *Shock of the Old* – what has been of interest to most reviewers has been what I say about technology, rather than technology in history, or history.

Perhaps a consensual approach to history was necessary for a programme of ‘contextual history’ of technology which locates its subject matter within its historical context. Without an implicit consensus about context the programme could easily become rather strained: which historians’ account would count as context would become the subject of contention. But contention is a key part of participation in the wider historical project. There is however a more significant flaw in contextualism: it assumes that the existing historical work which defines the context, does not already have a particular account of technology in it. But, it does, resulting in a potential problem of circularity. Let me give you a concrete case. I once thought that histories of the English aeroplane were de-contextualised. But I was wrong: it would have been pointless to contextualise the history of the English aeroplane in national history using the usual histories, for the aeroplane was already there. The problem was one of rethinking the already contextual history of the English aeroplane, and the history of England as conventionally written.³⁵

One way out of these problems in the history of science and technology has been to write the ‘history of content and context together’, to write a history from all the materials to hand, a programme strongly influenced by the work of Bruno Latour and his critique of social construction.³⁶ Co-production and mutual constitution of technology, politics history are interesting and illuminating concepts, not least because it does get us away from bashing at technological determinism.³⁷ Nevertheless I want to argue for a different kind of post-contextual history, one which avoids the Latourian temptation of seeing the world being recreated from scratch in the laboratory, and one which follows the scientists and engineers a little too closely. For post-contextual histories can too easily themselves depict the world as scientists and engineers imagined it to be, to assume the world was created as scientists and engineers claimed it would be. It is hard to find a usable sense of co-production of technology and a nation, much less technology and the world, outside a framework shaped by scientists and engineers themselves.

A different kind of post-contextual history is possible, and I think necessary. It needs to get away from its focus on scientists and engineers, and their originality, and to examine the extent to which, for example, the ideas of scientists and engineers, about science and technology to politics, are derivative rather than original. It needs to examine carefully the assumptions that are made in accounts of technology, and the context. That means understanding the standard narratives, often derived from popular sources, that shape our accounts (for example, in making them so innovation-centric). The point of a post-

³⁵ See my *England and the Aeroplane* (London: Macmillan, 1991) and now [online](#).

³⁶ ‘...without regard for traditional distinctions between history of science and history more generally, and especially without centering research upon an archive demarcated by such distinctions. Such an approach would blur the disciplinary identity of historians of science, of course, but no one is better placed than historians of science to speak of the *truly* integral place of science in global history, and the end result might be a clearer view of global history itself’ Andy Pickering, ‘The Rad lab and the World’, *British Journal of the History of Science* Vo. 25 (1992), p. 251. Latour is of course right to warn against the use of context (given by existing social science or history) to explain other knowledge. We shouldn’t explain say technology through sociology; fine, but Latour often confounds sociology with society; in order to understand society, and how it relates to technology, we need to understand sociology and criticise it in connection with empirical materials.

³⁷ Hecht *Radiance* is a very good example of this post-contextualist approach.

contextual picture is to give us a *different account* of the national and global historical context, and the place of technology in it, not merely adding technology to accounts, or glossing those of scientists and engineers.³⁸ In this post-contextual history thinking about existing big pictures and how they have affected the historiography of all sorts is a crucial, but preliminary, part of the wider enterprise.

The Global

Thinking about poor world in the twentieth century is a good example of the need to rethink object and context, and the underlying assumptions made in our accounts of both. It hardly figures in global histories,³⁹ and even less does it have a place in histories of technology.⁴⁰ A key built-in assumption is that the poor world, with some notable exceptions (which I discuss further below) *lacks* modern technology. The exception which proves the rule, is the routine mention of the ‘green revolution’ of the 1960s and 1970s in poor parts of Asia, often the only reference to agriculture in texts on the twentieth century. The neglect of even the most modern agriculture goes along with a much wider neglect of non-industrial technologies in studies of the twentieth century: the horse, the camel, the donkey cart, the wooden plough or the handloom, are seen as technologies of previous historical eras, not to be considered as part of the twentieth century. That they are primarily associated with a poor world, makes them even more invisible as technologies, even in the poor world.⁴¹ Our conceptualisation of these technologies reveals a deeply embedded assumption of how technological space and time works, one in which spatially separated rich and poor are put on a temporal scale, as ‘developed’ and ‘developing’, and in which we date technologies by invention. We may scoff at such naiveté, but we should beware the extent to which implicit unhelpful definitions of technology remain in play in the most sophisticated works. Francesca Bray has rightly called for the decentring of the standard ‘western’ account of technology, and thus for example, not to judge Chinese technology of the 18th century, say, by the standard stories of British technology: different technologies were central.⁴² That is a crucial point, but we should not believe that the standard stories give an adequate account of ‘western technology’, and we should also note that studies of technology in the poor

³⁸ For examples see my *Warfare State: Britain 1920-1970* (Cambridge: Cambridge University Press, 2005), and *The Shock of the Old* which attempts to rethink standard accounts of production, war, nations, killing and invention.

³⁹ Peter Worsley, *The Three Worlds: culture and world development* (London: Weidenfeld and Nicolson, 1984) is a rare case.

⁴⁰ An important and honourable exception is Arnold Pacey, *Technology in World Civilisation: a thousand year history* (Oxford: Blackwell, 1990) which has a fair amount on poor countries in twentieth century.

⁴¹ For an excellent review which parallels many of the arguments developed here see David Arnold, ‘Europe, Technology and Colonialism’, *History and Technology* Vol. 21 (2005), pp. 85-106

⁴² Francesca Bray, ‘Technics and Civilisation in late Imperial China: an essay in the cultural history of technology’, *Osiris* second series Vol. 13 (1998), pp. 11-33. Bray does not challenge the innovation-centredness of most accounts of western technology. Indeed, while one would expect anthropologists, archaeologists and so on to concentrate on use of established technologies, nevertheless in practice, innovation becomes central when ‘technology’ comes into the frame. Thus Pierre Lemonnier notes of his own collection of essays that ‘most papers are concerned [not with invention but] with a subsequent step of the process of innovation, that of "choosing" what to do with a new technical element, whether it has been contrived locally or not’. Pierre Lemonnier (ed.), *Technological Choices: transformation in material cultures since the Neolithic* (London: Routledge, 1993), p. 21.

world in the nineteenth and twentieth centuries, even by post-colonial historians, focus precisely on (some) technologies brought from the rich world. The case of the ‘green revolution’ has been mentioned. But the list is longer. Thus Gyan Prakash notes that to ‘speak of India is to call attention to the structures in which the lives of its people are enmeshed – railroads, steel plants, mining, irrigation, hydro-electric projects ... and now, the bomb’.⁴³ The long list he produces hardly includes anything which did not come from outside India, and was not central to Western accounts of modernity. This is far from unusual, for most studies of that well-studied case of India, when dealing with ‘technology’, take this to mean railways, dams, does not include, to anything like the extent merited, the technologies most Indians used (though one should not underestimate indeed the importance of such things as railways in India). The interest is not primarily in the material basis of Indian life, but in technology, which almost by definition it seems, comes from the West, and is defined by what counts as technology in the histories.⁴⁴ This is not to say we should not study railways, dams, or nuclear weapons in the poor world – far from it. It is to say that they do not exhaust the category ‘technology’ in the poor world (just as it does not in the rich world), even that which originated in the rich world. We don’t have a good account of the distinctiveness of the new poor world as it emerged in the twentieth century. We have neither an appreciation of the significance of ‘traditional’ technologies – whether the crucial agricultural ones or any others – nor those brought by colonising states, nor indeed that came in from the rich world through to native populations though trade, like the neglected cases of consumer durables like the bicycle and the sewing machine.⁴⁵ Yet we need to go further and see the poor world as a distinctive *technological* world, not merely a derivative one, or one which was a hybrid of rich and poor worlds. The poor world, was particularly fast-growing and changing in the twentieth century. It depended on a complex, original and changing technological landscape which included, importantly, mass technologies first developed elsewhere but used in distinctive ways, what I call *creole* technologies.

Concluding remarks

We have many critiques of what is taken to be old-fashioned history of technology – that it is masculine-oriented, production-oriented, materialistic, determinist, internal etc – and prescriptions for new approaches, focussed on consumption, the domestic and so on. But we don’t in fact have even a coherent traditional account of technology and history in the twentieth century. The standard stories are, I am suggesting, not as robust as they appear. We are a very long way from even a rudimentary understanding of ‘technology’ in the twentieth century. The technological aspects of practically any topic one cares to mention are very poorly understood – production, killing, war, nations, even innovation itself. We have big questions, and big issues to address, which are surprisingly open. While

⁴³ Gyan Prakash, *Another Reason: science and the imagination of modern India* (Princeton: Princeton University Press, 1999), p. 3.

⁴⁴ See for example the papers covering the 20th century in Morris Low (ed.), *Beyond Joseph Needham: Science, technology and medicine in East and South East Asia*, *Osiris* second series, Vol. *Osiris* 13 (1998); Roy MacLeod and Deepak Kumar (eds), *Technology and the Raj: Western Technology and Technical Transfers to India, 1700-1947* (New Delhi: Sage 1995); David Arnold, *Science, Technology and Medicine in Colonial India* (Cambridge: Cambridge University Press, 2000).

⁴⁵ A point also well made by David Arnold, ‘Europe, Technology and Colonialism’, *History and Technology* Vol. 21 (2005), pp. 85-106

disagreeing with Rosalind Williams that the ‘technological age’ is recent, I would strongly endorse her view of the potential importance of the history of a technology ‘whose ultimate goal is understanding how history works’.⁴⁶ That project is however, far from easy. I will require taking pride in as well as criticising the good work done on the history of technology. That will mean counteracting what Australians usefully call the ‘cultural cringe’; the term is used as a criticism of local intellectuals who underrate the production of their locality, and overestimate foreign high culture. It is a real problem for the history of technology since the very lowness and ubiquity of technology which makes it significant in history, but these very qualities make it suspect for intellectuals, making the temptations of theory and culture all the greater. Claiming historical importance for technology –the dread technological determinism – is the mark of very vulgar history indeed. But the real problem is that our accounts of technology are quite inadequate compare to those of society; we can’t even begin to test the technological determinism thesis.

Getting to grips with the problem of technology in history means mucking in with (and criticising) unfashionable areas of historical enquiry like business, economic and military history, with, if you like, material history rather than cultural history. Indeed we need to mix with writers even lower down the food chain, the amateur specialists on ploughs, tractors, aeroplanes, rickshaws, aircraft, small arms, electric toasters We need to embrace not only history from below but historiography from below.

⁴⁶ Rosalind Williams, ‘Opening the Big Box’, *Technology and Culture*, Vol. 48, (2007), pp. 104-116, p. 104