Creole technologies and global histories:

rethinking how things travel in space and time

By David Edgerton[*]

The Uruguayan writer Eduardo Galeano once wrote: 'la diosa tecnología no habla español' [the Goddess Technology does not speak Spanish].[1] Indeed historians of technology in many parts of the world are told the equivalent. Most of us, it is claimed, don't speak technology; don't have technology to speak of.[2] As I have argued elsewhere, in order to be able to write a history of technology which is both global and historical, and which engages directly with more

[*] Imperial College London. I am most grateful to participants at the Lisbon workshop on "The Circulation of Science and Technology: Places Travels and Landscapes" for their comments, as well as to Waqar Zaidi, anonymous referees, Tiago Saraiva, and especially to Eric Schatzberg.

[1] Eduardo Galeano, *Las Venas abiertas de America Latina* (Buenos Aires/México, D. F.: Siglo XXI, 1978), first published 1971, p. 381.

[2] This point has been made to me by many colleagues from around the world, and also by an American historian of technology, Pauline Kusiak, who noted that in Senegal, the Senegalese were astonished to find her studying 'technology' in their country.

than a tiny minority of white males, we need to break the unfortunate association, indeed conflation, that exists between invention and innovation on the one hand, and technology on the other. [3] In this paper, which draws on a chapter in a forthcoming book, I focus on twentieth-century horse transport in the rich world, and explore the new technologies of the poor world, and especially of its megacities.[4] By looking at these cases I show the continued vitality of what is taken to be a technology of previous centuries, and demonstrate how its twentieth growth and survival cannot be understood as persistence. Secondly, I show how the spectacular growth of the poor city depended on new technologies of poverty, which had origins elsewhere. I use this case to explore what I call *creole* technologies.

Conflating use/innovation and past/present

The vast majority of accounts of technology (academic and popular) conflate technology with technological

[3] See my "De l'innovation aux usages. Dix thèses éclectiques sur l'histoire des techniques", *Annales H.S.S.*, 1998, 53:815-837 (the English version is "From innovation to use: ten (eclectic) theses on the history of technology", *History and Technology*, 1999, 16:1-26) and Svante Lindqvist, "Changes in the Technological Landscape: The Temporal Dimension in the Growth and Decline of Large Technological Systems", in Economics of Technology, ed. O. Granstrand (Amsterdam: Elsevier, 1994), pp. 271-288.

[4] David Edgerton, *The Shock of the Old: technology and global history since 1900* (London: Profile; New York: Oxford University Press, 2007), translated as *Innovación y tradición: historia de la tecnología moderna* (Barcelona: Crítica, 2007), and into Portuguese by Editora Zahar, Rio de Janeiro. The book contains chapters on Significance, Time (which is drawn on here), Production, Maintenance, Nations, War, Killing, and, Invention.

novelty (invention/innovation/creativity). Such studies cannot usefully contribute to a rethinking of standard accounts of technology and society, for they are concerned neither with what technologies actors had available to them, nor indeed what was invented. Rather they focus on the early history of *some* technologies which later became important. Yet despite such limitations, such studies, implicitly and explicitly, do seek to say something about both invention/innovation and the relations of technology and society. Yet if we do want to examine these we need studies of technology-in-use on the one hand, and of inventtion/innovation on the other. This will yield a dramatically different picture to the one implicit in most existing accounts, and will allow us furthermore, to engage with and challenge, standard general historical accounts.

As well as conflating invention/innovation and use, most writing about past technology is not concerned with the place of technology in history, but with something subtly but significantly different. Its aim is to illustrate with examples from the past, what one historian calls, after Martin Heidegger, 'the question of technology'.[5] That is, the main concern is with exploring the nature of technology, its malleability, relation to culture, and so on. This helps us to understand more why so little work set in the past is concerned with historical arguments about technology, let alone challenging existing historical pictures. Its concerns are elsewhere.

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

The conflation of invention/innovation and technology is deep-seated. It is found not only in older studies, but is central to most work in the social construction of technology (SCOT) and actor-network theory (ANT) traditions.[6] It is also there, despite immediate appearances, in Ruth Schwartz Cowan's call for the study of the 'consumption junction', and in Ruth Oldenzeil's subsequent arguments that studying users shows women active in the *shaping* of technology.[7] 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.[8] It is revealing too that the key concept of 'technological determinism' has been routinely defined as something along the lines of 'technical change causing social change' rather than the older definition of technology shaping society. 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.[9]

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6 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", *Science Technology & Human Values*, 1993, 18: 362-378.

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

8 Ruth Oldenziel, "Man the Maker, Woman the Consumer: The Consumption Junction Revisited" in *Feminism in the Twentieth Century. Science, Technology and Medicine*, ed. Angela N. H. Creager, Elizabeth Lunbeck, Londa Schiebinger (Chicago: Chicago University Press, 2001), pp. 128-148; Trevor Pinch and Nelly Oudshoorn eds., *How Users Matter: the Co-Construction of Users and Technologies* (Cambridge, MA: MIT Press, 2003).

9 For examples see Edgerton, "From innovation to use".

In recent years there have been serious and rewarding efforts by historians of technology to engage with general histories of the nation and the world. Yet here too and innovation-centric picture of technology has been central. Thomas Hughes has written just such a book, explicitly committed to a providing a history of America. It is called, appropriately and revealingly, *American Genesis: a century of invention and technological enthusiasm*.[10] More recently Pauline Maier, 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*.[11] Global histories of technology too are innovation-centric. One very recent world history of technology illustrates this. The period 1870-1930 is discussed in terms of research and invention in electricity and chemicals; 1936-1990 in terms of the *war time* history of the atomic bomb, electronics and computing; and 1970-2001 in terms of the fax, hamburgers and the internet.[12] Such a list of technologies, in this chronological form is, apart from the hamburger, far from idiosyncratic. It is 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

[10] Thomas Hughes, *American Genesis: a century of invention and technological enthusiasm* (New York: Viking 1989).

[11] Pauline Maier et al., *Inventing America: a History of the United States* (New York: Norton, 2003), 2 vols.

[12] In Misa, *Leonardo to the Internet*, 1900-1950 is also dealt with in terms of modern architecture.

later is deemed to be the age of nuclear power, computers, space rockets, and the internet.[13] One historian of the United States 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.[14]

Innovation-centredness is also found in the global histories of writers other than professional historians of technology. So-called 'long-wave' theories, which see the world economy going through fifty year cycles of activity, driven by innovation, are a good example.[15] The Schumpeterian focus on innovation is also central to the global historical work of David Landes and Joel Mokyr: for

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[13] This is my reading of Thomas Hughes' *American Genesis*, and recent textbooks namely 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); and Thomas J. Misa, *Leonardo to the Internet*.

[14] Schwartz Cowan, *A Social History of American Technology*, p. 221.

[15] Chris Freeman and Francisco Louçã, *As Time goes by: from the industrial revolutions to the information revolution* (Oxford: Oxford University Press, 2002); 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, *Das technologische Patt: Innovationen überwinden die Depression* (Frankfurt: Umschau Verlag, 1975).

them a few innovations are of crucial importance, and are discussed mainly around the time of innovation.[16] Many global histories show a Smithian focus on technologies of communication, with, again, a strong innovation-centric bias.[17] We need to stress that these are not studies *of* innovation, but rather of studies of the economy, *focussed on* innovation.

Our understanding of the technology (and science) of the twentieth century is thus, I suggest, nowhere near as securely based as we routinely assume; our mental maps need redrawing. Our shared accounts of rich-world technology are systematically biased by a conflation of stories of innovation and use, and the focus on technologies and sciences of high cultural resonance at the early stages of diffusion. We have many critiques of what is taken to be old-fashioned history of technology – it is taken to be masculine-oriented, production-oriented, materialistic, determinist, internal etc which is to be countered by new approaches. But we don't in fact have even a coherent productionist, masculine, materialist account of technology (either of technology-in-use or invention) and history in the twentieth century.[18]

To produce a full account of technology we need a new approach. It needs to distinguish clearly between use and invention/innovation, and to focus on each. It should not be concerned with replacing the study of innovation with

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16 David S Landes, *The Unbound Prometheus: technological change and industrial development in Western Europe from 1750 to the present* (Cambridge: Cambridge University Press, 1969); Joel Mokyr, *The Gifts of Athena: historical origins of the knowledge economy* (Princeton University Press, 2002).

17 For example, J.R. McNeill and William H. McNeill, *The Human Web: a bird's-eye view of World History* (New York: Norton, 2003).

18 Thanks to Eric Schatzberg for helping me formulate this point.

the study of use but rather needs to recognise the significance of the distinction for the study of each. 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 environment, and historians of technology, above all Svante Lindqvist.[20] In the history of invention, oddly enough, it has fewer recent works of note to draw on, especially for the twentieth century.[21] The shift away from the conflation of technology and innovation is just the beginning. We need to be concerned with all kinds of technologies. Rather than seeking to replace a history focussed on high-tech, masculine, industrial technologies with low-tech, the feminine and the domestic, we need to deal with both, with the aim of getting a sense of the material basis of human existence. We need also, I would argue, to engage with history, and not just the question of technology,

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[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 technology from the open hearth to the microwave* (New York: Basic Books, 1983); Cynthia Cockburn and Susan Ormrod, *Gender and Technology in the Making* (London: Sage, 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", *ICON*, 1995, 1:9-15.

[20] Svante Lindqvist, "Changes in the Technological Landscape" (cit. n. 3); John McNeill, *Something New under the sun: an environmental history of the twentieth century* (London: Penguin, 2000); Vaclav Smil, *Energy in World History* (Boulder: Westview Press, 1994); Paul Josephson, *Industrialized nature : brute force technology and the transformation of the natural world* (Washington, DC: Island Press, 2002); Andrea Tone, *Devices and desires: a history of contraceptives in America* (New York: Hill and Wang, 2001); Ronald Kline, *Consumers in the country: technology and social change in rural America* (Baltimore, MD / London: Johns Hopkins University Press, 2000).

[21] Though see Kees Gispen, *Poems in Steel: the politics of invention from Weimar to Bonn* (Oxford: Berghahn, 2001).

and to do it in a particular way, offering a new kind of post-contextualist history to those already available.

This point requires a brief elaboration. One of the great aims of historians of technology has been to write contextual histories of technology/innovation, that is to say histories which locate their subject matter within their historical context. Historians of technology/innovation have become experts not just in particular technologies but in particular contexts.[22] But what is the context? Is it the conclusions of other historians? If so, which? Histories are as contested as we want technologies to be. There are deeper problems still: contextualism assumes that technology was not present in the literature on the context, and explicitly that was often the case. But there is a great difficulty here, which is that existing historical work, and indeed contemporary sources, already have a particular account of technology in them. No history of the USA, or of Britain, or anywhere, in the twentieth century, especially, does not already have an implicit history of science and technology in it. There is a problem of circularity.

One way out of all these problems is write the 'history of content and context together', to write a history from all the materials to hand.[23] This leads to the use of concepts like

[22] Those contexts have often been national, just as most histories are national, which raises problems in itself.

[23] Andy Pickering calls for histories '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

co-production and mutual constitution of technology, politics, history. They are useful not least because they get us away from bashing at technological determinism.[24] But there is a real risk in using this approach of falling for the Latourian temptation of seeing the world being recreated from scratch in the laboratory, and of following the scientists and engineers a little too closely. The danger is that we end up reproducing (yet again, I would argue) their accounts of national and world history, even if it is with a different gloss and in new language.[25]

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.[26] 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

history itself.' Andrew Pickering, "The Rad lab and the World", *British Journal of the History of Science* , 1992, 25: 247-251, p. 251.

[24] Gabrielle Hecht, *The Radiance of France: Nuclear Power and National Identity after World War II* (Cambridge, MA: MIT Press, 1998) is an example, in part, of this approach. See also Michael Allen and Gabrielle Hecht eds., *Technologies of Power: essays in honor of Thomas Parke Hughes and Agatha Chipley Hughes* (Cambridge, MA: MIT Press, 2001).

[25] See for example, Bruno Latour, "Give me a laboratory and I will raise the world", in *Science Observed*, ed. K. Knorr-Cetina and M. Mulkay (London: Sage, 1983), pp.141-170 and *Aramis: The Love of Technology* (Cambridge: MA, Harvard University Press, 1996).

[26] For elaboration of these points see my "British Scientific intellectuals 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*, eds. Paul Forman and J.M. Sanchez Ron (Dordrecht: Kluwer, 1996), pp. 1-35.

shape our accounts (for example, in making them so innovation-centric). The point of a post-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.[27]

Thinking about twentieth-century horsepower, and technology and poor world is a good example of the need to rethink object and context, and the underlying assumptions made in our accounts of both. Let us start with the poor world: rarely taken seriously by sociologists or historians, it hardly figures in global histories.[28] Some explanation of the term is required: I use it to mean that majority of places in the world, where the great majority of the population are and have been, by the standards of western Europe and north America, very poor. In other words, I am referring to those places we more usually study under labels like 'colonial', 'post-colonial', 'developing', and 'third world', none of which ever applied to all poor countries of the twentieth century.

In relation to technology the poor world is especially invisible. For innovation-centric history of technology the poor world does not exist as it has not been a significant technical innovator in recent centuries.[29] Thus a key built-in assumption in many kinds of treatments is that the poor

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[27] 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, by focussing on what technologies were in use.

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

[29] 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.

world, with some notable exceptions (which I discuss further below), *lacks* modern technology. This rule is proved by the exceptions to it. Many general texts on technology will mention the 'green revolution' of the 1960s and 1970s in poor parts of Asia. This is also interesting in that it is illustrative of the deep association between agriculture and poverty: it is rare to find other references to agriculture after 1945, even 1900, in histories of technology. That should be a matter of surprise, since there was a radical transformation in agriculture in the rich world, particularly after the mid-twentieth century, when agriculture saw much greater rates of productivity change than industry, and at much greater rates than before. This green revolution made a huge impact on patterns of world trade, belying the standard image of a poor agricultural world exporting food to a rich industrial world. The USA exported wheat to the USSR in the 1970s and 1980s and on a huge scale, and continues to export raw cotton to the whole world, including China.

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. Yet they, just like the aeroplane and the motorcar, were made, maintained, and used, and changed throughout the last century. They existed in the same, interconnected world. 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 not fall for the idea that we have an adequate account of the technology of the rich world, which we have to 'decentre' to get a decent account of the poor world. We have to decentre that account to get a good account of the technology of both.[30]

Twentieth-century animal power in the rich world

The history of twentieth century technology in rich countries, as well as poor countries, usefully starts with technology usually seen as old, perhaps even obsolete, merely persisting anachronistically, like horse-power.[31] If we were to date the age of horsepower by its maximum use, rather than by its innovation, it would be much more recent than the history books allow. Twentieth-century horsepower was not a left-over from a pre-mechanical era; for example, the gigantic horse-drawn metropolis of 1900 was new. In Britain, the most industrialised nation in the world in 1900, the use of horses for transportation peaked not in the early

[30] David Arnold, "Europe, Technology and Colonialism", *History and Technology*, 2005, 21:85-106, argues for the significance to the study of European technology of studying colonial technologies. My point here is more general.

[31] See, again, the seminal paper by Svante Lindqvist, "Changes in the Technological Landscape" (cit. n. 3).

nineteenth century but in the early years of the twentieth. How could it be that horse transport expanded at the same time as trains pulled by 'iron horses'? The answer is that economic development and urbanisation went hand-in-hand with more horse-buses, horse-trams, and horse carriages. In addition, while train and ship carried goods over long distances, over shorter distances horse-drawn vehicles became ever more necessary. Thus visitors to London's Camden Market, on the site of a huge railway yard and interchange with the canal system, will note that many of the old buildings were stables.[32] These were not there to house animals used for riding in nearby Regent's Park, but for draught animals. In 1924 the largest and most progressive British railway company, the London, Midland and Scottish railway had as many horses as it had locomotives – 10,000. By contrast it had just over a thousand motor vehicles. In 1930 the LNER railway had 7,000 steam locomotives and 5,000 horses, and only about 800 motor vehicles.[33] There is no doubt though, that by 1914 in the great rich cities of the world, horse transport was giving way to the motor-powered buses, lorries and cars, and electric-powered trams.

In agriculture, the horsepower peak was to come later. For example, in Finland the horse population peaked in the 1950s because they were used in logging. The United States provides the most graphic example. Agricultural

[32] 60% of Britain's capital stock in railways as it stood in 1961 was constructed before 1920, and 54% of harbours, docks and canals. See Geoffrey Dean, "The Stock of Fixed Capital in the United Kingdom in 1961", *Journal of the Royal Statistical Society* A, 1964, 127:327-351.

[33] E.J. Larkin and J.G. Larkin, *The Railway Workshops of Britain 1823-1986* (London: Macmillan 1988), pp. 230-233.

horsepower peaked in 1915 with more than 21m on American farms, up from 11m in 1880, a level to which it had returned by the mid-1930s.[34] The US case is particularly interesting because at the beginning of the twentieth century it had highly mechanised agriculture, but this was horse-powered agriculture. We are apt to underestimate the implications of relying on horsepower in the country-side. At the peak of agricultural horse use in Britain and the USA, about one-third of agricultural land was devoted to their upkeep: horses were large consumers of grass, hay and grain.[35] Mechanised agriculture helped the USA become the richest large nation in the world, and one that by the 1910s was by far and away the largest producer of motor-vehicles.

In one area of twentieth-century life, the use of horses for transport was particularly remarkable. The Great War and the Second World War are seen as industrial wars, as feats of engineering and science and organisation. And so they were. Because of this both involved huge numbers of horses, which, like men, were conscripted. Every belligerent depended on them, as well as on mules, and other beasts of burden. Before the Great War, the small British army had 25,000 horses but by the middle of 1917 the great new mass British armies had 591,000 horses, 213,000 mules, 47,000 camels and 11,000 oxen. In late 1917 there were 368,000 British horses and 82,000 British mules on the Western Front alone, hugely outnumbering British motor vehicles.

34 *Historical Statistics of the United States: Colonial Times to 1957* (Washington: US Bureau of the Census, 1960), pp. 289-290.

35 Colin Tudge, *So shall we Reap* (London: Allen Lane, 2003), p. 69.

This was not a question of a deluded commitment to cavalry. Only one third of the British horses on the Western Front were for riding (and only some of these were in cavalry units) – the great majority transported the vast quantities of *materiel* required in modern war, particularly from the railheads to the front. The use of horses was not an exceptional emergency measure to make use of Britain's existing horses. Horses were desperately needed, and Britain bought 429,000 horses, and 275,000 mules from North America, and imported vast quantities of fodder too. Britain's ability to exploit world horse markets was crucial to its military power.[36] In any case the British were not unique. The vast American armies pouring into Europe in 1918 equipped each of their very large infantry divisions with 2,000 draught horses, another 2,000 riding horses, and no fewer than 2,700 mules: one horse or mule for every four men.

An even starker example of the continuing importance of the horse is provided by the Second World War. The German army, so often portrayed as centred on armoured formations, had even more horses in the Second World War than the British army had in the Great War. The horse was the 'basic means of transport in the Germany Army'. German rearmament in the 1930s involved mass purchase of horses such that by 1939 the army had 590,000, leaving 3m others in the rest of the country. Each infantry division needed around 5,000 horses to move itself. For the invasion of the Soviet Union in 1941, 625,000 horses were assembled. As

[36] John Singleton, "Britain's Military Use of Horses 1914-1918", *Past and Present* , 1993, 139:178-203

the war progressed the German horse army got ever larger as the Wehrmacht pillaged the agricultural horses of the nations it conquered. At the beginning of 1945 it had 1.2 million horses; the total losses of horses in the war are estimated at 1.5m.[37] Could it be that the Great War and the Second World War saw more horses in battle than any previous war? Could it be that the draught-horse to soldier ratio also increased, despite the use of other forms of transport?[38] Certainly the Wehrmacht embarked on its march to Moscow with many times more horses than Napoleon's *Grand Armée*.

There is no doubt that the global horse and mule population dropped from the early decades of the twentieth century. Horses disappeared from rich cities and from the fields of rich countries. Yet in some parts of the world not only did animal traction remain important, but became more important as animals replaced human power. In one dramatic case, animal power replaced tractors. Cuban agriculture was transformed from the early 1960s with Soviet and east European agricultural machinery and supplies, leading to a downgrading of animal traction. But the collapse of the Soviet bloc in 1989 led the Cuban government to develop an animal traction programme. The agricultural horse population recovered, but the main focus was on oxen. They were

37 R. L. DiNardo and A. Bay, "Horse-Drawn Transport in the German Army," *Journal of Contemporary History* , 1988, 23:129-41

38 This compares with 300 draught horses in a Saxon division in the Napoleonic wars (a 1:20 draught horse:man ratio). http://www.napoleon-series.org/military/ organization/c_saxon11.html. I have seen estimates for the grand armée of around 50,000 draught horses for an invading army of around 400,000.

bred and trained in large numbers, and the technical infrastructure needed to use them was built up. The recovery in the number of oxen was spectacular. Numbers had fallen from 500,000 in 1960 to 163,000 in 1990 but increased to 380,000 in the late 1990s. These huge numbers of oxen replaced 40,000 tractors. [39]

Not Alphaville but bidonville: technology and the poor megacity

The story of the poor world and technology if it is told at all is one of transfer, resistance, incompetence, lack of maintenance, and enforced dependence on rich-world technology. Imperialism, colonialism, and dependence were the key concepts, and the *transfer* of technology from rich to poor, the main process.[40] There have been calls 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 of standard stories of British technology: different technologies were central.[41]

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39 M. Henriksson and E. Lindholm, "The use and role of animal draught power in Cuban Agriculture: a field study in Havana Province", *Minor Field Studies 100*. (Uppsala: Swedish University of Agricultural Sciences, 2000), citing Arcadio Ríos, *Improving animal traction technology in Cuba* (Havana: Instituto de Investigación Agropecuaria 1998).

40 For an excellent review which parallels many of the arguments developed here see David Arnold, 'Europe, Technology and Colonialism' (cit. n. 30)

41 Francesca Bray, "Technics and Civilisation in late Imperial China: an essay in the cultural history of technology", *Osiris* second series, 1998, 13:11-33. I would make the additional point that we should not believe that the standard story applies to the industrialised 'west' either. Bray does not challenge the innovation-centredness of most accounts of western technology. Indeed, while one would expect anthropologists,

That is a crucial point, yet studies of technology in the poor 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'. [42] 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.[43] This is not to say we should not study railways,

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's 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.

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

43 See for example the papers covering the 20th century in Morris Low (ed.), *Beyond Joseph Needham: Science, technology and medicine in*

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. Whatever the view taken of what technology has done in the poor world, what 'technology' is has not been seriously debated.[44]

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

East and South East Asia, *Osiris* second series, 1998, 13; 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).

44 For some white European intellectuals in the interwar years, a critique of western industrial civilisation was built on celebration, often with noble savage overtones, of the ancient less corrupted cultures of Africa and Asia. A very few non-white intellectuals, and fewer African and Asians were themselves putting this forward, among them Rabindranath Tagore and Mahatma Gandhi. See Michael Adas, *Machines as the Measure of Men: Science, Technology and ideologies of western dominance* (Ithaca: Cornell University Press, 1989), pp. 380-401.

45 A point also well made by David Arnold, "Europe, Technology and Colonialism" (cit. n. 30).

technologies first developed elsewhere but used in distinctive ways. The technologies of the poor megacity, and particularly the materials from which is has been made, are a key case: they represent, today, a distinctive, new technology of poverty.[46]

It is easy to underestimate the importance of the poor city in the twentieth century. Through the twentieth century they have growth at remarkable rates, as the poor world grew in population much faster than the rich world, and urbanised quickly too. By the end of the century (in stark contrast to the beginning) most of the largest cities of the world were poor places: where once Paris, London, and New York led in scale and opulence, the largest cities of 2000 were places few would seek to emulate: São Paolo, Jakarta, Karachi, Mumbai (Bombay) Dhaka, Lagos, and Mexico City. These cities did not replicate the earlier experience of Berlin or Manchester. These were not cities of horses, or of trains, or spinning mules, or great electrical or chemical industries. They do not conform to the standard story of modernity.

Central to this new urbanisation was the growth of the slum, or shanty town, though we must beware this language, for the terms used describe many different types of housing. For example the *favelas* of Rio de Janeiro are connected to electricity and water while the *asentamientos* (settlements) of Guatemala City are dark at night. At first sight, the term slum might refer, as it generally did in the rich world, and in many parts of the poor world, to decayed old

46 Gustavo Riofrio and Jean-Claude Driant *¡Que Vivienda han construido? Nuevos Problemas en viejas barriadas*, (Lima: CIDAP/IFEA/TAREA 1987).

parts of cities where the poorest lived. But in the later twentieth century in particular a new kind of slum, a newly-built, one might say purpose-built one, arose. The optimistic term 'pueblos jovenes', or young towns, used to describe the slums of Lima says something important about them. Shanty towns were built without architects or engineers or building contractors, or according to building regulations; they were not made for cars or trains, let alone the information super-highway.

We need to be particularly wary of the characteristic definitions of slums in terms of the *lack* of facilities characteristic of rich cities, like permanent structures, particular forms of sanitation, or electricity. We need to ask not what technology the shanty town *lacks*, but what it has. For poor cities had particular and often novel systems of building, of sanitation, or supply of water, of food and all the other necessities of life, which were not traditional but new. They proved capable of sustaining a new kind of rapidly expanding urban existence on an enormous scale, even if usually a miserable one. One modern technology of the slum was the Kenyan 'flying toilet'. A plastic bag, that ubiquitous product of the post-Second World War chemical industry, was used not only to defaecate into, but to dispose of what was once quaintly called night soil: the bag was tied, taken outside, swung around, and hurled away as far as possible from one's patch.[47]

[47] *Slums of the World*, p. 25 – quoted in Mike Davis, "Planet of Slums", *New Left Review*, second series, 2004, 26:5-34.

The modern materials from which many slums are built is sometimes inscribed in their very names. The early temporary slums of North Africa were known as *bidonvilles*, for the buildings were made from opened-up and flattened-out oil drums (*'bidons'*). The term is now generic in French. The Arabic term for *bidonville* in Morocco is *mudun safi*, 'metal towns'. The Durban slum dwellings are called *imijondolos* in Zulu, possibly derived from the use of wood from crates that had carried John Deer tractors in through the port in the 1970s.[48]

One material stands out in the development of the poor world, rural and urban, and that is 'corrugated iron', 'galvanised iron' used for making 'tin roofs'. In the nineteenth century, it spread around the world to areas of British army operation as transportable housing. It also became a key material for building roofs and walls of white settler communities in Australia, New Zealand, and the Americas, where it is now of interest as a vernacular architecture. It was hugely important in the twentieth century as a truly global technology. Its cheapness, lightness, ease of use, and long life, made it an ubiquitous material in the poor world in a way it never had been in the rich world. A visitor to West Africa in the Second World War noted of 'Ibadan, then the largest town in black Africa. … [it] had grown in less than a century from a local market into a city with nearly 100,000 inhabitants – though alas, as so often in Africa, the houses

48 http://www.ucl.ac.uk/dpu-projects/Global_Report/pdfs/Durban.pdf *Understanding Slums: case studies for the Global Report on Human Settlements* Development and Planning Unit, UCL. See http://www.ucl.ac.uk/dpu-projects/Global_Report/

were mostly roofed with galvanized iron'.[49] Today Ibadan is at one end of a shanty-town corridor of 70 million people.[50] Its roofs, to judge from aerial photographs, are still rusted corrugated iron.

Corrugated iron was not just an urban technology. It was used to replace thatch roofs on traditional rural buildings as well. In Rwanda corrugated iron was first used by the Belgian colonizers for their public buildings. By the end of the twentieth century a lighter type was the standard roofing material of even the poorest homes. Farmers' houses build of adobe had corrugated iron roofs, and were called *terres-tôles* (earth-sheets). As the only part of the house villagers cannot make, the iron roof became a prized possession, it was looted from Tutsis homes in the genocide of 1994. As the tables turned, Hutu refugees trudged to the Congo bearing sheets on their backs, others buried them in their fields.[51]

As in other technologies, there has been innovation in corrugated iron, in both shapes and materials. It has become lighter and stronger, available in many more grades and types. New shapes of corrugations have been used, and new coating introduced. Yet the long-established sinusoidal corrugations still dominate the cheapest grades.

A second key cheap and new material was asbestos cement, especially corrugated asbestos-cement. Asbestos-

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49 Julian Huxley, *Memories* (London: Allen & Unwin, 1970), Vol. 1, p. 269

50 Mike Davis, "Planet of Slums", p. 15.

51 Jean Hatzfield, *A Time for Machetes. The Rwandan genocides: the killers speak*. (London: Serpent's Tail, 2005), pp. 71-75 [First published in French, 2003].

cement was patented in 1901 by an Austro-Hungarian, Ludwig Hatschek, an asbestos producer. He called his invention 'Eternit', and the material and the name have both been long lasting. Production started by a Swiss company of the same name in 1903, which became a major multinational with branches all over the world. Eternit still means asbestos-cement in many places; in others it was called 'Uralite' or 'Uralita'. Although this is not always clear, by far the main use of asbestos – a fibrous mineral – has been for the manufacture of asbestos-cement (also known as fibro-cement), and the main uses of this material were corrugated roofing, sheets for building work, and water and sewage pipes. It has been a key material in modern urbanisation. At the beginning of the century it was primarily used in North America; after the Second World War its use boomed in North America, and particularly in Europe, but growth took off in Asia, South America and Africa in the 1960s and 1970s.[52] Unfortunately asbestos was found to be a serious carcinogen, and its use was progressively banned in North America, Europe and elsewhere. As a result, world production fell from the mid-1970s. But at the end of the century production was still at the levels of the 1950s. Even in the

[52] The ten largest consumers of asbestos 2000 were Russia 446,000 tons; China 410,000 tons; Brazil, 182,000 tons; India 125,000 tons; Thailand 120,000 tons; Japan 99,000 tons; Indonesia 55,000 tons; Korea 29,000 tons; Mexico 27,000 tons; Belarus 25,000 tons, and these countries accounted for 94% of the world total. Robert L. Virta *Worldwide Asbestos Supply and Consumption Trends from 1900 to 2000* (Reston , VA: U.S. Geological Survey), http://pubs.usgs.gov/of/2003/of03-083/of03-083-tagged.pdf

1990s in South Africa, 24% of new subsidized housing had asbestos-cement roofing.[53]

The Martinican/French writer Patrick Chamoiseau, in his novel *Texaco,* the great novel of the shanty town, reflected a new understanding of the poor city that was emerging in the 1960s and 1970s. In *Texaco* the history of Martinique is divided into the age of the ajoupas (shelters) and long-houses, the age of straw, the age of crate wood, the age of asbestos (fibro-cement), and the age of concrete, reflecting the key materials of the shanty towns.[54] In the age of asbestos, asbestos-cement sheet was used for walls; the roofs were of corrugated iron. Thereafter the people bought the occasional a bag of cement to make their world more stable and secure. One of the characters in the book is a new model urbanist who began to understand this novel kind of city. Indeed, 'self-help housing', and '*auto construcción'*, became terms of art in urban planning, recognising that houses were being built in vast numbers, well outside the standard networks of modernity.

Creole technologies

Corrugated iron, asbestos-cement, and cement were not invented in the poor world, they were first exported to it, and then locally-produced. The growth of the poor world went along with a massive increase in use of these 'old' tech-

53 Appendix 8 of *The socio-economic impact of the phasing out of Asbestos in South Africa, a study undertaken for the Fund for Research into Industrial Development, Growth and Equity (FRIDGE), Final Report* http://www.nedlac.org.za/research/fridge/asbestos/

54 Patrick Chamoiseau, *Texaco* (London: Granta, 1997).

nologies from the rich world, and yet also, importantly, it was a story of the spread of distinctive uses of these technologies. One can usefully describe them as *creole* technologies, not least as a way of pointing to the fact that most technologies in use are to varying extents creole. By a creole technology I mean one which finds a distinctive set of uses outside the time and place where it was first used on a significant scale. Thus it is to be distinguished from transferred technologies, though I include the latter in cases where the transferred technology is essentially no longer in use in the originating territory. Often, but not necessarily, these technologies originating elsewhere combine in original ways with local technologies, forming hybrids, which not only combine creole technologies with local technologies, but also themselves become new creole technologies.

We can explore these points further by examining the meanings of the term creole (*criollo* in Spanish, whence the term comes). The original meaning of creole is local derivatives of something originally from elsewhere, used specifically to describe the locally-born white and black populations of the Americas – descendants of European settlers, *and* African slaves, in contradistinction to the indigenous population. Creole means derived from, but different to, the originating case. Thus the creole horse of the Americas, originating from beasts brought by the Spanish and Portuguese conquistadores, entered a horseless world, yet became different from the horses of the Old World. The term creole also carries the sense of earthy, local, genuine, vulgar, popular, in contrast to the sophistication of the metropolitan. These are the senses in which I use the term here. Yet I also allow into

it elements of another sense from which it generally needs to be radically distinguished. In the United States in particular the term has come to be associated with hybridity, that is the mixing of traditions, races, cultures, and this is the sense in which it has found limited use in the history of science.[55]

The most straightforward sense of creole technology is that the basic imported technology got a new lease of life in the poor world. There were many cases of late adoption and long use in the poor world of rich-country technologies. A small example would be that carrier pigeons were introduced to the police services in Orissa (India) in 1946 and were only phased out in the 1990s. The Indian motor-vehicle industry provides some better-known examples. From the 1950s the 1955-model Royal Enfield Bullet motorcycle was manufactured in India. Production of the same model continues to this day at the rate of 10,000 a year in the original Madras factory, and with methods which still involve little assembly-line work. Hindustan Motors in Uttarpara, West Bengal still make the Ambassador, based on a mid –1950s Morris Oxford Series II motorcar. Production started in 1957 and to date 800,000 have been produced. The history of the Volkswagen Beetle is a particularly notable case given the

55 Stuart George McCook, *States of Nature: Science, Agriculture, and Environment in the Spanish Caribbean, 1760-1940* (Austin: University of Texas Press, 2002); Peter Galison, *Image and Logic: a material culture of microphysics* (Chicago: Chicago University Press, 1997). It is also used for languages – the languages of languages of the ex-slaves of the colonies, principally in the Caribbean that went from 'pidgin' simplified versions of English French, Portuguese, Spanish etc, to become separate 'creoles'. On language see Ronald Segal, *The Black Diaspora* (London Faber, 1995) chapter 34. The concept of 'hybridity' has been in vogue for a while in many fields, now including the study of technology. See Mikael Hård & Andrew Jamison, *Hubris and Hybrids: A Cultural History of Technology and Science* (London: Routledge, 2005).

scale of production of the car. By the early 1970s it had overtaken the Model T Ford as the car most widely produced in the world (15m), and it would continue to be produced, reaching a total of 21m. The end of production came in Mexico in 2003, where it had been in made since 1954. Brazilian production stopped in 1986 and restarted in 1993, and finally came to an end in 1996, long after finishing in Germany.

Communist China had its own distinctive attitude to old technologies of production, which provide examples like those above, and also an interesting variant. It pursued a 'walking on two legs' policy of industrialisation that has been called 'technological dualism'. The first leg was large-scale, urban, factory production, using models brought from the Soviet Union. This was a huge effort of transfer of technical skills, models, designs, and factories – China long remained a producer of Soviet technology. Till the end of the 1980s China was making Soviet trucks and steam locomotives from the 1950s. Steam train buffs flocked to the sidings and marshalling yards of China, for only in mid 1980s did diesel and electric locomotives overtake production of steam.

The second was locally run, small scale industry, reliant on local raw materials, and supplying local needs, usually the agricultural sector. These industries were based on centrally-supplied designs of technologies, usually themselves based on 'old' technologies that had gone out of use elsewhere in the world. From the late 1950s – 'backyard iron and steel' production, together with small-scale cement kilns, fertiliser plants, agricultural machinery workshops, food processing works, power generation, and mining, boo-

med under the Great Leap Forward. Fertiliser production was a rare example of a novel technology, for local fertiliser plants made a fertiliser used nowhere else in the world – ammonium bicarbonate.[56] The Great Leap cost the lives of millions and resulted in the waste of precious technical and natural resources. With its failure many local enterprises closed. But many did not, and survived till the next great expansion phase for these industries, the Cultural Revolution. By 1971 60% of fertiliser production came from small plants; 50% of cement; 16% of hydro generating capacity; overall around 10% of Chinese factory output.[57]

Varieties of creole transport technologies

Transport in the poor world provides rich examples of creole technologies of a kind which showed important elements of technical change. The poor megacities of the East had different transport patterns from the great rich cities of 1900, or even of 1930, but had transportation technologies which were in the most part derived from those common in these rich cities. Yet the patterns of development were different. Rich world cities never had, for example, the bicycle or motor-cycle densities of the megacities of late twentieth-century Asia. Indeed bicycle and motor bicycle production boomed in the world, particularly in the poor world, from the 1970s. For the first time in many decades bicycle produ-

[56] Carl Riskin, "Intermediate Technology in China's rural industries", in *Appropriate Technologies for Third World Development*, ed. Austin Robinson (London: Macmillan, 1979), pp. 52-74.

[57] Carl Riskin, "Intermediate Technology".

ction surged ahead of motor car production. In recent years around 100m bicycles were produced every year and only around 40 m cars. In 1950 there were around 10m of each, remaining about equal to 1970. The great change was the expansion in Chinese production to 40-50m bicycles from a few million in the early 1970s.[58] In addition Taiwan and India between them were, at the end of the century, making more bicycles than were produced in the world in 1950. Not only that but bicycle-derived technologies of the poor megacity provide an instance of a rich instance of creole technology.

In 2003 it was reported that the City of Calcutta was still trying to get rid of the hand-pulled rickshaw, long gone from most of the rest of Asia. These rickshaws were deemed old-fashioned even by the standards of long-gone hand-rickshaws: Calcutta's had spoked wheels, but not ones derived from bicycle technology: they were made of wood, and were rimmed with solid rubber rather than pneumatic tyres. Surely these were survivals from the distant past?

In fact the hand-pulled rickshaw, far from being an ancient invention, was apparently devised in Japan in the 1870s, though similar things had been in use in Europe on a small scale. The rickshaw replaced the palanquin/sedan chair. Use boomed from the very late nineteenth century, first in Japan, where numbers peaked around 1900. Use quickly spread in Asia. In Singapore their numbers peaked in the early 1920s, while Calcutta saw hand-rickshaw growth in

[58] See the statistics in World Watch Institute, *Vital Signs 2003-2004* (London: Earthscan, 2003) and earlier editions.

the 1920s and 30s. In most places the hand-rickshaw went out of use after the Second World War, condemned as a barbarous machine humiliating the poor pullers.

The cycle-rickshaw (sometime called a trishaw) was, as an invention, almost as old as the rickshaw; yet as a thing-in-use it peaked even more recently.[59] Developed in the 1880s, it found hardly any use until around 1929 in Singapore, where by 1935 they outnumbered hand-pulled rickshaws. They appeared in Calcutta around 1930, Dhaka around 1938; and Jakarta around 1936. By 1950 they were present in every country in south and east Asia. Japan had never had many. There were variations in design across countries but relatively little within countries. The most common was that with the passenger sitting behind the driver (India, Bangladesh, China, the Macao 'triciclo'). But the version with the passengers forward of the driver was also common, for example the Indonesian 'becak', Vietnamese 'cyclo', and the Malysian 'trishaw'. Others had the passenger to the side, as in the Philippines 'sidecar', the Burmese 'sai kaa', and the Singapore 'trishaw'.[60]

Far from disappearing after the Second World War, the number of cycle rickshaws continued to *expand* rapidly in the 1960s and 1970s. It was estimated in the late 1980s that there were 4 million in world, and that the number was still increasing overall though in some countries there were decreases. Dhaka was the capital of the cycle rickshaw with

59 I am indebted to a marvellous book: Rob Gallagher, *The Rickshaws of Bangladesh* (Dhaka: The University Press, 1992).

60 See Tony Wheeler and Richard l'Anson, *Chasing Rickshaws* (London: Lonely Planet, 1998).

some 300,000 at the end of the twentieth century. A subsequent creole technology, unknown in the rich cities of the world is the scooter-based taxi. From the 1950s these 'auto-rickshaws', appeared in India, based on the scooter. Similar designs have spread all over Asia (for example the Thai 'tuk-tuk' and the Bangladeshi 'baby-taxi').

The cycle rickshaw was an urban, not a rural, machine. It followed, rather than preceded, seemingly newer transport techniques. Rickshaws needed the metalled roads which were built for cars and buses and lorries. Yet in the great expanding cities of Asia they were seen as demeaning technologies of poverty, and as technologies of the past that needed to be got rid of. The city governments of Asia, whether colonial or post-colonial, wanted to control them, restricting licenses, and indeed in places banning them outright. Yet if governments had success in getting rid of machines like the spinning mule in the middle of the century, they failed miserably in the case of the rickshaw, for numbers, as we have seen, continued to rise. They have now appeared in places they had never been before, including central London, where they now operate regularly from the Soho entertainment district.

Water transport provides some good examples of creole technologies, in particular of creole technologies used in hybrids. In Bangkok the great river which runs through that megacity is home to a remarkable breed of craft. Long, thin, wooden boats have been converted to a species of power-boat by the addition of a large car engine mounted on gimbals which powers a propeller on the end of a long shaft. The operator controls the boat by moving the whole engine

and associated propeller, a brilliant variant of the outboard motor. The 'long-tailed boats' first appeared in Bangkok, but have since spread through Thailand, not just for the tourist trade, but as a standard means of powering a boat. The tails are made in Bangkok and cost $100; engines can be bought for around $600, compared with a motorbike at $500.[61] They are also present on the Mekong, in Cambodia and Vietnam, and some say on the Amazon in Peru.

Another case of a creole technology is the use of irrigation-pump motors in the 'country-boat' of Bangladesh, a country where millions depended on water transport. These boats, hand built by itinerant, and miserably poor, boat builders, were decreasing in use, as they lost out to land transport. It was in the north west of Bangladesh that they were transformed in the early 1980s. New wells, powered by petrol pumps, were installed there, but these were idle most of the year. An anonymous engineer used one of these engines to drive a boat; by the late 1980s many were used in the wet season and on market days in the dry season. Increasingly engines were permanently fitted, but irrigation-pump engines remained the most popular since they were subsidized. The transplantation of the engine to a new context resulted in a new kind of hybrid boat. In the 1980s iron sheet started to be used to make boats. For bigger boats, recycled steel plates from the shipbreakers on the coast began to be used.[62]

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[61] Informal interviews with a number of Thai tour guides etc, 2001

[62] Erik E. Jansen et al, *The Country Boats of Bangladesh social and economic Development and decision-making in inland water transport* (Dhaka: The University Press, 1989).

The use of creole technologies in new hybrids, which can themselves be called creole technologies, is a common feature of the modern poor world of the twentieth century. In many parts of the world donkey carts were made using motorcar axles and especially wheels. Wooden fishing boats of the most primitive sort were made much more efficient by synthetic fishing nets; larger wooden boats of craft construction were fitted with engines, with radar, and with sonar as a visit to any number of the world's small fishing ports will confirm.

An extreme case and some conclusions

I have used the concept of creole technologies to suggest that the technology poor world cannot be reduced either to its stock of rich world technologies, or traditional, local technologies, or hybrids between the two. A new technological world of technologies derived and adapted from those of the rich world in complex ways, and then often entering into hybrids, are some of the complexities the term seeks to capture. Yet while the term is very suggestive, it reaches the end of its usefulness when confronted with some technological novelties in the poor world. While it can usefully, for example, be used to conceptualize in a richer way than transfer, not only the cases discussed above, but also, for example, the development of industrial production in the poor world, it becomes problematic when confronted with the novel phenomenon of absolute technological retrogression at a global level, graphically illustrated by shipbreaking.

After the Second World War, as especially since the 1960s, Taiwan became a major force in the ship-breaking industry, using purpose-built facilities in Kaosiung. In the 1980s Taiwan was the largest shipbreaker by far, demolishing more than 1/3 of the world's ships. By the early 1990s Taiwan was out of this industry, which was now dominated by India, Pakistan and Bangladesh, which between them had more than 80% of the world market by 1995.[63] Demolition was done on beaches, far from electricity let alone any docking facility, and was carried out with the most minimal equipment by thousands of barefoot workers. It is not too fanciful to suggest that ship-breaking was more capital intensive in 1900 than in 2000. It makes no sense to see Arabian Sea and Bay of Bengal shipbreaking as an old, let alone traditional industry, which has survived into the twenty-first century. It is a new kind of new industry. As shipbreaking moved geographically it, for the first time, retrogressed leaving practically no more capital intensive operations in existence.

I hope I have suggested that looking at technologies-in-use, and looking at them globally, points to the signifycance of whole new technological worlds which have emerged in the twentieth century which have hitherto had no place in histories of technology. Understanding their significance involves much more that adding some hitherto neglected technologies to our histories, or simply of placing

63 Martin Stopford, *Maritime Economics*, (London: Routledge, 1997), second edition, pp. 485-6. See also the excellent William Langewiesche, "The Shipbreakers", *The Atlantic Monthly*, 2000, 286(No. 2): 31-49. Thanks to Eric Schatzberg.

technologies in new geographical and chronological spaces: it involves rethinking the whole map of technological history.

This paper is not meant as programmatic – it does recommend a particular way of studying the history of technology. It does not call, for example, for a history of the use of technologies, or that of technologies-in-use; nor does it call for the study of what many would regard as peripheral technologies, like corrugated iron. If it calls for anything it is for the history of technology to ask and answer historical questions, to engage in historical and other debates. It argues that to do this we need to attend very carefully to nature of the standard narratives that are at work in *today's academic* histories, which, for example, privilege the 'question of technology'; conflate invention/innovation/technology and equate technology with the rich world, or the internal study of technology with invention, and much more besides. For all the rhetorical decentring, deconstructing, incredulity towards meta-narratives, there is too often in our studies an implicit credulity towards *some* meta-narratives. For example, for all the tilting at Whig history, technological determinism and linear models, it is hardly difficult to note the continuing importance, in the very same works that criticize these, of historical models and agendas of a very familiar sort. We need to be aware of these models and their power, so that we can ask fresh historical questions. Depending on the historical question asked, and they might be big or small, global or local, we might answer with a history of invention, a history of technologies in use, an internal study of technologies, either as they are made or are in use, and do

each of these and many other kinds of studies in many different ways. That includes the history of invention and innovation, which itself looks different once it is released from its conflation with the history of (some) widely used technologies, and is treated both in its own right, and in relation to the history of technology-in-use. A global history of invention, which will necessarily be a history largely of failure, and only partially of R&D and patents, is still to be written, but it is one in which the poor world will also have a place, and one in which the rich world will look different too.