Telling histories of the future: the imaginaries of Indian technoscience

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When, in 1947, India became independent, its archetypal citizen-subject was the farmer; 60 years later it was the software engineer. Increasingly central, rather than marginal, in global economic networks, India's popular image at the beginning of the twenty-first century is of a postcolonial nation that has successfully used technology to leapfrog over its historical legacy of under-development. This shift in ideal citizen archetypes, from farmer to digital entrepreneur, has brought with it new assumptions about the role of information technology in shaping citizenly behaviour and nationalist subjectivity. This paper reads the contradictory aesthetics of this arrival by interrogating popular technological tropes.

Keywords: India; technology; Ehrlich; Friedman; science; leapfrogging

In nineteenth-century India, colonial anthropologists, concerned with the collection and preservation of the primitive, often spoke on behalf of the native. By the middle of the twentieth century, authority on backward spaces passed to economic development theorists such as Walt Rostow and neo-Malthusian population theorists such as Paul Ehrlich, who reflected on the place of primitive economies in the larger drama of post-World War II development. At the turn of the twenty-first century, information technology (IT) executives displaced development economists. Information technologists emerged as the new experts on global development.

This recent shift in representational authority has three sets of implications. Methodologically, it suggests the need to reshape the historiography of science with a focus on developing economies. How can we understand the growth of global science and technology not just in terms of core and periphery, originality and diffusion, but via heterotemporal transnational dynamics? From an 'area studies' perspective, it reminds us that research in South Asian studies occurs today under shifting regimes of reception and circulation. How will 'global' technological framings of South Asia reshape 'subcontinental' ethnographies and histories? How will new modes of representation break with prior expert discourses such as colonial ethnography and development theory? Finally, politically speaking, why does technology matter? South Asian politics have, for over a century, turned on events in the history of science and technology. But because

science and technology have, by their self-definition, claimed to stand outside of politics, scholars and activists have, either through awe or contempt, left the internal practices of science and technology outside the ambit of critical historical inquiry.

These implications go further than the scope of a single article. Much of the global political economy of the twentieth century pivots on histories of science and technology. I sketch some of the historical and methodological trends that foreshadowed these new academic and political challenges. Because science and technology come burdened with a Eurocentric historiography, many of my examples are drawn from Western representations of India. This is not to suggest that the Western gaze should define the future study of Indian technoscience. On the contrary, these examples demonstrate a paradoxical power: while this legacy fails in obvious ways to capture the complexity of India's emergence as a global technological force, its historical inadequacies, if left unquestioned, easily return to recapture new postcolonial technopolitics in familiar colonial frames. Popular global analytics (typical of both Western and Indian free-market boosters) tend to deploy a model of linear transition from backward to entrepreneurial nation, narrating a development from colonial to emerging economy. But scholars of technoscience might be better served by narratives of imbrication and heterotemporality.

Technoscience-as-fulcrum has often been invisible, and thus inaccessible as a critical position from which to compose a political analysis of development. This invisibility grew from a historical narrative about its value-free objectivity, as well as from a disciplinary narrative assuming the separate spheres of the humanities, technology and economics. Recently, scholarly critiques of objectivity and disciplinarity have challenged both (Shapin 1994; Haraway 1997; Latour 2002). Meanwhile, the domain of practical expertise in development has shifted, giving technological discourses a public voice more powerful now than at any time since the industrial revolution. The future, it seems, has arrived in India. The agency for its design and implementation is settling into new hands: once shaped by anthropologists and development theorists, it is now the domain of information designers (Suchman 2011). I revisit key moments in this shift.

India under Western eyes

Winning independence from the British in 1947, India began its nation-building at the crossroads of empire[1]. As the sun was setting on the British Empire, it was rising on the Cold War and a Bretton-Woods model of US-led global geopolitics. A poor, underdeveloped country, the newly independent India was largely agrarian, and committed in principle to the egalitarian distribution of land and wealth. Yet, by the end of the century, India was world-renowned more for its urban technologists than for its rural farmers. Popular commentary traces this shift to the 1991, and the role of International Monetary Fund loans in opening up the Indian economy. Political economists have contested the idea that there was one

moment of transition, chronicling a more gradual market liberalisation through the late twentieth century. The role of technology has remained largely under-theorised in these popular and scholarly accounts. As a result, Indian geeks now appear as historical singularities, seemingly emerging out of nowhere to catapult the nation to the forefront of emerging economies in the new millennium.[2] India's spectacular entry into the global marketplace has much to do with this seemingly magical appearance of geeks, appearing to transform India overnight, from failure to success.

The Indian state's investment in technology development and education predates the liberalisation decade. The boom in engineers was in part a result of the investment in engineering education in the first decades of independence, a project assisted by numerous Western countries. The Indian Institutes of Technology (IITs), founded in collaboration with the Soviet Union, Germany and the United States, educated highly successful engineers, whose emigration to the west was, during the 1970s and 1980s, regarded as a disastrous 'brain drain' for the poor country that had invested in them. Over the last three decades of the twentieth century, these engineers contributed substantively to the shaping of Silicon Valley's success. There followed a smaller migration reversing the brain drain, during which technological workers left the recession-ridden West and returned to India in the early twenty-first century. Class, caste and gender shape this history. The IITs educated largely upper-caste male engineers. Lower-paid technological workers populated the service sector jobs that began to expand with the Y2K crisis and continued through the software and services boom (Upadhya and Vasavi 2008). One explanation for the emergence of 'geeks' in India's 'spectacular' global period is the history of State investment in science and technology education, as well as the role of the global economy in taking up surplus educated labour that could not be accommodated in India's state-run pre-liberalisation big-science.

There were two common views of the relationship between technology and development.[3] In one, poor countries needed to develop through 'stages of growth', moving from 'traditional' agrarian stages of economic production, through industrialisation, towards a mass consumption. This view, systematised by US national security strategist W. W. Rostow, supported the prioritisation of industrial technologies in the development of poor nations. The stagist model assumed that the Third World lagged behind the first, and thus had to trudge through the same stages, towards the telos of a capitalist-free market economy. Another view, critical of Western development expertise and the paternalistic assumptions of modernisation theory, questioned the importance of industrial technology and called for radically different models of Third World development. This position was most usefully articulated by Latin American economists Andre Gunder Frank and Fernando Henrique Cardoso, and US New Left theorists Baran and Sweezy. They showed how the structural conditions of US capitalist expansion reproduced the historical conditions for the 'development of underdevelopment'. In post-independence India, both schools of thought were influential. Free

market liberals, and some Marxist modernisers, held that India would have to develop big industrial and military technology to catch up with the west; Gandhians and some revolutionary leftists, critical of big science, launched 'appropriate technology' movements to develop tools more appropriate to small-scale village economies.

Despite the wide ideological differences in debates on development, the underlying assumption of most participants in this conversation, through the middle of the twentieth century, was that Indian civil society was not ready for the latest, fastest, slickest, most advanced technology. Ambitious high-technology projects were for the military, and developed largely through Soviet assistance. Village populations were considered to need only those 'appropriate' technologies that could sustain rural production. To the extent that Western technology was considered to enter the everyday lives of citizens, it was through programmes of technology transfer, moving older and often obsolete technologies from the first to the Third World.

Why, then, did 'India-watchers' in the west come to regard India as occupying a central place the future of computational technology for the free market of the twenty-first century? This historical shift in ideal Indian citizen-archetype, from farmer to digital entrepreneur, is commonly invoked in business and popular media discourses. Liberals and technological utopians tend to see it as an overdue but inevitable marker of 'progress', while leftists tend to see this as a regrettable rupture or reversal in State obligations to poverty alleviation. It is useful to track the ways in which a shift in emphasis occurred through the late twentieth century, via real changes in the directions of State subsidies, educational opportunities and social practices. But this shift should not be reduced to a simple story about outdated socialist State policies giving way in the face of energetic technoliberal drives. Twentieth-century India did not experience a simple linear transition; rather, it was constituted by an ongoing struggle among contesting, overlapping and shifting relations of knowledge and power, citizenship and Statehood (Neveling 2014). Orientalist metaphors appear to persist from the nineteenth century; Fabian-socialist redistribution, modernisation theory and neo-liberalism come and go through the twentieth; and the futures of technology in the twenty-first century are defined by India's transnational class of IT practitioners and entrepreneurs, as they forge a precarious, always-contested hegemony. Neo-liberalism's profile is not self-evident; new forms of global political economy are imbricated with colonial continuities and local difference; the diffusion of international development models is not inevitable. Technology's proper historiography follows overlapping, hetero-temporal relations of power, not sequential chronologies. Pasts, presents and futures coexist in the formations of technological modernity.

One stinking hot night

In 1968, Paul Ehrlich's *The Population Bomb* electrified the development world with its dystopian visions of a future destroyed by an overbreeding Third World.

On the first page, Ehrlich juxtaposed an experiential narrative of his family's visit to New Delhi with a scientific plot of population against time, predicting an explosive situation at the dawn of the twenty-first century. Science and subjectivity come together in the crucible of postcolonial poverty. A red arrow points to the extrapolated population level at 2003, exclaiming: 'CARRYING CAPACITY REACHED ??' (Figure 1).

> I have understood the population explosion intellectually for a long time. I came to understand it emotionally one stinking hot night in Delhi a few years ago. My wife and daughter and I were returning to our hotel in an ancient taxi. The seats were hopping with fleas. The only functional gear was third. As we crawled through the city, we entered a crowded slum area. The temperature was well over 100, and the
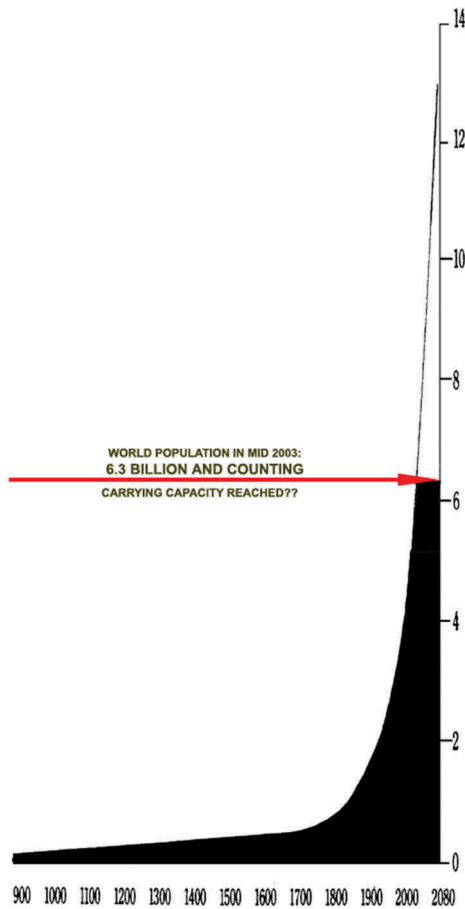

Figure 1.   The Population Bomb.

air was a haze of dust and smoke. The streets seemed alive with people. People eating, people washing, people sleeping. People visiting, arguing, and screaming. People thrusting their hands through the taxi window, begging. People defecating and urinating. People clinging to buses. People herding animals. People, people, people, people. ... All three of us were, frankly, frightened ...[but] the problems of Delhi and Calcutta are our problems too ... We must all learn to identify with the plight of our less fortunate fellows on spaceship Earth if we are to help both them and ourselves to survive. (Ehrlich 1968, pp. 1–2)

In the middle of the twentieth century, as waves of decolonisation events and accompanying nationalist, anti-capitalist and non-alignment movements swept formerly colonised spaces, a growing Western fear of the postcolonial world expressed itself via a technoscientific anxiety over the sustainability of modernisation, progress and growth. Sheer numbers of people ('people, people, people, people') were seen as calling into question the very possibility of a future in a world seemingly spinning out of control after the end of colonisation. The logical calculus of population demographics seemed to calm the panicked emotions of Western subjects adrift in the chaos of the decolonised world. Technoscientific rhetoric offered a narrative that seemed less murky for Western policymakers than the explanations offered by the contradictory histories of settlement, control, exploitation, cooperation and resistance with whose legacies postcolonial societies were wrestling, or the unsettling, open-ended questions about new relations between postcolonial subjects and former colonial powers.

There were other conversations through the second half of the twentieth century. Technical discourses were not monolithic; the rise to dominance, in the 1970s, of this particular demographic logic was not historically inevitable. There were radical movements that sought to bring technoscience 'to the people' (KSSP 1984; Steur 2009). Even neoclassical economics had internal dissensions, visible, for example, in various post-colonial economists' attempts to question key assumptions of the field while writing from its inside, drawing on the experience of redistributive economic policies and feminist household economics. But it was Ehrlich's alarmist call to population control that rose to prominence in economics and development studies, articulating a scholarly rationale for widespread population anxieties. The emergence of Ehrlich's book as the voice of the moment was not inevitable, nor was it based on the absence of alternative narratives about the developing world. It rose to hegemony because it resonated with and articulated the concerns of a strategically important State security apparatus and its enabling intellectual communities, while marginalising other, less alarmist, discourses, privileging narratives of competition and scarcity over narratives of redistribution and diversity.

First–Third World geopolitics in the 1970s drew on assumptions from the science of population, on the calculus of demographics and an equilibrium equation of danger and fear, leavened by pity for the 'plight of the less fortunate'. When Ehrlich, protecting his wife and child, intones: 'we were all three frightened', he

invokes the spectre of 1857, when white English women and children were so famously 'threatened' by the proximity of native bodies. His resolution comfortingly resolves uncontrollable fear into manageable pity. The rhetorical end of a terror-filled paragraph on a liberal, charitable note must be understood in the context of the history of aid programmes in the 1970s, which carried requirements that the transfer of development dollars to the developing world would hinge on the implementation of population controls. *The Population Bomb* was a symptom of mid-century geopolitics. Third World aid and investment economics thrived off panic about population, environment and resources. But 40 years later, in the first decade of the twenty-first century, an oddly inverted political economy emerged.

Holy mackerel, the world is becoming flat

The economic liberalisation of the early 1990s had brought an apparent reversal in the state of postcolonial India, as well as in its Western representations. This 1990s discourse was undergirded by a technoscientific rationale different from the 1970s global development narrative. If the complex cultural and political challenges of decolonisation and postcolonial relations were short-circuited in the 1970s by the science of population (promising a technocratic cut through the social messiness, delivering an equation among the variables fertility, GDP, carrying capacity, linking human bodies and agrarian productivity), the complexities of the turn of the century – rendered again in technocratic form – spoke through the practices of computational networked communication.[4]

At the turn of the twentieth century, there emerged a popular writer who, like Ehrlich, crystallised the concerns of global political economy and the promise of global technoscience into a dramatic narrative: Thomas Friedman. The opening page of his 2005 bestseller, *The World Is Flat*, stands in stark contrast with the opening of Ehrlich's *The Population Bomb*. Separated by almost half a century, each deployed different aspects of science and technology to carry their argument.

'Aim at either Microsoft or IBM.' I was standing on the first tee at the KGA Golf Club in downtown Bangalore, in southern India, when my playing partner pointed at two shiny glass-and-steel buildings off in the distance, just behind the first green. The Goldman Sachs building wasn't done yet ... HP and Texas Instuments had their offices on the back nine, along the tenth hole. ... The tee markers were from Epson, the printer company, and one of our caddies was wearing a hat from 3M. Outside, some of the traffic signs were also sponsored by Texas Instruments, and the Pizza Hut billboard on the way over showed a steaming pizza, under the headline 'Gigabites of Taste!'

. . .

Columbus was searching for hardware – precious metals, silk, and spices – the sources of wealth in his day. I was searching for software, brainpower, complex

algorithms, knowledge workers, call centers, transmission protocols, break-throughs in optical engineering – the sources of wealth in our day. (Friedman 2005, p. 1)

Brand names undergird, and punctuate, the euphoria in Friedman's happy discovery narrative, where Ehrlich's fear-filled travel narratives drew literally on colonial tropes of heat and dust. Paul Ehrlich and Thomas Friedman, both American writers in India, liberal social critics on casual visits (i.e. not shaped by long scholarly study, with no historical or linguistic familiarity), open their best-selling, world-shaping books with their personal experience of it. These shifting frames, from 1968 to 2005, suggest not so much the realities of India as the ways in which a fantasmatic image of India undergirded America's ideas of its place in a global technoscientific economy.

The World Is Flat suggests that changes in late twentieth-century global political economy, resulting largely from computational technology and its enabling supply chain systems, have created different kinds of citizens. Scripted for consumption by a new kind of US-based global actor, Friedman's narrative mixes classic colonial modes of representation (unnamed, faceless, multitudinous Third World subjects threatening to take 'our' share; shadowy mutant supply chains forming terrorist networks; contrasts between good, hard-working, westernised natives and bad, violent terroristic natives; Friedman as Columbus) with practical advice for worried Americans, assuring them that they can still do well if they learn how to leverage the new global situation.[5]

The World Is Flat narrates historical continuities as well as ruptures with *The Population Bomb*. Like Ehrlich's prose, Friedman's descriptions of Indians in public places deploy nature metaphors ('nature' and the 'native' were, in diverse orientalist and colonial discourses, commonly aligned; with potent ideological effect). In contrast to the 'swarming' imagery Ehrlich deploys, Friedman favours a water image. He describes himself standing in the manicured corporate campus Infosys, 'observing this river of educated young people flowing in and out'. Although his 'mind just kept telling' him that this scene was simply a picture of the political economy of comparative advantage, his 'eye' kept telling him 'something else: Oh, my God, there are just so many of them … And they just keep coming, wave after wave'. Like Ehrlich, Friedman allows the reader a candid moment insight into his emotional panic: at the sight of waves of 'them', an older narrative of fear at the seemingly unstoppable, undifferentiated masses of the developing world seems to reassert itself. But these masses are educated, rather than unwashed, as they were 40 years earlier; Friedman observes that 'they all looked as if they had scored 1600 on their SAT's', – that is, a perfect 800 on verbal and mathematical sections, putting them all in the top 1% of test takers – echoing the model minority stereotype common in the United States, in which Asians, through a combination of seemingly inherent mathematical ability along with a seemingly inhuman ability to practice drills and rote learning, consistently break the curve on aptitude tests. Friedman, like Ehrlich, allows us to follow him through the panic, subsequently coaching us into accepting a new

version of the 'we are all on the same spaceship' narrative. Population control was the soothing solution in the 1970s. Reviving the creative classes, and managing the global outsourcing economy through the savvy design and management of technology constituted the twenty-first-century solution.

Population control technologies originated in Western research labs, were disseminated by Western aid agencies and taken up by developing nation states. Computer technology, on the other hand, was difficult to centralise in the hands of Western states and aid agencies. The birth of software development in contexts of extreme sharing (such as the MIT lab environment that produced Richard Stallman and the free software movement), and the rapid adoption, and modification, of new software through networks of piracy in low-income contexts like India's student population in the 1980s, followed by the global rise of open-source software development through the turn of the century, meant that the realms of use and innovation were radically decentred and dispersed from their inception. The science of population had seemed to offer a clear method of application and resolution of the population crisis. But computational technology lent itself to a more dispersed functioning. Its most radical shifts had occurred through decentralised practices; coding skills seemed to flourish even in resource-poor institutions. Computational technology itself, with its agile, anti-centralisation tendencies, provided few metaphorical prophylactics for anxieties about disorder.

Early analysts of globalisation had identified similar anxieties as afflicting Western observers (Castells 1996; Sassen 1991; Jameson 1991). For instance, Frederic Jameson has commented on the ways in which global capitalism perplexes nationalist paradigms. Manuel Castells suggested that an epochal change in the nature of identity was resulting from the network effect, which was replacing centralised, localised identity formations. But Friedman's success was in experiencing, with his reader, the anxieties about America losing its central role in global economic affairs, and then pulling the reader back from the brink of despair with a narrative that looked like a Cold War story (reassuring, since 'we' won the Cold War), but that had a critical new element ('technology', which thus appeared as the promising but unpredictable new thing which must be better managed and controlled). He articulated all this as a challenge of citizenship, a challenge specific to this historical moment:

> You can't be a citizen of this country and not be in a hair-pulling rage at the fact that we're at this inflection moment and nobody seems to be talking about the kind of policies we need to get through this flattening of the world, to get the most out of it and cushion the worst. We need to have as focused, as serious, as energetic, as sacrificing a strategy for dealing with flatism as we did for communism. This is the challenge of our day. http://www.wired.com/wired/archive/13.05/friedman.html?pg=2&topic=friedman&topic_set=

Friedman simultaneously gives voice to an anxiety about globalisation – the vertiginous feeling a subject experiences when the belief that he is at the centre

of a controlled process turns out to be based on unpredictably shifting founda-
tions – and prescribes a reassuring antidote to it. Pop social diagnoses that
seemed to articulate a new *mal du siecle* had circulated wildly in US popular
discourse at the turn of the twentieth century: the decline of American exception-
alism; the death of the American Dream; the fear of technological excess; the
decay of nuclear family; the fear of being outsourced (or 'Bangalored'); and so
on. Technology appears in all these stories either as a tool or as the motor of
history. Friedman brought this fraught, millennial conversation to centre stage at
the beginning of a new century.

Pace Friedman, India's twenty-first-century development was not peopled
entirely by golf-playing executives. While many software executives were, indeed,
groomed as global leaders, they were a 'creamy layer'; the elite face of a stratified
labour environment. A vast labour pool of IT workers did emerge at the turn of the
century, employing three million people at the time Friedman's book appeared.[6]
Economic analysts distinguished carefully between these sectors, calling one IT
and the other IT-enabled services (ITES).[7] India's eleventh five-year plan document
reported both as part of India's success story in 2007:

> The rise and expansion of the Indian IT and ITES
> services industry is a much talked about subject the
> world over. Total export revenues earned by this sector
> have grown from US$ 7.7 billion 2001–02 to US$ 31.3
> billon in 2006–07, thus showing a near 32% compounded
> growth. India now accounts for 65% of the global market
> in offshore IT and 46% of the ITES market . A majority
> of the Fortune 500 and Global 2000 corporations are
> sourcing IT and ITES from India.

If IT involves information technology products and innovation, ITES was tied to
lower-value-added modes of work: large, low-paid, low-skill workforces pro-
vided services for higher-income global citizens. The sharp disparities between IT
executives and ITES service workers are papered over in Friedman's narrative.
Once again, popular culture refracts some of the underlying narratives at which
the data gesture. Consider the following image of India that captures the ITES
worker, rather than Friedman's IT executive. It emerged at the peak of the
'outsourcing debate' in the United States, roughly contemporaneous with
Friedman's 'flatism' thesis. It captures the multiple anxieties of the 'outsourcing
debate' in the twenty-first-century United States[8] (Figure 2).

Outsourcing marked a form of anxiety that was both familiar and new. Global
circuits of labour had long been a source of concern to First World economies;
the full genealogies of this story would include slavery, indentured labour and
colonial migration. But the globalisation of production in the late twentieth
century, speedier than before because of the 'instantaneous' communication
enabled by computational and satellite networks, created new forms of consumer
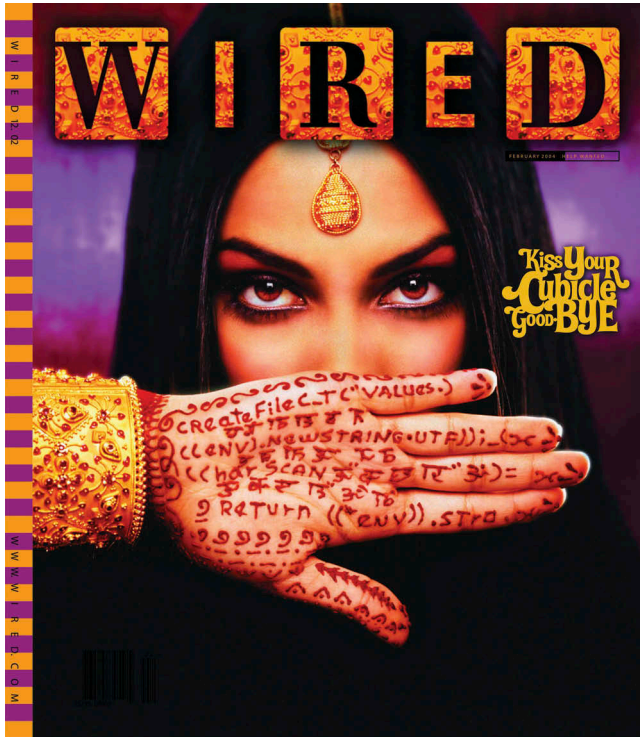
Figure 2.   *Wired* cover girl hand. Reproduced with permission, Conde Nast Publications, New York.

and professional anxiety. The February 2004 issue of *Wired* magazine carried a cover image representing the outsourcing threat as an exotic Asian woman on whose hand lines of code inscribed henna patterns. Her hand forms a mysterious veil across her face; but a closer reading of the apparently traditional patterns reveals a deep familiarity with modern technology. The henna-inscribed computer program's literal instruction to the machine is simply to return, unchanged, a string of characters. The hand-written characters (scribbled awkwardly, and with mis-drawn characters) spell 'Om Ka Cha Ra Om', appearing to intone: 'Om Garbage Om'. The sequence brackets the word for 'garbage' (*kachara*) within a Hindu sacred frame (*om*). While the mysterious (computer-generated) face seduces and beckons with her kohl-rimmed eyes, the savvy technologist must read her code veil as exposing the truth behind outsourcing, the idea that data entry workers take garbage in and spew garbage out. In hyperbolic analogies (what else can follow after the anxiety-provoking title, 'Kiss Your Cubicle Goodbye'?), global capitalism's machine is represented as chugging along via the mimic-man activities of those whose public face might have an exotic edge,

but whose real activities involve the dumb punching of keys in Third World data entry farms. This reflects a widespread argument during the height of the out-sourcing anxiety in the United States, that the creative skills of American workers were being replaced by the obedient but dumb mimicry of Indian workers.

Postcolonial technopolitics

Observing that, through the second half of the twentieth century, India changed from a formerly colonial periphery, at the edges of modern development, to a powerhouse of IT, a core participant in a global technological agora, popular journalistic analyses repeatedly ask: How did this happen? One popular answer is in Figure 3: 'It's the Global Economy, Stupid.' The cover image of *Business 2.0* in July 2004 showed the precolonial Indian 'wonder of the world,' the Taj Mahal, reflected as a $ sign: tradition transformed into wealth, Islamic cultural pasts into
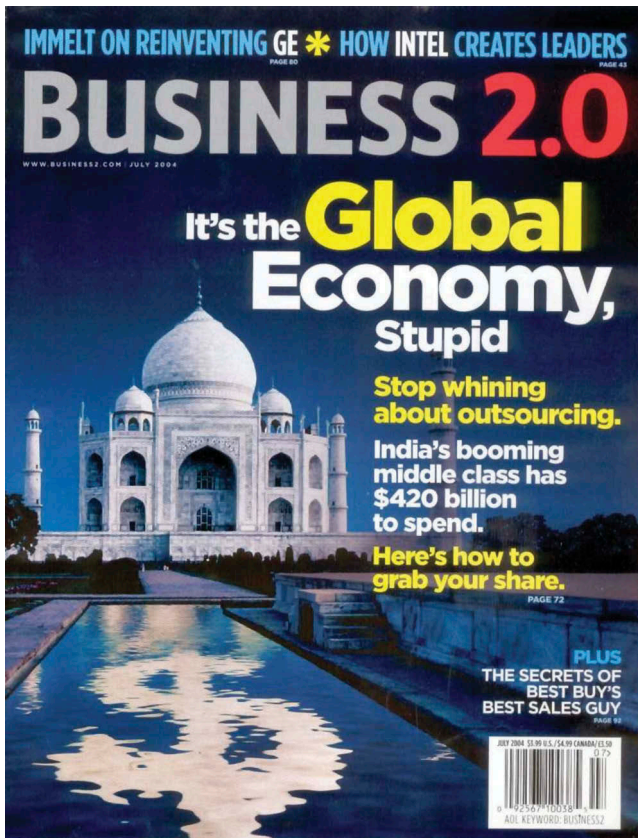

Figure 3.   *Business 2.0.*

secular capitalist modernity. This reflective sleight of hand is itself the latest 'wonder' in a world that cannot quite understand the rise to dominance of a postcolonial periphery as a modern economic force. Emerging studies in the history of technology and anthropologies of technoscience show how this new dawn of modernity in India has complex pre-histories and continues to grow, not on a purification of the economy from its old encumbrances, but via the layered cultural practices and economic temporalities that continue to shape global India's presents and futures.[9]

The 'global economy' as buzzword serves to obscure the relations of inequality that undergird it. More than a million people are employed in the allied industries of IT and ITES in India. The higher-status IT industry has an approximately 70:30 ratio of men to women, which the lower-status ITES industries reverse, with 70% women. From journalism to scholarship, a euphoric message pervades the reports on this topic in the first decade of this century. In a 2005 special report on women in IT, the news company Rediffusion proclaimed 'In the IT industry, women rock!':

> India is way ahead of the United States in the empowerment of women in the information technology services arena.... The ratio of women in IT services in India is rising steadily, whereas the percentage of women IT workers in the US has been declining over the years.

Anthropologists Chris Fuller and Haripriya Narasimhan found 'more empowerment' than 'exploitation' in their study of women in the Chennai IT sector:

> Almost without exception, our informants have insisted that there is no gender inequality in ... major software companies ... [and there is] virtually universal agreement that women and men have equal technical skills in software engineering, computer programming and other related fields, which is in turn linked to the assumption that both sexes are equally good at mathematics, science and technology.

Nevertheless, Fuller and Narasimhan offer evidence that gender, caste and geographic location are key shapers of India's IT experience.[10] While women and disenfranchised castes participate in the digital marketplace, their modes of inclusion are aligned with older patterns of privilege. A 2007 study of caste and employment reported a 'pattern of unemployment' that showed religious or caste-based minorities in India suffered from employment-based discrimination:

> [E]xperimental data turns up fairly persistent evidence of discrimination under controlled conditions ... far from fading as India modernises, the problem of discrimination remains a serious one – even at the very top of the human capital hierarchy. (Jodhka and Newman 2007, 4125)

Difference is not a premodern, atavistic vestige in a technological economy; rather, it is a dynamic component in the construction of contemporary citizenship,

and of India's new global technological image. Citizenship and subjectivity are newly tied to technological development, in ways that do not obviate the State, but alter the State's developmental interventions. As some have argued, this signals a shift in governmentality (Abraham and Rajadhyaksha 2015). New technological cultures shape new modes of caste politics; participation in the digital sphere is linked to public performances of masculinity; media hype about digital entrepreneurs accompanies technological-determinist, trickle-down economic models. The growth of corporate interest in the world's 'bottom billion' consumers adds a layer of political complexity: poor and marginalised populations are increasingly seen as potential new citizen-consumers, rather than as developmental lags or obstructions.[11]

Conclusion

In tracing the continuities and ruptures between Victorian cultural legacies, India's colonial economy and contemporary postcolonialism, we cannot assume that an ideological layer of tropic discourses can simply be extracted from the histories of political economy. The story of how technology becomes a dominant cultural and economic referent in the contemporary period is inseparable from the ways in which narratives of difference – especially those of caste, class, gender – are revivified through the infrastructures and practice of technologies (Berry 2003). Rather than assume that the categories of culture, politics, economy and science are preexisting spheres that produce objects and forces, that subsequently affect each other, we must assume that they are constitutively intertwined from the beginning. Standard understandings of science and technology tend to posit idealist knowledge claims, or instrumentalist technological systems, as driving forces of history, thus isolating them from the messy details of social history. In contrast, emerging work on Indian technoscience has begun to explore the ways in which technology works effectively because of (not *despite*) its multiple articulations with other social practices. Science and Technology Studies, Digital Humanities and New Media Studies have shown how science and technology are social, material, historical discourses of truth and practices of power. Information scientists and humanists engage each other to shape the Digital Humanities, and media theorists collaborate with game designers and military trainers under the moniker of Creative Industries. But the developing world's histories are still too often studied separately from these rubrics; they commonly occupy Area Studies frameworks and national paradigms, forged via the intellectual legacies of the Cold War.

This paper seeks to provoke a rethinking of the historiography of science along with the material and political re-theorisation of technology and capital. In response to the relentless linearity of popular narratives of technology, this emerging field must forge new methods of tacking between the histories of colonial science and the futures of technoscientific capitalism.

Acknowledgements

Disclosure statement

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Notes

1. The phrase 'under western eyes' alludes to the insights of an earlier generation of feminist cultural studies scholarship that introduced me to the ways in which representations of colonial space carried lasting ideological and material implications (Mohanty 1984; Pratt 1992). Even while histories of technology and political economy have led me to question an overly 'superstructural' mode of cultural analysis, these early works contain critical reminders of the value of representational and rhetorical analysis.

2. South Asian historical scholarship has begun to move away from the focus on the colonial period, to shed light on post-independence India. Ethnographic work on Indian engineers and designers is now extensive (Irani 2013). In this paper, I use a range of terms referring to software engineering, computational technology and the information economy; Irani reminds us of the need to be more careful about historical distinctions between engineers and designers, between software and infrastructure. There remains much empirical work to be done in specifying the dynamics and politics of technological design in different contexts; the parameters of gender, caste, class and region pose messy, compelling, starting points.

3. This is part of a larger work in progress on the history and political economy of technology. This conceptual map of political economy and popular representations of Indian technology reworks earlier versions of my argument (Philip 2010, 2012).

4. Many histories of institutional and academic development have linked mid-century population studies to State Department mandates, funding from well-connected non-profits (e.g. the Rockefeller Foundation, Population Council, business networks and State imperatives combined efforts to develop departments of demography). For links between State department imperatives and the study of computer networks, see Arguilla and Ronfeldt (2001).

5. Despite its global affectations, the book is pitched to a US audience. However, understanding the global circulation of magazines and web-based media, Friedman framed his press interviews (e.g. with *Wired* magazine, in 2005) with a multinational, upwardly mobile, global audience in mind. Nandan Nilekani and Vivek Paul (executives in India's most successful business process outsourcing companies, Infosys and Wipro) were the dispensers of global business intelligence behind many of Friedman's insights. Although Friedman mentions them in interviews, he does not name his golf partner Nilekani in the book's opening anecdote. The book unabashedly renders even this most privileged of Indian-global citizens nameless and faceless. But in an interview with Wired, he does mention Nilekani: 'I was in India interviewing Nandan Nilekani at Infosys. And he said to me, "Tom, the playing field

is being leveled." Indians and Chinese were going to compete for work like never before, and Americans weren't ready. I kept chewing over that phrase – the playing field is being leveled – and then it hit me: Holy mackerel, the world is becoming flat.' http://www.wired.com/wired/archive/13.05/friedman.html, accessed August 15 2012.

6. Three million was the total employment figure for IT and BPO services, which includes modes of 'indirect employment'. Direct employment at the end of 2006 was reported as 1.3 million. For a summary of data from in the first decade of the twenty-first century, see http://www.neoncarrot.co.uk/h_aboutindia/india_economy_stats.html#employment. The policy and analysis group NASSCOM reported that 2012 was a 'milestone year for Indian IT-BPO industry', when revenues reached $100 billion. 'Software and services revenues (excluding Hardware) made up nearly 87 per cent of the total industry revenues, expected to post USD 87.6 billion in FY2012; estimated growth of about 14.9 per cent over FY2011'. The Indian business processing industry's 'share of total Indian exports (merchandise plus services) increased from less than 4 per cent in FY1998 to about 25 per cent in FY2012'. http://www.nasscom.in/indian-itbpo-industry, accessed 1 September 2012.

7. In 2000, *Express computer* online reported on the relation between products and services in India's leading IT corporations: 'Products account for 7 percent of TCS' revenue, and for Infosys the figure is even lower at 5 percent.' http://www.expresscomputeronline.com/20011210/focus1.shtml, accessed 1 August 2012. Based on statistics like these, and ethnographic study of ITES, Upadhya and Vasavi (2008) characterise the Indian IT context as one 'where the information technology sector is primarily an outpost of global capital within a largely agrarian and still industrialising economy'.

8. *Wired* magazine, February 2004, cover image, http://www.wired.com/magazine. I build on a previous analysis of this image (Philip 2005). For an important sociological analysis of software economy, see Upadhya (2009).

9. Image from *Business 2.0,* cover image, July 2004. *Business 2.0* magazine reported on the 'new economy' from 1998 to 2007. It is archived at http://money.cnn.com/magazines/business2/business2_archive/. For ethnographies of Indian techno-entrepreneurship, see, for example, Amrute (2010); and Centre for Internet and Society Monograph Series on Histories of Technology, http://www.cis-india.org/research, accessed 1 November 2010.

10. See Fuller and Narasimhan (2007, 2014) and Upadhya and Vasavi (2008).

11. Pal (2012), Wright, Prakash, and Shah (2010), and Elyachar (2012).

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