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Perspective

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Recommended Citation:

Edgerton, David E.H. (2007) "The Contradictions of Techno-Nationalism and Techno-Globalism: A Historical Perspective," *New Global Studies*: Vol. 1: Iss. 1, Article 1.

DOI: 10.2202/1940-0004.1013

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The Contradictions of Techno-Nationalism and Techno-Globalism: A Historical Perspective

David E.H. Edgerton

Abstract

Techno-nationalism and techno-globalism are descriptive and prescriptive categories for understanding the impact of technology on society and vice versa. They reflect the underlying assumptions made by analysts of the place of technology in the world, and denote ideologies, rather than technological policies or realities. They also help us to realize that standard accounts of the nation and globalization are not as securely based as they appear. Indeed, nations and states are important in ways techno-nationalism does not capture, and the international and global dimension is crucial in ways which that techno-globalism overlooks. Yet an analysis of both terms yields building blocks to a more sophisticated appreciation of the linkages between the nation, technological innovation and globalization.

KEYWORDS: techno-globalism, techno-nationalism, technology

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In this article I distinguish two approaches, which I label techno-nationalism and techno-globalism, to the study of technology and society at macro-level. The terms have been used, though sparingly, and in a different way, in the specialized research and development policy literature: from the early 1990s, they were used as descriptive, and indeed prescriptive, categories particularly in connection with the Far East. I use them as descriptors of underlying assumptions made by analysts of the place of technology in the world, to denote ideologies, rather than technological policies or realities, though I note the unfortunate conflation of the two. I show that these two approaches, influential as they are, leave much to be desired but that we have to hand a suite of rich models, arguments, and cases to replace both.

I use the terms in the following ways. Techno-nationalism assumes that the key unit of analysis for the study of technology is the nation: nations are the units that innovate, that have R&D budgets and cultures of innovation, that diffuse and use technology. The success of nations, it is believed by techno-nationalists (who rarely if ever label themselves as such), is dependent on how well they do this. On the other hand, techno-globalism holds that technology is turning the world into a 'global village.' In this vision nations is at best a temporary vehicle through which the forces of techno-globalism operate but are always about to disappear through the advance of globalizing new technology. The steam ship, the aeroplane, the radio, and more recently television and the internet, it is argued, are forging a new global world economy and culture. Both approaches to technology are typically innovation-centric too, focussing on much the same restricted sample of spectacular technologies at early stages in their lives.

In this article I suggest that nations and states are important in ways techno-nationalism does not capture, and the international and global dimension is crucial in ways which techno-globalism is ignorant of. As we shall see techno-nationalist claims as applied to a particular country often seem credible, but collectively they often contradict each other. The claims of techno-globalism not only contradict those of techno-nationalism, but the examples usually given contradict techno-globalism itself. In any case, politics, multinational firms, empire and race were also crucial factors in shaping the use of technology which cut across the national and global divide in complex and changing ways. The nation, the state, and the global, are central to the history of twentieth-century technology, but not in the ways the relations are usually understood. We need to rethink not only nation-technology, but technology-state relations, and the place of technology at a global level too.¹

¹ My *The Shock of the Old: Technology and Global History since 1900* (London: Profile Books, 2007; New York: Oxford University Press, 2007) is an attempt at this. This article is a revised version of chapter five and I am grateful to colleagues who commented on earlier related papers

TECHNO-NATIONALISM

Nationalism, that great hidden ideology of the nineteenth and twentieth centuries, has been thought of as a deviant notion compared to more acceptable, and seemingly less ideological, liberal and internationalist ideas. Nationalism is seen as an ideological throwback – like and linked to militarism – a stirring up of supposedly ancient bonds of blood, a dangerous blast from the past. Not surprisingly, the linking of nationalism and technology has not been looked on favorably. Thus the term techno-nationalism is used by Western analysts primarily in relation to Japan and now China, to describe a potentially, perhaps actually, dangerous thing. For historians the favored site for discussion of the relationship of technology and nationalism is Germany, particularly in the interwar years.² To suggest that techno-nationalism applies only to such countries would be greatly mistaken. Intellectuals were very nationalistic about science and technology, particularly in mid-twentieth century, in nearly every nation.

Ernest Gellner's account of nationalism explains nicely why nationalism was, and remains, such an international phenomenon, taking much the same form in different nations, even though its central claim was for the uniqueness of each nation. For Gellner, nationalism was a widely shared way of adapting to a modern, industrial and globalizing world. In a modern industrial society, where education, bureaucracy, information and communication mattered deeply, to be alienated from this by linguistic and cultural barriers was intolerable. Hence all these functions needed to be carried out in the language spoken by the people. Modern nationalism was thus vital to modernity, not as a way of escaping from a globalized cosmopolitan modern world, but a means of participating in it while retaining one's dignity, and indeed creating one's capacity to participate.³ Gellner's theory would suggest, though I don't think he does so himself, that something like techno-nationalism should exist, though this is not to say that his global model of technology is adequate.

The celebration of the inventive citizen has been an important part of modern nationalism, everywhere. Curators of many national traditions have over-

on which it was based, particularly that given at a conference on the National Identities of Engineers: Their Past and Present, Syros, 2004.

² The study of aeroplanes and culture has been a particular site of analysis. The studies are usually national in scope, and particularly interested in nationalism Peter Fritzsche, *A Nation of Flyers: German Aviation and the Popular Imagination* (Cambridge, MA: Harvard University Press, 1992). Guillaume de Syon, *Zeppelin! Germany and the Airship, 1900–1939* (Baltimore: Johns Hopkins University Press, 2002)

³ John A. Hall (ed.), *The State of the Nation: Ernest Gellner and the Theory of Nationalism* (Cambridge: Cambridge University Press, 1998)

estimated the significance of inventors that shared their particular nationality, over-emphasized national connections, and made too much of the significance of making things first. “No we don’t have pasteurized milk in France, but we do have Pasteur” said a Frenchman to an American in the 1960s.⁴ Juan de la Cierva (1895-1936), is regarded as one of the greatest of Spanish inventors, but although he invented and developed the autogiro (a flying machine with rotating wings, a little like a helicopter) in Spain, he set up an enterprise in Britain. Or consider Ladislao José Biro (1899-1985), “without doubt the most important Argentine inventor there has been.”⁵ Yet the key context for his invention of the ballpoint pen, or biro, was the increasingly anti-semitic Hungary from which László Jozsef Bíró emigrated in 1938. Famously, in its most nationalist phase, the Soviet Union was able to find Russian inventors for many important technologies, thus Alexander Stepanovitch Popov (1859 – 1906) invented radio.

In Britain, France and the United States people laughed too easily at what they saw as techno-nationalist excesses in other countries. For here too very similar excessively nationalistic emphases were at work – it would have been hard for a British person to know that radar, the jet engine or even television were not uniquely British inventions. The great technological and scientific museums of the rich world, like the Science Museum in London, the Deutsches Museum in Munich and the Smithsonian Institution in Washington, are not replicas of each other, or complements, but in some senses competitors too. As a result of this emphasis on national inventiveness, the relations of nations and technology are particularly prone to being discussed in terms of invention and innovation.

Techno-nationalism takes other forms too, for example in claims that this or that country is best fitted for the technological age. The creation of new national identities fitted for a technological age was happening around the world. There was, for example, hardly a nation that did not have intellectuals who thought his or her nation was best fitted for the ‘air age.’ Interwar French writers argued that as a vital and aesthetic people the French were particularly suited to be aviators.⁶ Hitler described war in the air was a particularly Germanic form of battle.⁷ Sir Walter Raleigh, the Professor of English at Oxford, and official historian of the Great War in the air, claimed in the 1920s that Britain “had a body of youth fitted by temperament for the work of the air, and educated, as if by

⁴ John Ardagh, *France* third edition (Harmondsworth: Penguin, 1977), p. 82.

⁵ “Es, sin lugar a dudas, el inventor argentino más importante de toda nuestra historia, y el paradigma del ‘inventor profesional’ comprometido con su rol social a favor del progreso de la humanidad.” [Asociación argentina de inventores] <http://puertobaires.com/aai/diadelinventor.asp>

⁶ Robert Wohl, “Par la voie des airs: l’entrée de l’aviation dans le monde des Lettres françaises, 1909-1939,” *Le Mouvement Social* No 145 (1988), pp. 60-1.

⁷ Modris Eksteins, *Rites of Spring: The Great War and the Birth of the Modern Age* (London: Bantam, 1989), p. 427.

design, to take risks with a light heart - the boys of the Public Schools of England.”⁸ Soviet record-breaking pilots, dubbed “Stalin’s falcons” were closely associated with the “New Man” and with Stalin himself.⁹ The Russian-born aircraft manufacturer and propagandist Alexander De Seversky claimed that “Americans are the natural masters of the aerial weapon... more than any other people Americans are the natural children of the machine age”; “Air power is the American weapon.”¹⁰ Yet the inverse problem is just as significant – the attribution to *another* nation of extraordinary technological powers which elude one’s own: for example, the feeling in Britain that Germany, then the United States and the Soviet Union, and latterly Japan, does technology better, and that there is always one country which does it best. Thus Lindberg’s transatlantic flight of 1927 was hailed in Europe as well as America as evidence of the vigor of the New World.¹¹ Communists everywhere saw in “Stalin’s falcons” evidence of the superiority of Soviet society.¹² Fascists, and indeed some anti-fascists, saw Nazi Germany and Italy as the nations most fitted to aviation. More recently Japan was widely regarded as the nation most suited to the electronic age.

NATIONAL INNOVATION AND NATIONAL GROWTH

This techno-nationalism is implicit, not only in any number of national histories of technology, but also in many policy studies of “national systems of innovation,” a term coined in the 1980s by Christopher Freeman and much used since, though without its ideological baggage always being clear. Freeman espoused a national political-economy of technology, drawing on the nineteenth-century German advocate of, in Roman Szporluk’s phrase, “scientific nationalism,” Friedrich List.¹³ For Freeman, particular world-changing

⁸ Sir Walter Raleigh, *The War in the Air* Vol. 1 (Oxford: Oxford University Press, 1922), p. 111.

⁹ Kendall Bailes, ‘Technology and Legitimacy: Society, Aviation and Stalinism in the 1930s’, *Technology and Culture*, Vol. 17 (1976), pp. 55-81.

¹⁰ Alexander de Seversky, *Victory through Air Power* (New York, 1942), pp. 350,352.

¹¹ Eksteins, *Rites of Spring*, p. 359.

¹² Valentine Cunningham, *British Writers of the Thirties* (Oxford: Oxford University Press, 1988), pp. 176-81.

¹³ Christopher Freeman, *Technology Policy and Economic Performance: Lessons from Japan* (London: Pinter, 1987). Here Japan is very much the Prussia of the East, and it is this and Wilhelmine Germany which provided the contrast to the British case. For the Listianism in Freeman, I am indebted to Simon Lee. See Lee, “Industrial Policy and British Decline” and “British Culture and Economic Decline,” in Andrew Cox, Simon Lee and Joe Sanderson, *The Political Economy of Modern Britain* (Cheltenham: Edward Elgar, 1997). See also Daniele Archibugi and Jonathan Michie, “Technological Globalisation Or National Systems Of Innovation?” *Futures*, Vol. 29, (1997), No. 2. pp. 121-37. On List as the intellectual of ‘scientific nationalism’ see Roman Szporluk, “Thoughts about Change: Ernest Gellner and the History of

technologies are associated with particular nations. Cotton textiles and steam power are seen as British, chemicals as German, mass production as North American, consumer electronics as Japanese. Particular nations became the bearers of a global modernity in particular eras, characterized by particular technologies. This is despite the fact that all these countries were strong in all these technologies.

An implicit techno-nationalism is found in an extreme and widespread form in the assumption that *national* economic and technological performance is determined by *national* rates of innovation. It is there in the standard market failure argument, developed in the United States in late 1950s, for state support of research. The argument was this: individuals in a society would not fund enough research because others could make use of the research just as much as the funder could. This is the famous free-rider problem. The market failed, and thus government should step into to fund research, which would benefit everyone. Of course, states supported research long before this argument was put forward, including the US federal government, and of course would continue to do so for other reasons.¹⁴ Yet the argument only worked for a closed system, if each nation was insulated from every other one. For the free-rider problem would otherwise also apply to governments – why should the Indian government fund research that would equally well be exploited by Pakistani, or US citizens? We should recognize of course that in the 1950s the US dominated world research and development, and thus could be thought of as a closed system.

This implicit techno-nationalism is also found in another justification for national funding of research (and development). It is the idea that to overtake rich countries a nation needs to innovate more, and that if it doesn't innovate it will descend to the depths of the poorest countries. Even casting doubt on the role of *national* R&D can lead the analyst to be accused of being indifferent to one's nation becoming like Bulgaria or Paraguay, as if there problem was a lack of R&D.¹⁵ In such arguments it is often first claimed that innovation is of huge importance to other nations, and then that Britain, India or say Thailand spends much less on R&D than the United States and Japan. Thus Spaniards complain that Spain's share of innovation has been lower than its share of population, and

Nationalism" in John A. Hall, *The State of the Nation: Ernest Gellner and the Theory of Nationalism* (Cambridge: Cambridge University Press, 1998).

¹⁴ David Hounshell, "The Cold War, RAND, and the Generation of Knowledge, 1946-1962," *Historical Studies of the Physical and Biological Sciences* Vol. 27 (1997): 237-267; David Hounshell, "Medium is the Message, or How Context Matters: The RAND Corporation Builds an Economics of Innovation, 1946-1962," in A. Hughes and T. Hughes (Eds.), *System, Experts, and Computers* (Cambridge, MA: MIT Press, 2000).

¹⁵ I write from personal experience – see my exchange with Keith Pavitt in the *Guardian* 30 August 1993, 27 September 1993 and 25 October 1993.

indeed production. But Spaniards compare themselves to the richest countries in the world, not the world as a whole.¹⁶

This innovation-centric techno-nationalist understanding is central to national histories of technologies. Historians and others have assumed that Germany and America grew fast in the early years of the twentieth century because of rapid national innovation. They also argued that the British “decline” (that is slow growth) must have been associated with low innovation, indeed this “decline” was itself taken as evidence of poor innovation.¹⁷ For example, a recent book on innovation and economic performance, most of it arranged in typical fashion in chapters based on *nations*, expresses surprise that in the case of Japan recent economic performance has not been on a par with the country's huge R&D spending, which is second only to that of the United States in scale.¹⁸ In the 1990s crude versions of endogenous growth theory, which claimed that inputs like R&D led to growth, globally and nationally, flourished.

So powerful has this innovation-centric view been, especially in its nationalistic versions, that all evidence to the contrary has been studiously ignored. It was known in the 1960s that national rates of economic growth did not correlate positively with *national* investments in invention, research and development, and innovation. It has *not* been the case that countries that innovate and grow a lot. Take the cases of Italy and the United Kingdom. Each was very different in 1900 but not so different in 2000. In the 1980s Italy overtook the United Kingdom in output per head, a shock the Italians named *il sorpasso*. That these countries, such opposites in the usual estimations of national character, had now reached the same level of income per head was unsettling on both sides. In the techno-nationalist world it was literally incredible that Italy had become richer than Great Britain spending much *less* on R&D than Britain did. Italian scientists and engineers and research policy experts had long complained that Italy was by no measure a great centre of innovation; it has very few Nobel prizes (one is for the polymerisation of the plastic polypropylene), and its expenditure on R&D has been low by the standards of rich countries. In Britain, so peculiar are the politics

¹⁶ Francisco Javier Ayala-Carcedo “Historia y presente de la ciencia y de la tecnología en España,” in Francisco Javier Ayala-Carcedo (ed) *Historia de la Tecnología en España* Volume II (Barcelona: Valatenea, 2001), pp. 729-752.

¹⁷ For a critique of these literatures see my *Science, Technology and the British Industrial ‘Decline,’ 1870-1970* (Cambridge: Cambridge University Press, 1996).

¹⁸ Ben Steil, David G. Victor and Richard R. Nelson (eds), *Technological Innovation and Economic Performance*. A Council for Foreign Relations Book (Princeton: Princeton University Press, 2002). If this is not enough to convince that I am not arguing against a straw man, in 2005 the head of one of the world’s major centres for the study of the economics of innovation publicly countered my argument as above with the claim that I had been ‘proved wrong’ by more recent researches. These were not specified.

of technology that it has been claimed, in order to square this particular circle, that Italy was spending more on R&D than Britain. What one does not find is the idea that Italy has been brilliantly successful in that with little R&D, it has become as rich as Britain.

It is important to stress that this is not a unique case. Spain was one of the most successful European economies in terms of rates of growth in the 1980s and 1990s, and yet this is a country which spends less than 1 percent of GDP on R&D. It had much less of a historical track record in industry and technology than Italy: it is indeed a “sistema tecnológico que progresa sin innovar.”¹⁹ Going further from Europe allows one to make the case even more strongly: the most spectacularly fast-growing economies in world history have been some Asian economies like Malaysia, Taiwan, Korea, and most recently and significantly of all, given its size, China. While China has transformed itself and flooded the world with manufactures, the much more innovative Japanese economy has been, by comparison, stagnant. Moreover, while national R&D expenditures have increased in the rich countries in recent decades, economic growth rates have dropped below those found in the long boom, when R&D expenditures were lower!

To add further to these seeming paradoxes – the two countries which grew both very fast and had high and increasing R&D expenditure in the twentieth century, the Soviet Union and Japan, were not particularly innovative. The Soviet case is particularly stunning. It spent 2.9 percent of GNP on R&D in the late 1960s, the same as the United States, and spent more than the United States in early 1970s. The number of Soviet scientists and engineers in R&D, in absolute numbers, overtook the US total in very late 1960s, giving the USSR the largest R&D workforce in the world.²⁰ Yet it is regarded, perhaps unfairly, as having contributed practically nothing novel to modern industry. Japan did better than the Soviet Union after the Second World War, but its record of innovation is felt, again perhaps unfairly, not to be congruent with huge R&D expenditures.

How can we make sense of this? What general rules are there? Firstly, we may note that richer countries spend a higher proportion of their output on R&D than poor ones.²¹ There are exceptions to this, for example, Italy in recent decades

¹⁹ Santiago López, “Por el fracaso hacia el éxito: difusión tecnológica y competencia en España,” in Emilio Muñoz et al (eds), *El espacio común de conocimiento en la Unión Europea: Un enfoque al problema desde España* (Madrid: Academia Europea de Ciencias y Artes, 2005), pp. 229-251.

²⁰ Charles Feinstein, “Technical Progress and technology transfer in a centrally planned economy: the experience of the USSR, 1917-1987,” in Charles Feinstein and Christopher Howe (eds) *Chinese Technology Transfer in the 1990s: Current Experience, Historical Problems and International Perspectives* (Cheltenham: Edward Elgar, 1997), 62-81.

²¹ Terence Kealey, *The Economic Laws of Scientific Research* (London: Macmillan, 1996)

was rich but spent little. The USSR, while very poor, spent as much or more than the richest countries. Secondly, the relationship does not necessarily hold over time: as rich countries got slowly richer in the 1980s and 1990s, the proportion of national income spent on R&D remained broadly static, and in some cases fell. There is a second general rule of thumb, again with important exceptions. That is that the fastest growing countries are not the richest. The slowest growing were already rich. The fastest growing countries in the twentieth century have been poor countries, which spent very little on innovation. Thus taking these two general rules together, we can conclude that rich, slow-growing countries spend a lot more on R&D than fast-growing poor ones.

Why does the techno-nationalist assumption about innovation and growth not hold? The link between innovation and use, and thus economic performance, is far from straightforward. Yet the techno-nationalist assumption implies that the things a nation uses derive from its own innovation, or at the very least that innovating nations have early leads in the technologies they innovate; and the site of innovation is not always the major site of even early use of technology. In the case of the motor car, Germany, where the internal-combustion-powered motor-car was invented, was not the dominant early producer of cars in the first twenty years of the industry. The United States became easily the dominant producer by 1914, and Germany remained less motorized than other rich countries for many decades. The powered airplane was innovated in the United States by the Wright brothers in 1903 but Britain, France and Germany had much larger air fleets by 1914. As we shall see, photography and television are also examples.

More significantly, national use of technology is hardly dependent on national innovation. Most technologies are shared across national boundaries; nations acquire more new technology from abroad than they innovate themselves. Italy did not have to invent afresh all the technology it used, just as Britain did not either. Both were sharing in a global pool, as was every country in the world. One can make this clearer by looking around one's immediate surroundings and asking about the origins of the things one can see; nowhere in the world would more than a small minority have local origins. Thus it is unfair to complain that of 75 major technologies in use in the Soviet Union through much of its history, five were of Soviet origin and ten of joint/Soviet origin.²² One needs to specify the comparator, and to recognize that for most countries, even the richest and most innovative, the proportions may well have been similar.

The concept of technological sharing is an important one. Yet its importance in the history of the twentieth century is obscured by thinking about the movement of technologies across national boundaries in terms of technology

²² A.C. Sutton, *Western Technology and Soviet Economic Development 1945 to 1965* (Stanford: Hoover Institution, 1973), p. 371

transfer from technological leaders to others. The term was first used to describe the export of modern technologies to poor countries. Transfer in this sense is much less significant than the movement of technologies between rich countries. Thus the two-way movements between British and France in the twentieth century have been much more significant than those between Britain and India. This is not to deny the importance of movements across technological boundaries. Indeed one of the most important features of the twentieth century world economy has been the convergence of certain countries on, roughly, one technological level. The now rich countries of the world are much closer in all economic measures than they were in 1900, the result of the richest growing more slowly than poorer countries. These countries have borrowed from each other and perhaps most from a particular technological leader which set the highest level. Italy, Spain, Japan, the USSR and now China have been imitating foreign technologies on a huge scale, and this has been an essential aspect of their rapid economic growth.

There is one very special case in this story of convergence among the richest nations. In the nineteenth century the United States did not catch up with Europe in terms of productivity, it shot ahead – through the twentieth century it remained ahead, with, in the middle of the century, productivity levels at least twice as great as that of the European industrial giants. This lead did not come from dominance in ‘pure science’ or even ‘industrial research’ – in 1900 the United States was leader in neither. Where historians have claimed to find US distinctiveness and a particular surge in innovation is in production technology – the sort of thing which led to mass production. Yet, the evidence for the centrality of US invention in this area is not as strong as nationalistic analyses of American technology would have us believe. There were extraordinary flows of technological know-how across the Atlantic in the late nineteenth and early twentieth centuries.²³ By mid-century however, the United States was a clear leader in industrial research and innovation; it dominated both world production and world innovation. As such it was atypical, and exactly the sort of case where we would expect technologies to derive from national innovation. Only perhaps in the exceptional case of the United States after the Second World War might locally-innovated products have registered strongly, and thus it is no surprise that studies show that U.S. innovation promoted U.S. growth – the mistake was to

²³ David Hounshell, “Rethinking the History of ‘American Technology,’” in Stephen Cutcliffe and Robert Post (eds), *In Context: History and the History of Technology* (Bethlehem: Lehigh University Press, 1989), pp. 216-29. On this and more generally see Sally M. Horrocks, “The internationalization of science in a commercial context: research and development by overseas multinationals in Britain before the mid-1970s.” *The British Journal for the History of Science*, Vol. 40, (2007), pp 227-250.

believe that this applied to other countries too, and that the rate of growth in the United States was particularly high.

We may conclude then, that global innovation *may* be the main determinant of global economic growth, but it does not follow that this is the case for particular nation-states. Since national innovation has not been the main source of national technique, it should not be at all surprising that there is no clear positive relationship between national innovation and national rates of growth. Global technological sharing, between rich countries, and between rich and poor, has been the norm. Should we then discard techno-nationalism, and think techno-globally?

TECHNO-GLOBALISM

Techno-globalism is harder to pin down in the academic literature, for few have been rash enough to attempt global accounts of both technology and global history, so we need to look at texts focused on each in order to see what they say. The first and most important problem is that the innovation-centricity of studies of technology means that they cannot be global, yet they do make claims for the relationship between technology and the process of globalization, and also imperialism.²⁴ Global histories generally give insufficient weight to poor countries too, even though global is sometimes a euphemism for poor, just as “world music” is folkloric music from poor countries.²⁵ For all this there is a common underlying theme in studies of the world as a whole in relation to technology. Many kinds of technologies affected the relations between nations, let alone the development of the productive power of the globe. Yet, a productivist view is surprisingly rare in global accounts. By contrast an innovation-centric techno-globalism focused on technologies of *communication* has been at the heart of any number of histories of the world, the musings of information society gurus and many a portentous address about science and technology, and for a very long time past, and remains so.²⁶ Indeed it often looked forward to globalizing technology eliminating the nation-state, which it regarded as an outmoded organization. A whole series of new technologies was also about to change the

²⁴ See my “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

²⁵ An honorable exception is Arnold Pacey, *Technology in World Civilisation: a Thousand Year History* (Oxford: Blackwell, 1990)

²⁶ See for a recent telling example, see the chapter on technology, called ‘A Shrinking World’ in Gordon Martel (ed.), *A Companion to International History 1900-2001* (Oxford: Blackwell, 2007). See also the treatment of technology in John Robert McNeill and William H. McNeill, *The Human Web: A Bird’s-Eye View of World History* (New York: Norton, 2003)

world into a global village, the most recent in a long line being the internet. A simplistic Smithian vision trumps even vulgar Marxism when thinking about technology.

Techno-globalist accounts are particularly reliant on historical amnesia. In the late nineteenth century the steam-ship, the railway and the telegraph reached across and into the world which was, with justification, seen as interconnected as never before. Yet that globalization was ignored when claims for new technologies of globalization were being made just a little later. Thus in the 1920s Henry Ford in his *Philosophy of Industry* claimed that:

Machinery is accomplishing in the world what man has failed to do by preaching, propaganda or the written word. The airplane and wireless know no boundary. They pass over the dotted lines on the map without heed or hindrance. They are binding the world together in a way no other system can. The motion picture with its universal language, the airplane with its speed, and wireless with its coming international program - these will soon bring the world to a complete understanding. Thus may we vision a United States of the World. Ultimately it will surely come!²⁷

For Henry Ford, "The motor-car has done for the United States what the airplane and wireless may do for the world."²⁸ Twenty years later the Canadian Air Marshal and Great War air ace Billy Bishop claimed that "The horse and buggy developed purely local geographical cultures. Railway trains and motor cars developed nationalism." This begs the question, of course, when the age of the train and the motor car was, but in this innovation-centric account, it was passing. With the airplane came the necessity, as Bishop saw it, for "the establishment of *world* culture, a *world* view of the responsibilities of citizenship ... The Air Age must bring us entirely new concepts of citizenship, of national and international relations." The choice was between "Winged Peace or Winged Death."²⁹

H.G. Wells was one of the great propagandists for this kind of thinking. In the *Shape of Things to Come: The Ultimate Revolution* (1933) airmen bring peace and civilization to a war-devastated world.³⁰ Wells imagined a Conference in 1965 of scientific and technical workers in Basra [Iraq]. It was organized by the Transport Union, which brought together surviving airplane and sea transport,

²⁷ Henry Ford, *My Philosophy of Industry* (London: Harrap, 1929), pp. 44-5. See also Jenifer Van Vleck's article in this issue.

²⁸ Ford, *Philosophy*, pp. 25-6.

²⁹ Air Marshal William A. Bishop (RCAF), *Winged Peace* (New York: Viking, 1944), pp.11, 175.

³⁰ H.G. Wells, *The Shape of Things to Come* (London: Hutchinson, 1933) Using J.M. Dent/Everyman edition, 1993). See E. M. Earle, 'H.G. Wells, British Patriot in Search of a World State', in E.M. Earle (ed.) *Nations and Nationalism* (New York: Columbia University Press, 1950), pp. 79-121.

and used as its language the Basic English of the aviators.³¹ As a result there was central control of the airways, with an air force to enforce peace. The unit of currency was the air dollar.³² The Air and Sea Control, and the Police of the Air and Seaways were owned by the Modern State Society, made up of qualified fellows. In 1978 they decided to put down the re-emerging national governments opposition with a new gas called Pacificin. Wells was not alone in putting forward these ideas. In the early 1930s there were all sorts of suggestions for the creation of an “international air police” along these lines, and similar thinking continued into the 1940s, usually suggesting that the British and Americans were that international police force. In more recent years the atomic bomb, television and above all the internet and the world-wide-web have featured in this kind of techno-globalism.

Historically-aware, and more knowledgeable commentators, couldn’t stomach this kind of stuff. In 1944 George Orwell noted the repetitiveness in the claims.

Reading recently a batch of rather shallowly optimistic ‘progressive’ books, I was struck by the automatic way people go on repeating certain phrases which were fashionable before 1914. Two great favourites are the ‘abolition of distance’ and the ‘disappearance of frontiers.’ I do not know how often I have met with statements that ‘the aeroplane and the radio have abolished distance’ and ‘all parts of the world are now interdependent.’

But Orwell criticized not only the historical amnesia involved. He claimed there was quite different relationship between technology and world history. “Actually, the effect of modern inventions has been to increase nationalism, to make travel enormously more difficult, to cut down the means of communication between one country and another, and to make various parts of the world *less*, not more dependent on one another for food and manufactured goods.”³³ He was thinking about what had been happening since 1918, and particularly since the early 1930s. His was a powerful, and defensible, argument.

The great era of global trade had ended in 1914 – in the interwar years trade stagnated and fell, and especially in the 1930s nation-states all over the world became increasingly autarchic. In the middle of the twentieth century the world was much less globalized than it had previously been, and was to be, at the end of the century. There was a profound nationalization. There was also a powerful move to turn political empires into trading blocks to a degree unknown before. Innovation-centred political history puts the great age of nationalism in

³¹ Wells, p. 271

³² Wells, p. 279

³³ George Orwell, “As I Please,” *Tribune* 12 May 1944, reprinted in *CEJL*, Vol. 3, p. 173.

the nineteenth and early twentieth centuries; the age of imperialism is put between the 1870s and the First World War. Yet empire accounted for a greater proportion of trade in the 1930s, 1940s and 1950s than it did in the pioneering days of the new imperialism. Nationalism was at least as important in the middle of the twentieth century as it had been earlier. And as Orwell noted, science and technology were key tools of autarchy, the policy of national economic self-sufficiency in the 1930s and 1940s. Orwell pointed in particular to the role of the airplane and the radio in bolstering this new and dangerous nationalism. In other words the very technologies that were at the heart of the naïve techno-globalism vision of an interconnected world were the tools of a new national despotism.

One can go much further than Orwell did in ironically inverting the claims of innovation-centric techno-globalist propaganda. For many of the technologies invoked as being somehow essentially internationalizing were profoundly national in origin and use. Radio, which had a military origin, was intimately connected to national power. The development of the radio before the Great War was intimately tied to navies – indeed the Royal Navy was the largest single customer for the Marconi Company, which led the world in radio. During and after the Great War, radio and the military remained closely tied; the Radio Corporation of America, for example, was closely tied to the U.S. state.³⁴

More stunningly still, the airplane was primarily a weapon of war, even in peacetime. Far from threatening to transcend the nation it was the product of a system of competing nation states and empires. In peace as in war, the aircraft industry was utterly dependent on the patronage of the military. In peacetime some three-fourths of the output of all the main aircraft industries in the world went to the military. In the interwar years air forces had hundreds of aircraft, airlines tens. Since then, too, the military continue to dominate aircraft industry sales. Yet, to this day histories of technology treat aviation under transportation; histories of aviation are really histories of civil aviation, and technical development is seen as driven by civil transportation needs. Histories of the aircraft producing industry also overemphasize the significance of the production of civil aircraft; accounts of the industry in peace-time are accounts of the production of civil aircraft.³⁵

³⁴ R.F. Pocock, *The Early British Radio Industry* (Manchester: Manchester University Press, 1988); Daniel Headrick, *The Invisible Weapon: Telecommunications and International Politics, 1851-1945* (New York: Oxford University Press, 1991).

³⁵ See the twentieth century volumes of the *A History of Technology* Vol. 7, *The Twentieth Century, c. 1900 – c. 1950* parts I and II (Oxford University Press, 1978), where the only chapter with an explicitly military connection is one on atomic weapons. Aviation is alongside transport technologies, and there is treatment of the military aspect within the chapter. The condensed version by T. I. Williams *A Short History of Twentieth Century Technology, c 1900-c1950* (Oxford: Oxford University Press, 1982) has a chapter, not in the original on military technology,

But radio and the airplane were not the only cases. The atomic bomb too was the product of a world of competing states. So too was the internet, which arose from U.S. military needs and funding. Many other great technologies of the twentieth century were also technologies of autarchy and militarism. Oil-from-coal, many synthetic fibres and synthetic rubber are just a few examples of technologies which would not have survived in a global liberal free market. They were the product of the particular state system which operated to force nations into particular relations with each other. The very specific role of the state, and the specific nature of its competition with other states has given *states* particular roles in the promotion of *particular* technologies. Even techno-nationalists have not recognized the centrality of the state system to twentieth century technology. Techno-national projects were of the greatest importance, though their histories are not to be found in techno-nationalist writings. This conclusion casts doubt on Gellner's picture of a cosmopolitan, global modernity to which all must respond. Many of the most important technologies of the twentieth century, and earlier periods, are the product of a particular state system (and not just say, capitalism, industrialism, imperialism, or even militarism or the "Cold War") – aviation and nuclear power are central cases. The national dimension is critical, especially and obviously for weapons, but also for those technologies which are routinely labelled as such but also some technologies regarded as quintessentially international and internationalizing like aviation and telecommunications.³⁶

There is another serious problem with the usual versions of technoglobalism, and one which it shares with techno-nationalism: its addiction to novel, spectacular technologies means that it very seriously mis-times and mistakes the impact of the key technologies of global communication. "The great distinction of the communication and transport technologies which shaped the twentieth century (telephone, radio, TV, movies, automobile, airplane, Internet) was that they altered the everyday lives of billions of people" write McNeill son

which is taken essentially as guns, tanks and such like. Charles Gibbs-Smith, *The Aeroplane: an Historical Survey of its Origins and Development*, (London: HMSO/Science Museum 1960 and developed into *Aviation: an Historical Survey from its Origins to the End of World War II* (London: HMSO/Science Museum, 1970) and 2nd edition (London: HMSO/Science Museum, 1985). Gibbs-Smith worked not at the Science Museum but at the Victoria and Albert Museum. R. Miller and D. Sawers, *The Technical Development of Modern Aviation* (London, 1968), pp. 58,257. Peter King *Knights of the Air* (London, 1989) and Keith Hayward, *The British Aircraft Industry* (Manchester, 1989). Much the same has happened in the case of the US aircraft industry. See as an example, Roger Bilstein, *Flight in America 1900-1983: from the Wrights to the Astronauts* (Baltimore, 1984).

³⁶ I set out my critique of the standard view of military technology as derived from civil (and usually globalizing) technology, together with an alternative historical sociology in my *Warfare State: Britain 1920 -1970* (Cambridge: Cambridge University Press, 2005), chapter 8 especially.

and father, citing the usual list.³⁷ Yet technologies of communication only got to be important once they had disappeared from techno-globalist rhetoric: Into the 1950s the key modes of transport of people across boundaries were the train and the ship; today the ship still carries the great bulk of rapidly expanding international trade, not the information superhighway of our supposedly weightless economy. In short the standard assumptions about technological time which underlie studies of technology and global history are usually faulty.³⁸

AUTARCHY AND THINGS

Political and technological boundaries are different, but states have often acted to bring them into line, by controlling the movement of things across borders and by developing particular national technologies. They have controlled movements of things by tariffs, quotas and nationalistic procurement policies. They have developed national technologies by insulating the nation from the rest of the world, and by the direct funding of national innovation programs. This practical technological nationalism has had wonderfully contradictory effects – far from making national technologies different, it has encouraged movement of technologies across political boundaries. It has also helped impoverish nations rather than strengthen them.

In the histories of some nations, autarchy became an explicit political economic program, with that very term being used by political actors, and historians have had no trouble in using the term too. The most obvious and important cases are Italy under fascism, Nazi Germany, and Francoist Spain, where the period of *autarquía* lasted to 1959. Governments protected industry, they engaged in import substitution, they promoted strategic industries, linked to the military and the state often had great control over domestic industry, sometimes through specialist bodies like Mussolini's IRI (Industrial Reconstruction Institute), and its Spanish variant established in 1941, the Instituto Nacional de Industria.³⁹ The Soviet and Chinese blocs were also autarchic. Autarchy was to become most extreme indeed in nations which were isolated from the capitalist world and the socialist blocs. In North Korea *Juche* (self-reliance) was pursued from the 1960s when the country was isolated from both China and USSR. Albania relied on the Soviet Union to 1960 and China thereafter, but became increasingly autarchic from the early 1970s, and especially from 1978 when China removed all support.

³⁷ McNeill and McNeill, p. 269

³⁸ See my *Shock of the Old: Technology and Global History since 1900* for the full argument.

³⁹ Santiago López García and Luis Sanz Menéndez, "Política tecnológica versus política científica durante el franquismo," *Quaderns d'Història de l'Enginyeria* Vol. II (1997), pp. 77-118

In the middle years of the century many more countries were autarchic. Throughout the world, countries sought to industrialize, to replace imports with domestic products, produced by local companies. Among the countries that turned to autarchy was that previously great champion of Free Trade, Britain. Greece, the great commercial center of the Eastern Mediterranean, hardly known for manufacturing, also turned to autarchy under Metaxas in the 1930s. Often war elsewhere was crucial, forcing autarchic development to replace imports that were no longer available. Virtue was made of these necessities, for example in Argentina under General Perón, where national industrial development became a central policy of the regime. Similarly India, South Africa and Australia developed new industries in this period.

Autarchy was supported by elements of the left, as well as the right. In the 1960s Latin American dependency theorists complained that under free trade nations exported raw materials while even its most basic manufactures were imported; they attacked their own countries as places which made nothing, invented nothing, which were forever subservient to the metropolis. Breaking away from the world market, and developing national industries was essential to development, and to independence. The European Left too, at least in part, wanted to promote national industrial development strategies, and thus rejected free trade and indeed the European common market.

HYDROGENATION

At the beginning of the twentieth century a French chemist, Henri Sabatier, showed that metal catalysts could be used to make possible the hydrogenation, the chemical addition of hydrogen, to many compounds, organic and inorganic. Three uses of hydrogenation turned out to be particularly important: the manufacture of margarine, ammonia and fuel. All three processes produced substitutes for older products: ammonia was used to make nitrates, replacing nitrate from Chilean guano deposits; fuel made from coal replaced that distilled from petroleum; margarine made from hydrogenated fats and oils substituted for butter and other forms of margarine. All three were to be closely connected to the national question in the twentieth century.

The hydrogenation of nitrogen to make ammonia, pioneered by the German chemical firm BASF before and during the Great War, was of enormous importance to national power, not only because it created locally produced nitrogen fertilizer, but also because nitrate was a major source of explosives too. In 1913 BASF began production at Oppau of synthetic ammonia, and a new plant was built at Leuna in 1917. Coke, steam and air were the raw materials. In the war Oppau developed and operated the process for making nitrate from ammonia. No great power, it seemed, could be without “synthetic ammonia,” and governments

sought to develop the Haber-Bosch and other processes (for there were a number of alternative ways of making synthetic fertilizers). In Britain, for example, synthetic ammonia became central to the new enterprise Imperial Chemical Industries, founded in 1926, taking over an initially state-sponsored project to make synthetic ammonia and nitrates at Billingham. Yet synthetic nitrogen fertilizer (mostly, but not only Haber-Bosch) was to become extraordinarily global, and indeed was to become an industry of profound importance, particularly after the Second World War. Nitrate was poured onto the world's fields after 1945, such that by the end of the century, some one-third of the nitrogen in human food had come from human-made nitrate.

Perhaps the most important use of hydrogenation in terms of its national associations was the hydrogenation of coal. In the rich countries of the world, coal was the dominant source of energy of the first half of the twentieth century. Yet, very quickly petroleum became important as a source of power for cars, trucks and airplanes (gasoline) and ships (diesel and fuel oil). The leading western European nations did not have their own sources of supply – the main producers were the United States, Russia, Romania and Mexico. The German chemist Friedrich Bergius developed processes for making cheap hydrogen from coal; he then hydrogenated heavy oils, and in 1913, coal. Bergius started building a plant in Rheinau in 1915, to produce his oil-from-coal. This massive project was embarked on because Germany was about to become fatally short of gasoline for the war effort. But Germany and Austria defeated Romania in 1916, and were thus able to secure access to its huge petroleum production. This hugely expensive and long project was not completed before 1924. It was financed by various private firms, including Royal Dutch Shell and then BASF. IG developed a variant of Bergius, with different catalysts, and started building at Leuna in 1927 (where it had hydrogen capacity for synthetic ammonia production). This was the great new project of IG Farben, which brought together the main German chemical companies in the 1920s. By 1931 300,000 tons of petroleum were being produced (or in oil terminology, 2.5 m barrels).

For the Nazis, self-sufficiency in fuel was a key objective, and under the four year plan of 1936, the establishment of synthetic oil production was a key element, with Herman Goering as 'fuel commissar'. The key process chosen was IG's hydrogenation, and IG built and ran many plants, including one to be built for the new coal-based chemical complex at Auschwitz. As ever there were alternatives, and indeed the Fischer-Tropsch process, involving the hydrogenation of carbon monoxide rather than coal was also used. Other alternatives included

generators of gas from wood for powering cars.⁴⁰ By 1944 production was up to 3m tons, or 25.5 m barrels. These synthetic plants were extremely important to the German fuel economy in the war, and particularly so in the production of aviation fuel.

On its defeat, Germany was banned from hydrogenating and in 1949 its plants were ordered to be dismantled. The Soviet Union took four to Siberia. Later in 1949 the decision was changed and the plants were converted to cracking petroleum. In East Germany, isolated from western oil markets, coal was hydrogenated until the 1960s.⁴¹ The chemical industry remained coal-based until increased shipments of petroleum from the USSR came in the 1950s. By the 1980s, with the restriction of Soviet oil exports after 1979, there was a shift back to coal, another case of re-appearance, with dire ecological consequences as the German brown coal generated a good deal of acid rain.⁴²

Coal hydrogenation was taken to many countries, but it never went global. In an autarchic age, technologies of autarchy internationalized. By the early 1920s the key patents were controlled by IG Farben in Germany, but the international rights were, by the early 1930s, controlled jointly by IG Farben, Standard Oil of the United States, the Anglo-Dutch oil company Royal Dutch Shell and the British chemical combine ICI. In Britain and the United States plants were built. In Britain ICI, taking over a good deal of work done in a government research station, built a plant in Billingham which produced petrol between 1935 and 1958. As in Germany, the petrol produced had to be subsidized by various means. Spain developed a synthetic fuel programme at Puertollano (Ciudad Real) following a 1944 deal between the pro-Axis Spanish government and Germany. In 1950 new deals with BASF and others for technology were signed and plant was built.⁴³ Production started in 1956 and lasted until 1966. Spain had a hugely expensive R&D programme in the late 1940s and early 1950s, reaching 0.5% of GDP, a remarkable proportion for a poor country of the period.⁴⁴

⁴⁰ A. Krammer, "Fueling the Third Reich," *Technology and Culture*, Vol. 19 (1978), pp. 394-422; A. Stranges, "From Birmingham to Billingham: High-Pressure Coal Hydrogenation in Great Britain," *Technology and Culture*, Vol. 26 (1985), pp. 726-57

⁴¹ Anthony Stranges, "Friedrich Bergius and the Rise of the German Synthetic Fuel Industry," *ISIS*, Vol. 75 (1984), pp. 643-667

⁴² Rainer Karlsch, "Capacity Losses, Reconstruction and Unfinished Modernisation: the Chemical Industry in the Soviet Zone of Occupation (SBZ)/GDR, 1945-1965," in J.E. Lesch (ed), *The German Chemical Industry in the Twentieth Century* (Dordrecht: Kluwer Academic, 2000)

⁴³ Elena San Román and Carles Sudrià, "Synthetic Fuels in Spain, 1942-1966: the Failure of Franco's Autarkic Dream," *Business History* Vol. 45 (2003), pp. 73 -88.

⁴⁴ At first, during the Second World War, there were attempts to bring over Nazi technology (for example the oil-from-coal case discussed below); after the war German and Italian scientists and engineers were given places in Spanish industries and research institutes. In Spain, the state

Another case was coal-rich South Africa where in 1955 the SASOL company started producing petrol using the Fischer-Tropsch process. Following the Arab oil embargo of 1973, Sasol II was built; the cut off of supplies from Iran after the Iranian revolution of 1979 led to Sasol III.⁴⁵ Like the German plants, the SASOL complex was bombed, not by the United Nations, but in June 1980 by Umkhonto we Sizwe (Spear of the Nation), the armed wing of the African National Congress. The attack marked a very important point in the development of a guerrilla war against the apartheid regime. Racist South Africa, run by its National Party, produced 150,000 barrels per day, twice the level of synthetic fuel production in Nazi Germany.⁴⁶ Indeed oil-from-coal research started up again on a large scale in the 1970s, as the price of oil increased in 1973 and 1979, and looked to stay high. The oil companies and governments were involved once again, and sought out the records the earlier Nazi effort.

In the history of research and development coal hydrogenation should have a very important place. It was the biggest single project of the world's greatest chemical firm of the 1920s and 1930s, IG Farben, and of Britain's ICI in the late 1920s and early 1930s, as well as post-war Spain, and South Africa. Yet it never produced petrol which could compete in world markets. As a source of petrol it was of minor importance, except in the special cases of Nazi Germany and South Africa. Here, it was significant to history. It kept the Luftwaffe flying and apartheid in business.

THE NATION ISN'T EVERYTHING

Technology like nationalism, crosses national borders. Indeed it does so in times and contexts which we might not expect from national histories. For example, in nationalistic, totalitarian, autarchic, fascist Italy of 1935, there were places better connected technologically to the United States than to the rest of Italy. For example, the village of Aliano, in what is now called Basilicata, had 1,200 people, one car, one toilet, and far too many malaria-carrying mosquitoes.⁴⁷ Yet the mechanical equipment of the village was American; its weights and measures the pounds and inches of the Anglo-Saxons, rather than the kilograms and centimeters

promotes the creation of SEAT in 1950, but this has participation from FIAT, and makes FIAT cars, including the famous FIAT 600. Manuel Lage Marco, "La industria del automóvil" in Francisco Javier Ayala-Carcedo (ed) *Historia de la Tecnología en España* Volume II (Valatenea, 2001), pp. 499-518

⁴⁵ http://www.fischer-tropsch.org/DOE/DOE_reports/13837_6/13837_6_toc.htm

⁴⁶ <http://www.sasol.com/sasol> gives the history.

⁴⁷ Carlo Levi, *Christ Stopped at Eboli* (London: Penguin Classics, 2000) edn. First published in English 1947, in Italian 1944, pp. 82, 96. The gentry did not know what to make of a woman doctor, the peasants, many of whom had been to America, did (p. 89).

of continental Europe. The women wove on ancient looms, but used scissors from Pittsburgh; the axe blades of the peasants came from America.⁴⁸ How come? Some 2,000 men from Aliano lived in America and sent over a “stream of scissors, knives, razors, farm tools, scythes, hammers, pincers ... all the gadgets of everyday life.” The carpenters of Grassano, a larger and richer town, had American machinery.⁴⁹ Connections between peoples did not follow the boundaries of nation states, and had a consequence for the traffic in things.

More remarkable is the case of military technology after the Second World War. Despite the Cold War, and intense national efforts to develop national technology, in the 1950s the United States, Britain and the *Soviet Union* shared a remarkable amount of technology, aside from captured German technology. The multinational atomic bomb project became more multinational still, not because of scientific or technological internationalism, but because of espionage by *political* internationalists. They helped ensure that the Soviet Union made a near copy of the plutonium bomb in 1949.⁵⁰ Britain’s bomb, tested in 1952, also replicated the Los Alamos plutonium bomb. The first atomic bomber of these three powers was the same one too. In the early 1950s, all three main powers were using the Boeing B-29, the first atomic bomber. Britain was loaned them by the United States between 1950 and 1954. The USSR had a fleet of Tu 4s, copies of B-29s forced down on Soviet territory during the war. In addition British Nene and Derwent jet engines (and also copies) powered Soviet jet aircraft, notably the MiG15 over the skies of Korea (the transfer was authorized in 1946).⁵¹ Indeed, the Nene engine was everywhere.

After the Second World War a remarkable range of countries decided they needed not only to acquire jet fighters, and to manufacture them, but to design them. Many of the experts came from Germany, which was prevented from having an aircraft industry. Its aeronautical engineers, including the most famous, went not only to the United States or the USSR but to such countries as Spain, Argentina, India and the United Arab Republic. These nations were in different periods and for different reasons “non-aligned” with the two great power blocs of the post war era, the Soviet Union and the United States. Argentina, India and Egypt, the main part of the United Arab Republic, had been to different degrees, British imperial territories, and in all three German aeronautical expertise was used more than British.

⁴⁸ Levi, pp. 128-9.

⁴⁹ Levi, p. 160

⁵⁰ David Holloway, *Stalin and the Bomb: the Soviet Union and Atomic Energy, 1939-1956* (London: Yale University Press, 1994)

⁵¹ The politics of these transfers is nicely explored in: Jeffrey A. Engel, ““We are Not Concerned Who the Buyer Is”: Engine Sales and Anglo-American Security at the Dawn of the Jet Age,” *History and Technology* Vol. 17 (2000), pp. 43-68

Under the nationalist-populist Perón regime, Argentina built a jet fighter, the *Pulqui* which first flew in 1947. The name meant “arrow” in the indigenous language, Mapuche, a sure sign of the nationalist impulse behind it. It was built under the leadership of one of France’s great aeronautical engineers, Emile Dewoitine, on the run from France, where he was wanted for collaboration.⁵² He had arrived in Argentina in 1946, via Spain where he had gone after the liberation of France. Dewoitine was to stay in Argentina till the late 1960s.⁵³ He was to be replaced in 1947 by an even more famous designer, Kurt Tank (1898-1983), the key designer at Focke-wulf. Tank had nearly gone to the Soviet Union. He had met with one of the key Soviet aeronautical experts, Colonel Grigory Tokaev, who put him off from journeying to Moscow to see Stalin. Tokaev would soon defect to the British, partly because he was unhappy with the Russian nationalism that Stalin was imposing.⁵⁴ From 1947 Tank designed and built the *Pulqui II* jet, which flew, with Nene engines, in 1950. It was, like the Soviet MiG15, descended from Tank’s Ta 183 and powered by Nene engines. The *Pulqui II* was never put into production and Tank and much of his team moved on to India. Here they designed the supersonic Hindustan *Marut* fighter, in service from the 60s to the 80s: over 140 were built. This too depended on a British engine. India would collaborate with that failed pan-Arabic nation, the United Arab Republic (UAR), of Egypt, Syria and Yemen to design aero-engines for their national fighters. Again German expertise was central.

The UAR aircraft program had started in Spain.⁵⁵ Spain saw autarchic development in aviation, in the 1940s and 1950s, again with German specialists.⁵⁶ Claude Dornier (1884-1969) worked for the CASA company in Madrid, designing light utility aircraft for the military, also later to be built in Germany. Willy Messerschmitt (1898-1978) went to Spain in 1951. First he developed a jet

⁵² Ignacio Klich. ‘Introducción’ to the CEANA final report. <http://www.ceana.org.ar/final/final.htm>. CEANA set up by the Argentine foreign minister Guido Di Tella to study the role of the Peronist government in bringing Nazis to Argentina. The report named 180 war criminals went to Argentina including many French and Belgian. See Robert A. Potash y Celso Rodríguez, ‘El empleo en el ejercito argentino de nazis y otros tecnicos extranjeros, 1943-1955’, in the CEANA final report. French sources are vague and embarrassed, see Raymond Danel, *Emile Dewoitine : createur des usines de Toulouse de l'Aerospatiale* (Paris : Lariviere, 1982).

⁵³ Diana Quattrocchi-Woisson, “Relaciones con la Argentina de funcionarios de Vichy y de colaboradores franceses y belgas, 1940-1960,” CEANA final report <http://www.ceana.org.ar/final/final.htm>

⁵⁴ G.A. Tokaev, *Comrade X* [trans Alec Brown] (London: the Harvill Press, 1956)

⁵⁵ Hans Ebert, Johann Kaiser and Klaus Peters, *The History of German Aviation : Willy Messerschmidt - Pioneer of Aviation Design* (Forlag: Schiffer Publishing Ltd, 1999).

⁵⁶ Jose Antonio Martinez Cabeza, “La ingeniería aeronáutica,” Francisco Javier Ayala-Carcedo (ed) *Historia de la Tecnología en España* Volume II (Valatenea, 2001), pp. 519-35.

trainer, which could also be used in combat, and a good number were built. Egypt started producing them in the 1950s and some were still in service in the 1980s (they were called *Al-Khahira* (Cairo)).⁵⁷ Messerschmitt (with the collaboration of Ernst Heinkel) also built the H300 supersonic fighter which never went into production, and was further developed by the Egyptians through the 1960s, without success. It too depended on British engines. These non-aligned technologies would not be very significant. Spain would get U.S. aircraft from the early 1950s; and Egypt and India went to the USSR, as well as other suppliers.

FOREIGN TECHNOLOGY AND SOCIALISM IN ONE COUNTRY

The Soviet Union provides a particularly startling case of autarchic development based on foreign technology. Socialism in one country, the central dogma of Stalinism, depended on foreign expertise. The Soviet Union, and thus the rest of the Soviet bloc (including China for a while) relied on processes, and sometimes in effect products, first developed in the capitalist countries, particularly the United States. Ford was one of many companies that transferred their equipment, skills, personnel and products. The USSR not only imported but built Fordson tractors, as it did Ford's Model A cars, and Model AA trucks. The tractors were built in a plant in Kirov reconditioned by Ford, the cars and trucks in a large plant modelled on the River Rouge at Gorky. The result of a deal signed with Ford in 1929, the plant was easily the largest vehicle plant in the USSR producing nearly 70% of output by the end of the 1930s, around 450,000 per annum. The Gorky plant is still the second Russian producer of cars, and the largest maker of trucks and buses.⁵⁸ There were two other plants for cars/trucks. The AMO factory in Moscow was rebuilt with US equipment, renamed ZIS and then ZIL, and also made cars and trucks to US designs. This plant was the parent of the Chinese First Automotive Works formed in 1953, which made 1.28 million Jiefang (Liberation) trucks, between 1956 and 1986, another remarkably long-lived machine, which was itself a copy of the ZIL 150 4-ton truck.⁵⁹

Apart from the production of Fordson tractors between 1928 and 1933, the USSR bought two entire new tractor factories from the United States, one for

⁵⁷ One was given to the Smithsonian in the 1980s, from where this data comes.

⁵⁸ But productivity turned out to be about 50 per cent lower than that of Ford's US factory. Cf. John P. Hardt and George D. Holliday, "Technology Transfer and Change in the Soviet Economic System," in Frederic J. Fleron, Jr., *Technology and Communist Culture: the Socio-Cultural Impact of Technology under Socialism*, New York and London, Praeger, 1977, pp. 183-223

⁵⁹ Chunli Lee, "Adoption of the Ford System and Evolution of the Production System in the Chinese Automobile Industry, 1953-1993," in Haruhito Shiomi and Kazuo Wada (eds), *Fordism Transformed: the Development of Production Methods in the Automobile Industry* (Oxford: Oxford University Press, 1995), p. 302

Stalingrad, the other for Kharkov, to make International Harvester 15/30 machines. This was the tractor which in huge numbers had replaced the Fordson on American farms. A third new factory made the tracked Caterpillar 60, called the Stalinet, in Cheliabinsk. Together with the Fordson plant, the USSR had four plants by the mid-1930s, which were meant to produce 30-50,000 tractors per annum each.⁶⁰ The USSR was to be tractorized with American-designed tractors.

The other great symbols of Stalinism also depended on American expertise. Many of the gigantic dams and hydro-electric projects, like the Dnieper complex, depended on US experts, skilled workers, designs for plants and product, and vast quantities of equipment. The famous steel works at Magnitogorsk, built partly by kulaks thrown off their farms in collectivization, was a copy of a US Steel Corporation plant. At the peak of construction in 1931 there were 250 Americans, plus other foreigners, directing the work at Magnitogorsk, just as in many other places.⁶¹ The US plant was built from 1906 in Indiana on a greenfield site near Chicago named Gary after Elbert Gary, the then chairman of US steel. Thus even the naming of factories and cities after important people had roots in the United States.

During the Second World War there was a wave of transfer of technology, though not production equipment. After the war too, transfer continued covering everything from marine diesels, and fishing boats, to the chemical industry. In the 1960s the USSR once more turned to the West for car models and plant. A deal with FIAT led to the supply of (largely American) plant for a huge new car plant that would produce versions of the Fiat 124 and 125 at the rate of 600,000 per annum from around 1970. They were to be known as Ladas in export markets, and are still being produced. The plant remains the largest car producer in Russia, making around 700,000 cars a year, at less than half the level of productivity of the main international firms. It was built in a new town named Togliattigrad. Set on the banks of the Volga the town was part of a giant projects involving the building of the Lenin Dam on the Volga. It was named after, of all people, the leader of the Italian Communist Party. Palmiro Togliatti had succeeded the intellectual Antonio Gramsci as party leader. Both had studied and become active in Turin, home of FIAT; a essay written in prison by Gramsci was to be the source of the term "Fordism" for the left at the end of the twentieth century, for whom "post-Fordism" became a significant analytical concept.

The Soviet Union was a poor country. The rate at which it took in foreign technology and itself industrialized was remarkable, as of course was the human cost it was forced to pay by Stalin. Its ambition was not merely to emulate, but to create a new and superior society. This new society would be more innovative,

⁶⁰ Sutton, pp. 185-191.

⁶¹ Sutton, pp. 62-3, 74-77.

and more capable of using new technologies than crisis ridden, uncoordinated capitalism. The expectation was that planned economies, with no significant private ownership, and no competition from capitalist enterprises for very long periods, would prove superior. From 1957, following the launch of Sputnik, many non-communists, indeed anti-communists in the West, came to believe that the Soviet Union had indeed cracked the problem of innovation. Khrushchev's famous declaration in the early 1960s that the Soviet Union would overtake capitalism was not a personal exaggeration but an expression of a long-standing and deeply felt interpretation of the likely course of history. Yet despite vast investments in R&D the Soviet Union and its satellites did not lead the world into a new technological era. Generally the Soviet Union lagged, and that lag increased in the 1970s and 1980s. The Soviet historian, Roy Medvedev, plausibly claimed that Lenin would have been surprised to find that the USSR had not overtaken the capitalist world in technology by the 1980s.

The classic Soviet view was that there was one technology, what mattered was the context in which it operated. It made all the difference in the world, they claimed, that although Soviet workers labored under the same division of labor as capitalist workers, and were paid by the piece, they (indirectly) owned the means of production. Yet one finds some suggestions that Soviet technology took a different course from capitalist technology. Notably, it is argued that there was a particular tendency towards gigantism, the most recent expression of which is the massive Three Gorges dam in China. That seems doubtful as similarly giant projects can be found in the United States, indeed the Soviets were inspired by them. However, there may well have been much more pointless gigantism, like the famous case of the White Sea Canal, a more than 200km canal from Leningrad to the White Sea, built in the early 1930s, which while still open, has hardly been used. It took more than 100,000 workers to build. Most were convicts, and most of whom apparently died.

After 1945 the most technically advanced part of the Soviet bloc was not the Soviet Union but the German Democratic Republic. And from here came "group technology," trumpeted as a specifically socialist technology. It involved the grouping of work of particular types of machine in batch production to increase its efficiency. The idea was to analyze components and set up particular groups of machines (a cell) to produce this range of related components. Group technology was not a thing, but a means of organising particular forms of production, and one which turned out to be completely compatible with capitalism. The hoped for technological leadership with this never materialized.⁶² The GDR is also known for a distinctive car, the Trabant, an exceptionally long-

⁶² Raymond G. Stokes, *Constructing Socialism: Technology and Change in East Germany 1945-1990* (Baltimore: Johns Hopkins University Press, 2000).

lived machine. It had a synthetic body, and a 2-stroke 500cc engine. It was in production in the same factory from 1957 to 1989; around 3 million were built, with maximum output of 100,000 units per annum in 1970s.⁶³ Yet it was not even copied within the Soviet bloc. It was clearly a particular response to all sorts of shortages of materials, not a brave new venture in car technology. The GDR also provides one of the few cases where it has been shown that a planned system clearly led to rapid diffusion of technology: the GDR's health system pioneered the widespread use of Swiss technique for dealing with broken bones.⁶⁴

NATIONS VERSUS FIRMS

The greatest transnational institutions of the twentieth century were not the Second, Third or Fourth internationals of the socialists and communists, or bodies such as the League of Nations or the United Nations. They were firms which operated in more than one nation – the so-called “multi-nationals,” and among them were most of the world's largest firms. Not only do some of the world's largest firms have larger GDPs than some small countries, many were founded, and operated multi-nationally, before the majority of modern nation-states were formed. Even before the First World War, Ford, the Chicago meatpackers, the major electrical firms like GE, Westinghouse and Siemens, major armorers like Vickers, and the Singer Sewing Machine company operated around the world.

The technological capacities of firms, national and multinational, need to be distinguished from those of their home nation. The photographic industry exemplifies the need to look at firms and their histories. At the end of the nineteenth century, knowledge about the photographic process was concentrated in Europe, and yet by 1914 a US company, Eastman Kodak, dominated photography in most countries of the world. Kodak was to compete against different kinds of firms. In Britain, specialized photographic firms, merged into Ilford Limited in the 1920s, were a reasonably strong alternative. In Germany and elsewhere, the chemical giant, IG Farben, under the trade name Agfa, was the key competitor. Each firm had different technical resources and innovated different kinds of color photographic processes. IG Farben, the world's leading dye firm, was able to make a film by creating dyestuffs called Agfacolor in which it had embedded most of the reagents that were necessary to process the film. The film could thus be processed by amateurs and chemist's shops. Kodak developed

⁶³ Werner Abelhauser, “Two Kinds of Fordism: On the Differing Roles of Industry in the Development of the Two German States”, in Shiomi and Wada (eds), p. 290.

⁶⁴ Thomas Schlich, “Degrees of Control: the Spread of Operative Fracture Treatment with Metal Implants: a Comparative Perspective on Switzerland, East Germany and the USA, 1950s-1960s,” in Jennifer Stanton (ed), *Innovation in Health and Medicine: Diffusion and Resistance in the Twentieth Century* (London: Routledge, 2002), pp. 106-125

expertise in dye and fine chemicals chemistry during the Great War, and it used this to produce Kodachrome, a film that relied on very complex processing, which had to be done by Kodak in its existing network of processing facilities. Kodachrome and Agfacolor, introduced in the 1930s, were ‘subtractive’ processes. By contrast the Dufay process, promoted by Ilford, was ‘additive’ – it essentially created three different photographs, each occupying a third of the image, a process which required no expertise in dye chemistry. By the 1930s Britain had that expertise, Ilford did not.⁶⁵

The early history of television provides another interesting case, though the key connection is not to Germany as in the case of synthetic dyes, but to Russia. Two key technical leaders, Isaac Schoenberg of EMI and Vladimir Zworykin of RCA were both Russian, and had both studied with the Russian pioneer, Boris Rosing, at the Imperial Institute of Technology in St Petersburg, before the Great War.⁶⁶ Zworykin arrived in the United States in 1919; Schoenberg in Britain in 1914. But the key organization at the centre of this activity was the Radio Corporation of America, Zworykin’s employers. It had investments and technical connections in two key European firms which supplied the modern TV equipment, EMI in Britain, and Telefunken in Germany. The Marconi-EMI system developed in Britain was directly derived from related RCA work. More intriguingly still, RCA was to transfer a great deal of technology to the USSR before the Second World War, including television, such that RCA technology was used to broadcast TV in the USSR before the United States.⁶⁷ Britain, Germany, the United States and the Soviet Union, all developed television in an experimental form at the end of the 1930s, based on RCA technology. It is worth noting that with the exception of the United States, television, like broadcasting generally, was under the direct control of the state in these countries.

NATION, EMPIRE, RACE

In thinking about the relations between the global and the national in the history of twentieth century technology it has been obvious that things, expertise and experts crossed political boundaries. The importance of these boundaries changed, and radically so over time. The boundaries themselves changed too. Nations and

⁶⁵ For more details see “Industrial Research in the British Photographic Industry 1879-1939,” in Jonathan Liebenau (ed.), *The Challenge of New Technology: Innovation in British Business since 1850* (Aldershot: Gower, 1988), pp. 106-134.

⁶⁶ Brian Winston, *Media, Technology and Society* (London: Routledge, 1998) chapter 6.

⁶⁷ Sutton, pp. 161-163; Alexander B. Magoun, “Adding Sight to Sound in Stalin’s Russia: RCA and the Transfer of Electronics Technology to the Soviet Union,” paper presented at SHOT annual conference, Amsterdam, 2004. See also <http://www.davidsarnoff.org/index.htm>

nation-states were hardly eternal. More than that, multi-national states were hugely important. The USSR was a multi-national state, half its population was non-Russian; its 'national' anthem had been, until 1943, the *Internationale*. Trans-national political commitments were also important. For example Italian communist engineers went to the Soviet Union in the 1920s. While post-war Spain had many German and Italian technicians working there, there were many Spanish experts working in the French aircraft industry in Toulouse who would not have wanted, or been able, to work in nationalistic and autarchic Spain.⁶⁸ Most important in this respect were the close links between the Soviet Union and China between 1949 and 1960. One of the most bizarre was the political link between China and Albania in the 1960s and 1970s. Albania relied on Chinese technology; the common language was the Russian dominant in the Soviet Union, the source of much of the Chinese technology.

The great empires of the twentieth century were also hugely important trans-national and trans-ethnic political and technological entities. Far from being throwbacks to the past, empires were intimately associated with particular new technologies, for example long distance radio broadcasting, aviation, and tropical medicines. They lasted into the 1950s. But Empire not only left a technological mark, post-imperial relations did to. One finds few French cars in India, or British cars in Tunisia.

National and imperial boundaries were often radically less important than racial boundaries within nations and empires. For many European intellectuals, ideas around scientific and technological superiority were crucial.⁶⁹ Much discussion of inventiveness in particular was associated with racial and cultural analyses which transcended nations. In the United States blacks were deemed, by whites, to be un-innovative, to the extent that a pioneering sociologist of invention noted that it is "inadvisable to count in the colored populations of the United States and the British Dominions" in computations of relative national inventiveness "since these people do not figure in invention."⁷⁰ Another analyst of the 1920s argued that the United States had low per capita inventiveness because "the United States have a dilution in the negroes in our population."⁷¹ If women

⁶⁸ See Santiago López García, 'El Patronato "Juan de la Cierva" (1939-1960) part I, *Arbor* No 619 (1997), p. 207

⁶⁹ Michael Adas, *Machines as the Measure of Men: Science, Technology and Ideologies of Western Dominance* (Ithaca: Cornell University Press, 1989). The later part of the book has a lot of material on lack of western self-confidence, especially around the Great War, but not all is related to a contrast with the non-western world.

⁷⁰ S.C. Gilfillan, 'Inventiveness by Nation: a Note on Statistical Treatment', *The Geographical Review* 20, (1930): 301-4., p. 301.

⁷¹ M. Jefferson, "The Geographic Distribution of Inventiveness," *The Geographical Review* 19 (1929): 649-64, p. 659.

had been distributed unevenly around the world the same argument would have been made.

In the United States armed services were racially segregated, and the black formations were generally of very low status. There were for example, no black pilots in the US forces in the interwar years. However from 1941 there was segregated training for black pilots who would go into segregated squadrons; only after the war were U.S. forces officially de-segregated. Bell telephone maintained segregation, they did not employ black telephone operators pre-war, and after the war only did so because labor market forced them to.⁷² While in the interwar years there were very large number of black car mechanics and taxi drivers, yet at the same time many whites held blacks to be bad drivers with no mechanical sense.⁷³ No place in the world is more symbolic of the new technologies of the late twentieth century than Silicon Valley in California. Perhaps 80 percent of the production workers also belong to ethnic minorities; and the great majority were recent immigrants to the United States, and are women.⁷⁴ Here technical language may be English, but its workers are in the main Spanish speakers. Many of the technical staff are South and East Asian.

Sometimes of course, some have celebrated uni-inventive peoples. The celebrated Martinican poet of *negritude*, Aimé Césaire, lauded

those who invented neither powder nor the compass
those who have never been able to tame steam or electricity
those who have explored neither the seas nor the sky

...

Eia for those who have never invented anything
for those who have never explored anything
for those who have never subjugated anything.⁷⁵

But many others, including the *dependencia* theorists, lamented, for example, that “La diosa tecnología no habla español,” which meant Spanish speakers were not

⁷² Venus Green “Race and Technology: African American Women in the Bell System, 1945-1980,” *Technology and Culture* Vol. 36 Supplement, pp. S101-S144.

⁷³ Kathleen Franz, “‘The Open Road’: Automobility and Racial Uplift in the Interwar Years,” in Bruce Sinclair (Ed) *Technology and the African-American Experience: Needs and Opportunities for Study* (Cambridge MA: MIT Press, 2004), pp. 131-154.

⁷⁴ Karen J. Hossfeld, “‘Their logic Against Them’: Contradictions in Race, Sex and Class in Silicon Valley,” in Alondra Nelson and Thuy Linh N. Tu (eds) *Technicolor: Race, Technology, and Everyday Life*. (New York and London: New York University Press 2002), pp. 34-63. The study reports data from the 1980s.

⁷⁵ From his *Cahiers d’un retour au pays natal* first published in part in 1938, quoted in David Macey, *Frantz Fanon: a life* (London: Granta, 2000), p. 183

notable in the world of research and invention.⁷⁶ “Que inventen ellos” said the Spanish essayist and Rector of the ancient university of Salamanca, Miguel de Unamuno, at the beginning of the twentieth century. The phrase has achieved notoriety among those who want to see invention flourish in Spain, and indeed no Rector of that ancient university would say it today. A document prepared by a “western intellectual” around 1960 claimed that Russian, and “Eastern Slavonic nations” were “much less inventive and imaginative” than the Anglo-Saxon nations. But, the Soviet Bloc was inventive in many ways, and *Homo sovieticus* was not a Slav.⁷⁷

These comments reflect very substantial differences in participation in elite inventive activities. Only sixteen non-whites have won Nobel prizes in science and medicine, but not one has been of African descent, despite the fact that the United States, the clear leader in the Nobel Prize league table, has a very large African-American population.⁷⁸ Very few Spanish speakers have won science or medicine prizes, while Spanish-speaking writers and poets from many nations have been garlanded with the Literature Prize. Latin America, Africa and some parts of Asia produce few patents, while most of the Northern Hemisphere, including Japan and Korea, turns them out. Uruguay and Brazil give 2 patents per million population to residents, while Finland gives 187. In the United States in particular, there are worthy listings of Afro-American inventors, the fact that such lists are manageable points to the small numbers involved.

Racial and cultural differentiation was far from confined to invention. In the great empires, there was a profoundly racial economy of technology-in-use. Empire created rich enclaves for European colonizers in colonies, and in near-colonies, with motor cars, telephones, electricity, running water, cinemas and so on. These were places like the international settlements in Shanghai, Carthage/Tunis, Casablanca, Ismailia (on the Suez Canal), New Delhi and Singapore. On a smaller scale compounds for white engineers and workers from the rich world were dotted around the poor world. Thus American employees of the United Fruit Company lived in special compounds in the company’s banana plantations in South and Central America; while American and other engineers had special housing and facilities in the USSR in the late 1920s and early 1930s. Within imperial territories race was central to social organization. In all the places where white technology went, white technicians were in control. The pilots who steered ships through the Suez Canal were British and French, not Egyptian. On

⁷⁶ Eduardo Galeano, *Las Venas abiertas de América Latina* (Mexico: Siglo XXI, 1978), first published 1971, p. 381

⁷⁷ G.A. Tokaty, “Soviet Rocket Technology,” republished in *Technology and Culture* Vol. 4 (1963), pp.515-528 on p. 525.

⁷⁸ These are my not wholly reliable estimates from the lists available from the Nobel Museum website. The Nobel Foundation do not provide ethnic data.

the vast Indian railway network, the great majority of its senior engineers were white British. In the interwar years whites born in India became more important, and at lower levels mixed race “Anglo-Indians” or “Eurasians” did too, of whom there were over 100,000. Into the 1930s there were still many British-born locomotive drivers among the large number of Anglo-Indian train drivers. In the Dutch East Indies (later Indonesia) the railway equipment, down to the rails, was imported from Europe. Until the end of the colonial era, only some parts of carriages, and the sleepers (made of teak) were local. At least as late as 1917/18 “not a single clerk, station master or machinist was a non-European.”⁷⁹ Motor vehicles were much more open to natives.⁸⁰ In 1935 the number of native car owners was just below the number of European owners, and just over the number of “foreign oriental” owners; however, there were twice as many licensed native drivers as Europeans, who presumably were chauffeurs and taxi drivers.⁸¹

There was a particular racial order in the vast British merchant marine that served India and elsewhere. This depended to an extraordinary degree on “lascars,” seamen recruited from the Indian sub-continent. In 1928 there were more than 52,000 lascars aboard British ships; 26 percent of all crews, 30 percent of engine-room crews. Special regulations applied to their employment, for example in voyages through cold seas.⁸² There were divisions along geographical, religious and ethnic lines—Catholic Goans served in ships’ galleys and acted as waiters and servants; Muslim Punjabis dominated in the engine room, and deckcrews, both Muslim and Hindu, came from many places.⁸³ Needless to say these British ships were all officered by white British mariners. The Indian army, officered very largely by white officers, was given older and less powerful equipment than all-white formations of the British army.⁸⁴ The prewar Indian Navy and Air Force (created 1933) were tiny. In India non-technical higher education was much more available to Indians than technical education; British technical education was much more technical than its Indian offshoots.⁸⁵ When

⁷⁹ Rudolf Mrázek, *Engineers of Happy Land: technology and nationalism in a colony* (Princeton: Princeton University Press, 2002), p. 10

⁸⁰ Mrázek, p. 17

⁸¹ Mrázek, p. 239 n94.

⁸² J. P. Jones, “Lascars In The Port Of London,” *Port of London Authority Monthly* February 1931. Transcribed in <http://www.lascars.co.uk/plafeb1931.html>

⁸³ “A Pattern of Loyalty by ‘Lighterman,’” (first published *Port of London Authority Monthly*, December 1957) From <http://www.lascars.co.uk/pladec1957.html>

⁸⁴ David Omissi, *The Sepoy and the Raj: Politics of the Indian Army, 1860-1940* (London: Macmillan 1994).

⁸⁵ See Daniel R. Headrick, *The Tentacles of Progress: Technology Transfer in the Age of Imperialism, 1850-1940* (New York: Oxford University Press, 1988), especially chapters 3 and 9.

they took over Malaya from the British, the Japanese boosted technical education for Malays and Indians as well as local industrialization.⁸⁶

It is little wonder that the end of imperialism was so important to national technological development, and indeed that nations emerging out of empires felt a strong need not only to develop national technologists but national technologies too.

ASIA AND TECHNO-NATIONALISM

Japan represents the great twentieth century exception to white dominance in technology. It was a strong, imperial state in the early twentieth century, ruling Taiwan, Korea, and for many years, much of China. The so-called Prussia of the East replicated Britain with its great navy and cotton textile industries of the interwar years. Even in defeat after the Second World War, Japan kept control of its economy, and Japanese owned and controlled firms not only imported technology, but began to generate technologies of their own. Japan rose to be the second performer of research and development in the world by the 1970s. At the same time its car and consumer electronic industries posed a serious threat to North American and European companies. In this respect the Japanese were much more successful than the Soviets, another power which had spend a great deal on importing technology and on research and development.

The Chinese case is quite different, from the Japanese case, or indeed the Korean and Taiwanese cases. Although nationalism was and remains a very important part of communist politics in China, the opening to world since the late 1970s has not led to the development of a powerful local technological infrastructure. Most of China's exports, especially in the electronic sector, come from foreign-funded and foreign owned enterprises, rather than either state-owned or locally privately owned ones. In any case, much of China's export is low-tech, supplying textiles, toys and all sorts of other cheap goods to the world. If Wal-Mart were a country, it would be China's eighth largest trading partner. There is however one distinctive aspect of foreign enterprise in China – it is mostly eastern rather than western. It comes from Japan, and from the so-called overseas Chinese. These Chinese minorities in Malaysia, Indonesia and the Philippines have been central to industrialisation and technical development in these post-imperial nations. Political structures, and ethnic and linguistic links are interacting in very complex ways.

Yet nationalism, and national control, is far from dead in the new globalized China. The internet, supposedly necessarily an agent of

⁸⁶ Christopher Bayly and Tim Harper, *Forgotten Armies: the Fall of British Asia, 1941-1945* (London: Penguin, 2004), pp. 228-9

internationalization, is thoroughly controlled in China. Search engines do not recognize words, like “democracy,” which the government does not like. Sites cease to exist when access is attempted from China. China also pursues some very old-fashioned techno-nationalist enterprises. In 2003, more than 40 years after Yuri Gagarin became the first man in space, China put a Shenzhou-5 capsule into orbit carrying a man.

CONCLUSION

One of the most intractable problems for the serious student of technology is that we all believe we know what the important technologies of particular historical periods are, and what their impact has been, at the level of the globe and the nation. We believe we know not because we are peculiarly deluded about technology, but because reputable books, documentaries, museums and so on tell us again and again that a small selection of technologies have transformed the world, in well established ways. There is, to exaggerate only a little, a deep consensus about this, crossing ideological, national, gender lines, as well as field of study or methodology. There may be some dispute as to evaluation, but not much as to what to evaluate. And yet, as I hope to have shown, our accounts at least in respect of the nation and globalization, are not as securely based as they appear. That the arguments found in refined academic texts are similar to the commonplaces of popular culture (which I have put side by side as an exercise in what I call historiography from below) is suggestive. Understanding technology better is important since it figures powerfully in accounts of the rise and fall of nations, and even more so in accounts of globalization. The moral of the story is this: whenever technology is invoked in discussions of the nation or globalization, remember that it is very probable that it is not technology which is doing the explaining, but an account of technology which should have been discredited long ago. A new history of technology has the potential to give us new accounts of national and global histories.