Reviews

Alan Irwin and Jeanne Guillemin

Social Studies of Science 2002; 32; 615
DOI: 10.1177/030631270203200405

S|S|S

REVIEWS

On the Juggernaut's Trail

Alan Irwin

Maggie Mort, *Building the Trident Network: A Study of the Enrollment of People, Knowledge and Machines* (Cambridge, MA & London: The MIT Press, 2002), 217pp., £22.50/$32.95/€39.39. ISBN 0–262–13397–0.

Ian Welsh, *Mobilising Modernity: The Nuclear Moment* (London & New York: Routledge, 2000), 261pp., £57.50/$100.00/€122.90. ISBN 0–415–04791–9.

One of the more enduring metaphors for the relationship between technology and society is that of a juggernaut. Devotees of the Hindu deity from whom the term derives are alleged to have thrown themselves under the cart bearing his image. The implication is that members of the public are likewise flung beneath the wheels of unstoppable technological trajectories. Whilst those at the religious festival presumably had some choice in the matter, the new 'protector of the world' casts its irresistible influence over both sceptic and believer alike. Meanwhile, and perhaps confusingly, the juggernaut metaphor applies not only to specific technologies but also to the very structure of modernity. In the face of technical change and globalization, what possibility can there be for local resistance and the development of alternative futures? Turning in unison, the wheels of modernity and technology leave little room for cultural diversity and the pursuit of different tracks.

Recognizable within this juggernaut metaphor are the ghosts of technological and social determinism: approaches long discredited within social studies of science and technology. The social construction of technology (SCOT) has explored the social contingencies and shifting networks which constitute technology's black box. Equally, scholars in the area of risk have demonstrated that unacknowledged cultural assumptions and unexpressed institutional commitments lie at the heart of technological systems. The view of technology as juggernaut fails to recognize that technology is a cultural product, a reflection of social and institutional arrangements rather than something imposed upon them.

Social Studies of Science **32/4(August 2002) 615–624**

[0306-3127(200208)32:4;615–624;029464]

A similar critique can be offered of modernity as an unstoppable force. Just as with technology, modernity cannot be an alien force since it draws its very lifeblood from social relations. At the same time, neither technology nor modernity is monolithic in character: each is more fractured, polycentric and divergent than the juggernaut image suggests. In the face of apparently all-powerful social and technological change (and the claims made for the 'knowledge society' or 'information age'), individuals continue to make sense of their world and establish their own personal and collective identities.

Whilst this challenge to the juggernaut view of social and technological change seems persuasive enough, the metaphor retains its influence. Nowhere is this more apparent than in current discussions over the 'democratization' of science and technology. As concern over the 'public understanding of science' gives way to a renewed interest in 'science and society' and 'public engagement', the notion that 'you can't stop progress' seems as powerful as ever. To take one prominent example, enthusiasts for the biosciences argue that we are only at the first stages of a technological revolution that will transform our approach to food production and health care. Meanwhile, critics of the institutional call for public engagement see all this as mere window dressing: innovation will follow the perceived needs of international enterprise, rather than the partially expressed anxieties of members of the public. Either way, and despite the careful analyses of S&TS, the juggernaut will rumble on.

Such debates over the future direction – and dirigibility – of the biosciences bring to mind previous discussions over the emblematic technology of the late 20th century: nuclear power. From a determinist perspective, the nuclear juggernaut never really faltered, but instead gained momentum for at least three decades of the 20th century. Whether concerning the civil nuclear energy programme (the subject of Welsh's book) or the development of weapon systems (as discussed by Mort), the technology simply ran its course. As the conventional wisdom amongst industry and government – but also certain academic commentators – puts it, conceived in a golden age of popular support, nuclear power represented the very height of modernity. Meanwhile, dissident voices emerged too late, achieved only a minor degree of success, and exerted little influence over the direction of this technology. The juggernaut may eventually have run out of steam (although even that may be a premature judgement), but with technology providing the vehicle and modernity at the wheel, oppositional groups never stood a chance. Consequently, the prospects for open and productive discussion over the new generation of technologies appear limited indeed.

In the context of these broad arguments about technology and society, Mort and Welsh set out to uncover the technological and social tracks that have led the nuclear juggernaut to its current troubled position. How and by whom were these trails blazed? Both authors are keen to explore why certain trails were ignored while others were enthusiastically pursued. The hope is that the careful study of past trailblazing can help us find fresh

roads to take us forward. Equally, and as Welsh suggests, analysis of this important case may generate much-needed sociological insights which can help us steer a way through the technologies of the future.

Maggie Mort's account of a failed attempt to wrestle with the technological steering wheel is both revealing and sobering. Adopting an actor-network approach that eschews the sweeping language of modernity, Mort tells the story of the Trident nuclear submarine and the workforce who built it – only to be set aside once the project was complete. In September 1998, the last Trident submarine was launched at Barrow-in-Furness. Whilst this event was presented by some as the successful culmination of a huge development programme, press coverage was virtually non-existent and workers, all too aware of the job implications, looked gloomily on. Mort traces the path that led to that rather subdued event. She considers the relationship between the technical system involved and the local community that was essential to its development and maintenance. More than this, she recreates the history of technological roads which were not taken despite the imaginative efforts of one group of workers and researchers. In so doing, she raises many of the core issues for any wider engagement with technology. She also argues convincingly that the 'social' and the 'technological' cannot be separated when coming to terms with an artefact such as Trident.

At the heart of Mort's account of the UK Trident weapons system is a presentation of technology, not as a juggernaut, but as a dynamic network of human and non-human actors. Crucial within this network is the 'enrollment' of the local population and the workforce. Successful networks must bind actors together, even as the networks shift over time. Thus, one major issue concerns the manner in which the engineering plant at Barrow was gradually transformed from a broad facility to a single-purpose nuclear submarine construction site. This move allowed a concentrated effort towards a major technological target: in fact, the largest and most ambitious technological enterprise ever undertaken by the UK. However, this decision to focus on 'core business' led to the destruction of jobs in the medium and long term. In order to achieve this, the Trident programme had to be sold twice to two different audiences. Firstly, the argument had to be won (in the face of considerable opposition) that this was a necessary boost to the UK's national security. Secondly, and more locally, the case had to be made that this was the only project large enough to provide employment security for Barrow. Overall, the process was one of 'technological shrinkage' as a diverse base (including the workforce) was narrowed in order to achieve a single-purpose industry. Within this shrinkage, workers and the local community wielded very little influence.

Mort places the story of Trident firmly in its social and political setting. Parts of the industrial empire in question were nationalized, denationalized and renationalized as government policies altered. Throughout such changes, the people of Barrow – like many in such 'company towns' – viewed the industry with a mix of pride and resentment. In the 1980s, the new ideology of privatization led to the

development of a workers' share option scheme. Heralded as a demonstration of popular capitalism, Mort discusses in some historical depth this attempted enrollment of workers into the Trident network. However, the initial enthusiasm for share purchase among workers did not erode traditional class allegiances. Rather than participating in popular capitalism, employees took the opportunity to sell up and make a quick few pounds. Soon afterwards, in an apparent demonstration of old-fashioned class relations rather than popular capitalism, the shipyard's entire workforce walked out on strike. By 1989, the local paper contained news about both the soaring value of company shares and the latest redundancy round. Enrollment was always partial, and masked a deep ambivalence within the community.

What then of local efforts at changing the technological direction? Mort pays particular attention to one group who attempted not only to oppose the dominant 'core business' network, but also to develop a viable alternative. From its initially broad engineering base, Trident had become black-boxed: it represented not simply the only technology in town, but also the only contract and the only source of work. Faced with this situation, the Barrow Alternative Employment Committee (BAEC) deconstructed the technical system into its component technologies, skills and resources. Derided by management and some trade unionists as seeking to convert submarines into kidney machines, the BAEC set out to steer the shipyard away from defence dependence and a technological straitjacket. A novel exercise in workplace democracy, the ultimate failure of this initiative tells us a lot about the practical possibilities of steering technology.

One immediate problem for the 'counter network' concerned the timing of its activities. The argument that Trident would ultimately destroy jobs (even if it created them in the first place) became irrefutable once actual redundancies were announced. However, by the time that alternatives became attractive to the unions, it was too late for diversification to take place. Equally, at times when the Trident contracts were subject to considerable political uncertainty, trade unions and management were reluctant to push for an alternative lest it undermine their lobbying efforts. Frustrating as it may be, it can prove very hard to argue for creative alternatives when economic survival seems to depend on 'keeping with what you know'. Likewise, the peace movement that supported change at Barrow was viewed with suspicion: as an outside troublemaker with little understanding of local circumstances. For a community of this sort under extreme economic and political pressure, the lesson from the past is often that it is best to 'stick together'.

Another problem was with the message itself. The BAEC was keen to concentrate on technical possibilities for future production. However, such arguments made little sense without an acknowledgement of the political and social context. It was then relatively easy to dismiss their reports as 'politically motivated'. Perhaps most disappointing of all, one of the main trade unions failed to make the transition from 'bread and butter' issues

(primarily, wages) to engage with longer-term job security and technological alternatives. In the end, and despite the innovative alliance between university researchers, workers and the peace movement, the company could afford to ignore the alternative plan. Trident workers, enrolled into the production of the technology, were not about to shift allegiance to a radically different vision of the future. At this point, Mort moves to a discussion of human redundancy, which she portrays as an exercise in 'disenrollment'. In a final reflection on the BAEC activists, Mort observes:

> It wasn't that they did too much technical work and not enough political work (or vice versa); it was more that their resources were few or too far distant, their allies (in the trade unions) unstable or recalcitrant, their micropolitical and macropolitical timing unfavorable, and their energies exhaustible. [180]

The consequence for Mort is a wastage of both human skills and innovative technologies. Redundant workers and abandoned products serve as absent intermediaries. Whilst Mort would not accept at an analytical level the notion of technology as juggernaut – since technologies are not inevitable but depend upon social and technical networks – for the workers abandoned as the Trident programme reached its technological conclusion, such an image must seem compelling. The success of the venture (at least from the company's point of view) depended upon the sacrifice of their jobs. Meanwhile, it is hard to resist the conclusion that the power to direct technology is unevenly distributed. Going further, and as Mort suggests, this is not simply a matter of brute political force but also of the ability – and willingness – to engage creatively outside the black box. Nevertheless, critical engagement means little without the consequent ability to control the technological system. It is here that the network concept has both strength and weakness. On the one hand, it allows a flexibility of interpretation that static conceptions of power cannot attain. On the other, there is something unsatisfying (and rather circular) about an explanation that certain groups succeed over others because their networks are more resilient.

Whilst Mort works on one specific manifestation of nuclear technology, Ian Welsh adopts a much wider historical and theoretical sweep. Ambitiously covering a 50-year period of development in the UK, Welsh explores the relationship between nuclear energy, nuclear opposition and modernity. Along the way, Welsh argues that public responses to nuclear science and technology have always been deeply ambivalent. However, during the period of what he terms 'peak modernity', such ambivalence existed at the local level and at considerable social distance from the institutional euphoria which carried civil nuclear energy forward. Whilst full-scale nuclear opposition was slow to emerge and somewhat limited in impact, Welsh sees this opposition as being ultimately influential – not least in establishing forms of collective organization and direct campaigning

which would later become familiar at Greenham Common and environmental protest across a range of issues. For Welsh, losing individual battles against nuclear power (as at a series of public inquiries) does not mean that the overall fight was lost. Indeed, throughout *Mobilising Modernity*, Welsh is keen to undermine what he presents as the 'common sense' of nuclear power (for example, the notion of a 'golden age' of public acceptance) and replace it with a much more nuanced treatment of the issues. At the same time, and in sharp contrast to Mort, Welsh presents nuclear power as a key test for theoretical accounts of modernity, especially those of Ulrich Beck and Anthony Giddens.

Welsh's trailing of the 'nuclear moment' takes us back to the scientific social movement that fostered and sustained the technology. This movement combined faith in science with a moral authoritarianism reinforced by high levels of secrecy. Whilst the Manhattan Project, to take a founding episode in 'peak modernity', can be presented as the ultimate demonstration of rational planning, Welsh emphasizes the variety of desires which drove the team forward (exemplified by Oppenheimer's famous observation: 'I am become death, destroyer of worlds'). Later, all this would be bound up with feelings of national pride and ambition. As one over-excited parliamentarian put it in a 1950s Commons debate: 'If Britannia no longer rules the seas, it is a certain fact that she rules the isotopes and the reactors' [cited on 63].

Once British commitment to civil nuclear energy grew, the technology was transformed into public spectacle. Overriding confidence in the industry's ability to overcome technical difficulties led to an enthusiasm for risk-taking. Concerns over the level of capital expenditure and the need for alternative energy sources were swept aside within the overall climate of adulation. For Welsh, the 1950s witnessed a unique congruence between the objectives of the nuclear enterprise and the state. Meanwhile, there was very little sign at a national level of public scepticism or disquiet. The juggernaut looked unstoppable.

At this point, discussion shifts from the national to the local level. Despite the prevailing view that public opposition is a recent phenomenon (the 'no one objected when they were built' dogma), Welsh argues that legitimation regimes which were nationally successful tended to be less effective when applied to particular local settings. The nuclear enterprise may have received adulation in the national press, but the public inquiry process was to prove rather different. Early inquiries at Bradwell (1956) and Hunterston (1957) were very restricted compared to the nuclear protests which began some 20 years later. However, they did raise central issues of the relationship between democratic decision making and the technological characteristics associated with nuclear power (for example, the long-term nature of nuclear projects and their inflexibility once commenced). In a manner similar to that described by Mort, such concerns were met with the full rhetoric of scientific and institutional self-belief. The public was expected to accept on faith the ability of the nuclear enterprise to deliver its considerable promises. The nuclear case suggests how this

assumed dependency can, over time, be transformed into an explicit withdrawal of support. In this way also, the example of nuclear power has implications for current debates over 21st-century technological futures: there is still a tendency for government to assume that public ambivalence can be equated with public acceptance.

For Welsh, the 1957 Windscale fire was a 'nodal event' in the history of nuclear power. It demonstrated the implications of the previous enthusiasm for risk-taking. It re-emphasized the social distance between public groups and the 'atomic science social movement'. However, despite the huge implications of this accident, nuclear institutions emerged even stronger than before. Critics were effectively marginalized, and the enterprise moved confidently forward: if anything, the nuclear juggernaut had gathered momentum. By the 1960s, nuclear power had evolved from its initial euphoria to being assimilated into more mundane bureaucratic processes. Viewed from a longer-term perspective, the net effect was to enhance a culture of blind trust and institutional secrecy that would prove increasingly dysfunctional for the nuclear enterprise. In another lesson for the handling of future technologies, the very strength of the enterprise in brushing aside criticism and downplaying uncertainty would become a major weakness when the volume of public disquiet increased. For Welsh, the nuclear opposition of the 1970s had its roots in just this combination of unreasonable optimism and social distance. So long as public deference persisted, the system was stable enough. Once critical voices grew, the seamless web of legitimation became destabilized.

What then of the national nuclear opposition as it took shape from the 1970s? Often caricatured as internally divided and practically ineffective, Welsh presents the early movement as engaged in longer-term capacity building and 'enclave formation'. Whilst the BAEC's (ultimately unsuccessful) 1980s strategy was to focus on the technological alternatives to nuclear power and so avoid charges of political mischief making, the early nuclear movement took the opposite line (and its perceived failures presumably led in turn to the more 'technical' focus of the Barrow plan).

Welsh draws upon a participant observation of the mass occupation at Torness in 1978 to explore the roots of direct action. In vivid representation of the change in the nuclear opposition since its local beginnings in the 1950s, demonstrators created a weekend festival complete with workshops on patriarchal oppression, civil rights, racism and state terrorism. Lengthy debates took place between those who saw non-violence as a way of life and those who viewed it as an expedient tactic. Central to this debate was an argument over whether it was justifiable to damage private property, especially wire perimeter fences. Summoning up the mood of the time, Welsh notes that such prolonged discussions 'tested the commitment to consensus decision making to the limits' [169]. Later, a local farmer donated a straw bale stile, which rendered the discussion redundant by permitting site access to activists of every persuasion.

The Torness Alliance eventually (and very predictably) fell apart, its immediate objective unachieved. However, for Welsh the movement was

not a failure. Instead, it had placed nuclear power on the political agenda and demonstrated that direct action could be used, at least tactically, by ordinary citizens. In the unpromising UK political climate of the 1980s, nuclear opposition laid roots of social unrest that would grow into further nuclear protests and stimulate linked activities such as the women's peace camp at Greenham Common. As Welsh summarizes his case:

> To regard the British anti-nuclear movement as a failure then is to discount its social and cultural roles within a network emphasising non-hierarchical, non-sexist, peaceful, co-operative social relations which both prefigured and outlived the instrumental objectives associated with nuclear technologies. The capacity of this movement to mobilise against technologies embodying hierarchical, exploitative, aggressive, sexist relations has increased over time. ... [197]

Welsh's preoccupation (to use his own term) with 'capacity building' leads him to adopt a longer-term perspective on technological opposition. The techniques of resistance developed in the 1970s have, for example, been recreated in more recent campaigns against road building. Resisting one juggernaut, then, can have important implications for other struggles against modernity. In that sense also, there is a close connection between the anti-nuclear festivals of the 1970s and the technical reports prepared by the BAEC. Both suggest an optimism, despite all the evidence to the contrary, that alternative paths into the future can be created by those who currently feel excluded from technological influence. As Welsh describes direct action generally, it 'is not merely a matter of rational selection of particular action repertoires but represents a more basic rejection of alien, externally conceived and imposed futures' [214].

In his conclusion, Welsh argues that studies of modernity have typically over-emphasized its 'hyper-rationality' without acknowledging the embedded social desires reflected in new technologies. Nuclear power was not simply a technology but the attempt to build a better world and to make amends for the horrors of nuclear weapons. As such, at least in the early years, it attracted many left-inclined scientists to its cause. More generally, authors such as Beck and Giddens have placed too much importance on the rôle of knowledge and unhelpfully elevated the status of technocratic discourses. Instead, it is necessary to recognize both the polycentric and cultural dimensions of modernity. These cultural dimensions include the collapse of electoral turnouts and the growth of non-violent direct action across society.

If the juggernaut of modernity is to be re-directed, a new vision of the future must be created: a vision that can deal with a wider range of social values, but also mobilize scientific, cognitive, symbolic, iconic and aesthetic registers. In practical terms, this might involve techniques such as backcasting. Rather than scientific institutions enthusiastically creating a 'rational' vision for society to follow, society would direct science towards its own desired future. Intriguingly, Welsh also calls for a nuclear truth commission, based on the South African model, which could help clear away the accumulated burden of suspicion and blame. In wider terms,

conflicts over specific technologies such as nuclear power should not be seen as solely rational or necessarily knowledge-centred. Instead, they are conflicts over human direction and meaning, conflicts built around emotion and intensity of feeling. As such, we need forms of public engagement which can recognize and build upon this range of social commitments rather than limiting discussion to the technical and narrowly rational.

Both these accounts capture the momentum, power, social insularity and uni-directionality that drove the nuclear juggernaut forward. They uncover the socio-technical processes, institutional relationships and symbolic commitments that lay behind the appearance of hyper-rationality. Along the way, they also re-discover lost trails and suggest why such alternative tracks were never given serious consideration. The ability to ignore opposition, or else to belittle it as irrational and ignorant, gave the juggernaut considerable force. However, and as we may now be witnessing in the area of GM foods, the juggernaut approach to technological innovation can be hard to sustain once barriers of deference have broken down. For those who wish to learn from the past, the challenge is to move on from the very notion of a juggernaut and create a richer sense of social and technological possibilities. In that way also, science and technology policy can learn from the kinds of sociological insight demonstrated in these books.

Modern initiatives in public engagement appear limited when viewed in this richer context. Clearly, it would be naïve to suggest that a consensus conference or media debate can, in itself, divert technological tracks that have acquired juggernaut momentum. However, the test should not be whether each initiative has discernible impact but, instead, whether a richer culture of debate and public scrutiny can be established: a culture in which social powerlessness in the face of technological progress (as implied by the juggernaut metaphor) is no longer widely applicable. In this context, there is a particular need for social studies of science and technology to play an active rôle in analysis and reflection.

Whilst it may be possible (and indeed essential) in academic terms to move away from the notion of juggernaut technology, there are obvious reasons why institutions might wish to maintain such a posture of invulnerability. Unfortunately, analysis so far has not changed citizens' experience of certain symbolic technologies. Rather than simply stepping aside or ignoring its rhetorical force, it may be time to confront the juggernaut construction directly. Such a confrontation will demand both intellectual creativity and the creation of new social networks. A starting point could be the recognition that juggernaut technologies can only operate in a culture of unprincipled compliance and uncritical acceptance.

Looking to future academic work in this area, one lingering question concerns the mechanisms whereby pockets of local and individual resistance can begin to resemble social movements with the influence necessary to challenge – and steer – large-scale technological systems. Social science has typically emphasized the rôle of organized social groups and self-appointed stakeholders. An acceptance of the polycentric structure of

modern life implies that such traditional modes, whilst still of importance, are giving way to more diverse forms of citizen expression (including personal choice relating, for example, to child vaccination and diet, and local actions over environmental pollution and conservation). At the same time, it becomes necessary to break away from some of the old polarizations (government *versus* industry, citizens *versus* experts, pressure groups *versus* consumers) since these fail to capture the new social circumstances. Rather than opposing one juggernaut with another, a more nuanced understanding of everyday sociotechnical interactions becomes necessary.

The move away from juggernaut technologies implies a fresh approach to both technological governance and our interpretation of social responses to technical change. Critical to this will be an improved understanding of the dynamics of citizen concern in the face of globalized technologies and shifting networks of power. Social studies of science and technology should be well placed to respond empirically and theoretically to this emergent challenge.

Alan Irwin is a Professor of Sociology at Brunel University, West London. His most recent book is *Sociology and the Environment: A Critical Introduction to Society, Nature and Knowledge* (Cambridge, UK: Polity Press, 2001).

Address: Department of Human Sciences, Brunel University, Uxbridge, Middlesex UB8 3PH, UK; fax: +44 1895 274697; email: alan.irwin@brunel.ac.uk

REVIEWS (continued)

Life or Death?:

The Life Sciences and Weapons Research

Jeanne Guillemin

Brian Balmer, *Britain and Biological Warfare: Expert Advice and Science Policy, 1930–1965* (Basingstoke, Hants., UK: Palgrave Macmillan, 2001), 246pp., £47.50/$75.00/€83.83. ISBN 0–333–75430–1.

The use of disease by humans against humans is a perverse enterprise of extremely rare occurrence, even though massive state programmes have been devoted to it. Before the 1972 Biological Weapons Convention made the hostile use of bacteria, viruses and toxins illegal, most major world powers had germ weapons programmes and some, especially the USA, UK and the Soviet Union, had developed significant offensive capability.

Social Studies of Science **32/4**(**August 2002**) **624–630**

[0306-3127(200208)32:4;624–630;029465]

As with other offensive weapons programmes, state justification of biological weapons rested on the claim that biological weapons (BW) offered some advantage in war. Yet, except in imagined scenarios, biological weapons never met their advocates' expectations. The first developed weapon, anthrax in aerosol form, was difficult to target, and could contaminate a captured territory for decades. Contagious diseases such as smallpox could infect one's own troops either on the battlefield or as they advanced into conquered towns and cities. In forays in the late 1930s and early 1940s, the Japanese Imperial Army used relatively primitive biological weapons on towns and villages in Manchuria, and experienced these drawbacks of germ weapons first-hand. Modern military establishments preferred conventional weapons and, when it came to the ultimate deterrent, nuclear weapons. Yet in the second half of the 20th century, the major biological weapons programmes stood ready to use anthrax, tularemia, botulinum toxin and other dangerous pathogens in massive air campaigns that would have sickened or killed hundreds of thousands of civilians.

How then do we explain the paradox of such useless and inhumane weapons programmes? Even though these large programmes have been terminated, the question is far from idle. The old military endeavours enlarged the potential for contemporary impoverished nations to seek alternatives to nuclear and conventional weapons. The old programmes have also fed fears of bioterrorism. In the United States the anthrax-laden letters mailed in September and October 2001 contained weapons-grade material. These few grams of spores from an unknown perpetrator, which caused five deaths and dozens of cases of illness, shut down the US Congress, crippled the postal system, and caused waves of panic, hoaxes and suspected anthrax attacks world-wide.

In *Britain and Biological Warfare*, Brian Balmer forcefully confronts the paradox of biological weapons. Government secrecy was fundamental to the British programme, itself a primary influence on all subsequent BW developments. Biological weapons then and now thrive in secret environments where suspicion reigns and facts are revealed belatedly and in fragments. Only recently has the Public Record Office begun releasing documents about the pivotal British investment in biological weapons. The scholarship of Julian Robinson at the University of Sussex has been the bedrock for policy analysis of modern biological and chemical weapons.[1] With that, and following Harris and Paxman's 1982 revelations,[2] we understood that the British programme was the template for the United States' enormous post-war programme and, by extension, for the USSR in its arms race with the West, but documentation was sparse. Now Balmer meticulously reconstructs the essentials of this missing chapter in military history.

Drawing on a broad range of social theory, including the work of Bruno Latour, Sheila Jasanoff and Chandra Mukerji, Balmer emphasizes the rôles of key science experts and their impact on the formation of an inherently immoral, bureaucratically-entrenched programme. Further, he

emphasizes the importance of the cultural construction of risk, along lines suggested by anthropologist Mary Douglas, sociologist Peter Berger and others. As the case of the British BW programme demonstrates, a shift in the configuration of risk can have enormous organizational consequences over many years. Balmer modestly explains that his book is not a full account of the history of Britain's Porton Down facility or of anti-crop or anti-livestock weapons, but the documents he has unearthed speak fully to the crucial formative decades of the British programme. His cogent analysis of the interplay of science and policy sets the standard for how future revelations about BW in any state endeavour will be interpreted. *Britain and Biological Warfare* is a scholarly marvel, a trustworthy treatise in an important field too often of late dominated by sensationalists. It presents challenging new facts about science-advising, and offers an analytical framework of great significance for understanding current US preoccupation with bioterrorism.

Using scientific research to counter perceived threats was key to the British BW programme. The threats that motivated the British to develop germ weapons were parallel to those which spurred continued BW development in the USA during the Cold War, and which have recently motivated the United States government towards 'homeland defense' policies against bioterrorism. Starting in the 1930s, what Balmer calls 'the fear of the possible' centred on the threat of saboteurs or, in today's parlance, terrorists. In 1934, the respected journalist Henry Wickham Steed claimed that German spies had been testing bacteriological weapons in the London Underground and the Paris Metro. A committee of British scientists asked to review Steed's documentation rejected the possibility that large crowds in cities could be infected by dropping glass vials of pathogens. As for larger attacks, they argued that the shock from exploding BW bombs would kill most bacteria, and that spraying from aeroplanes would be unlikely to offer a sufficient concentration of germs to cause epidemics.

Instead, they imagined another risk, that after an air raid the civilian population would be prone to infected wounds and the dangers of a war-torn environment. Not unlike today's American proponents of civilian biodefence, they argued for an enormous co-ordinated public health response, including the means to diagnose and treat disease quickly, to stockpile vaccines and sera, and to decontaminate food and water supplies. The British government did mobilize in this direction. The 1939 institution of the Emergency Public Health Laboratory Service laid the groundwork for the post-war Public Health Laboratory Service for England and Wales.

Behind the scenes, though, influential players such as Sir Frederic Banting, the Nobel Laureate who discovered insulin, envisioned a future in which pathogens could be made into effective aerosol and bomb weapons. Banting, a Canadian, was particularly concerned about suspected German initiatives, and saw Hitler and the Nazis as fiends capable of a biological weapons attack on the British. Retaliation in kind, he felt, was justified. In

a 1940 report, he argued that in the event the Nazis used germ weapons, 'the Allies should be in a position to retaliate one hundred fold without delay' [33]. Banting's alarm resonated with a small coterie of other prominent scientists, especially noted microbiologist Sir Paul Fildes, who also envisioned offensive capability as technologically feasible. The actual creation of the British BW programme, headed by Fildes, was accomplished by a bureaucratic sleight-of-hand behind the backs of the War Cabinet. In 1941, senior civil servant Maurice Hankey, influenced by both Wickham Steed and Banting, set up a secret UK research base at Porton Down parallel to the chemical weapons programme. He eventually gained Prime Minister Churchill's consent for an offensive biological weapons programme, after experiments were in process. The United States co-operated, with a considerable development and production effort, including the Vigo, Indiana, plant which was ultimately able to manufacture 500,000 anthrax bombs per month. In secret consultation with his military advisors, Churchill approved the Vigo plant: 'They consider and I entirely agree, that if our enemies should indulge in this form of warfare, the only deterrent would be our power to retaliate' [quoted at 50].

The understanding that enemy civilians would be targets was clear and judged morally acceptable, despite the 1925 Geneva Protocol. Echoing Banting, other proponents of offensive BW claimed that biological weapons offered more humane ways of killing civilians, compared to deaths inflicted by aerial bombings. That bizarre logic, one hopes, is behind us.

The pioneers in the offensive BW effort, among Britain's top biologists, suffered no professional loss for their work on biological weapons. After five years as director, Fildes, a Fellow of the Royal Society, retired to rejoin the prestigious Lister Institute. His successor, David Henderson, was elected FRS in 1959, and was President of the Society for General Microbiology from 1963 to 1965. Neither American nor Russian scientists recruited for early biological weapons research seem so illustrious or free to mingle in polite society. One cannot help but wonder how any of the scientists in offensive BW programmes, whatever their status, reconciled the killing aims of their work with healing goals of the life sciences, or if they even pondered the conflict between the two. Did they, like the physicists working on US nuclear weapons described by Hugh Gusterson,[3] simply deny the consequences of their work? This moral aspect of the history of biological weapons is all but lost to history.

Balmer's book also raises the problematic rôle of objective scientific methods applied uncritically to the ends of weapons development. Given the problem of a political threat, the biologists in the British BW programme reacted as if confronted with a scientific problem. Their solution was always to perform more research as a means of resolving government fears and uncertainties. The combination of fear and uncertainty about the BW threat was essential to the programme's mission. It became 'a crucial mechanism by which the biological warfare research programme became a self-sustaining institution throughout the entire period' [186]. Thus the phantom Nazi saboteur-terrorist generated and sustained a governmental

bureaucracy aimed at destroying life, not tanks, planes, or buildings. It mattered little that no sound evidence existed for a German investment in biological weapons. Towards the end of the war, even Fildes became convinced that Hitler had forbidden biological weapons development and that, despite some random resistance to that order, the Germans had no offensive capability. Like the Nazi anti-smoking campaign, it was one of the few good aspects of Hitler-era policy.

The post-war expansion of the offensive programme by the UK presents the most disturbing information in Balmer's book. The wartime programme accomplished little in the way of material advances; anthrax 'cattle cakes' and a crude bomb were its main inventions. Still, Fildes had ambitions to link biological weapons with basic medical science. In an August 1944 report on the future of BW, he asserted that the main hindrance to weapons production was ignorance of fundamental bacteriology. 'The basic problems of BW', he observed with chilling disinterest, 'are the basic problems of medicine. The applications only are different' [56].

After World War II, British, Canadian and US government biologists continued their close collaboration on germ warfare. The US use of nuclear weapons in 1945 made the risks of biological weapons seem minimal. Threatened with extinction, the wartime BW programmes were saved by a conceptual innovation that carried them through another two decades and more. If biological weapons could be constructed as a threat on a par with nuclear weapons, this scale of threatened destruction – the annihilation of thousands by epidemics – would justify continued experimentation. Thus a biological bomb became configured as equivalent in magnitude to the atomic bomb, and research began to prove this 'weapon of mass destruction' capacity. In 1947, the British Chiefs of Staff elevated biological weapons research to 'highest priority, in the same category as the atomic bomb'. In this way, importance was given an essentially backwater weapons endeavour which threatened civilians much more than the military.

In 1948–55, the British engaged in numerous open-air experiments with a host of bacteria and viruses in the Bahamas and elsewhere to test the efficacy of their bombs and aerosols, and therefore the potential threat from the Soviets. These experiments were the basis for the Large Area Concept (LAC), an idea akin to the 'carpet bombing' of cities in World War II. The idea was that if aeroplanes could disseminate lethal biological weapons over hundreds of square miles, we should learn how to do this before the enemy, the USSR, did. By 1958, the UK had pulled back from open-air testing and biological bombs. The final sea trial was Operation Negation, in which smallpox attacks were simulated by using vaccinia virus, which causes cowpox. The Americans picked up on field testing where the British stopped. For example, in the 1960s, the US 'St Jo' experiments simulated deadly anthrax attacks against major Russian cities by targeting St Louis, Minneapolis, and Winnipeg with aerosol sprays. Whether smallpox and its simulants were also tested remains a question.

In the immediate post-war atmosphere, distinctions between offensive and defensive research achieved relative clarity. In a 1946 memo, Henderson saw research on vaccines, antibiotics, masks, and the control of epidemics as defensive initiatives. Under 'Offence' he listed more numerous activities that would and did keep legions of scientists busy: 'more efficient methods of dissemination of agents, knowledge concerning the probable effectiveness of new agents, large-scale production methods, preparation and storage of agents, information of sabotage methods to initiate animal disease epidemics, methods to increase the efficiency of the agents already known and tested in the field' [62].

By 1969, when President Nixon renounced biological weapons for the USA, the UK had already reduced its offensive programme in favour of research on defence strategies. The termination of the US offensive programme, which Nixon announced at the main research and pilot production facility in Fort Detrick, Maryland, was abrupt, and marked by resentment on the part of some BW scientists about to lose their jobs or be reassigned. Although committed to defence alone, the US distinction between offensive and defensive research was destined to blur. Presuming that the enemy had the goal of more efficient weapons, military policymakers and scientists could then justify experiments with new generations of weapons, in the name of national security.

The history of biological weapons programmes did not end when the USA and UK retreated to defensive programmes. Although USSR representatives worked with the USA and UK to formulate and then sign the 1972 Biological Weapons Convention, the Soviet investment in BW ballooned during the 1970s and 1980s. The suspicion that the USA was secretly applying new biotechnologies to weapons apparently influenced the Soviets to increase their BW production sites and to attempt pathogen innovations.

In the aftermath of the Cold War, the destructive pattern of secrecy surrounding biological weapons repeats itself anew. The Soviet threat has receded, only to be supplanted by Iraq's covert efforts, discovered by United Nations investigators, to create a biological weapons arsenal, along with chemical and nuclear weapons. The isolation of Iraq feeds the 'fear of the possible'. Is it true that former Soviet experts on biological weapons have found new employment in Iraq? Is it true that Arab terrorists, like those who attacked the USA on 11 September 2001, have possession of biological agents? Another kind of arms race seems in play. In the United States, fears of bioterrorism increase the secrecy surrounding the BW programme, and blur the line between offensive and defensive research.

All the determining factors of biological weapons programmes are found in the past, save one, the advent of the biotechnology revolution. Fifty years ago, when the major powers were in a 'golden age' of offensive BW programmes, the biological sciences were far from the growth area they are today. Antibiotics were the miracle inventions of those days. Today, innovations in molecular and cellular biology may ultimately affect our essential humanity, how we reproduce, our cognition, and our evolution as

a species. As the American molecular biologist Matthew Meselson has observed,[4] the most powerful technological innovations have been exploited for warfare – chemistry for chemical weapons and physics for nuclear weapons – while biology still remains an exception. If Richard Nixon had not renounced biological weapons, biotechnology would surely have been exploited to horrific effect in a legitimized US offensive BW programme, and in copycat efforts around the world. But is there now sufficient international political will to prevent the exploitation of biotechnology for hostile uses?

At present, responsible scientists and citizens should aggressively support any and all restraints on the exploitation of the life sciences for weapons use. One crucial dimension of that support is to insist on transparency in defensive programmes that veer toward offensive research on new, secret weapons. Another important dimension is the encouragement of stronger legal restraints on BW development and use, to deter potential criminals. As *Britain and Biological Warfare* illustrates, neither governments nor scientists are immune from temptation. In not uncommon circumstances, patriotic politicians will dehumanize enemy civilians, and expert biologists will attempt to solve threats with experiments. After decades of toying with biological weapons, the world needs more than ever the certain message that the life sciences are exclusively for life, not for killing.

Notes

1. J.P.P. Robinson, *The Problem of Chemical and Biological Warfare* (New York: Humanities Press, 1973).
2. Robert Harris and Jeremy Paxman, *A Higher Form of Killing: The Secret Story of Chemical and Biological Warfare* (New York: Hill & Wang, 1982).
3. Hugh Gusterson, *Nuclear Rites: An Anthropologist Among Weapons Scientists* (Berkeley: University of California Press, 1996).
4. Matthew Meselson, 'Bioterror: What Can Be Done?', in Robert B. Silvers and Barbara Epstein (eds), *Striking Terror: America's New War* (New York: *New York Review* Books, 2002), 259–76.

Jeanne Guillemin is Professor of Sociology at Boston College, Chestnut Hill, MA, and Senior Advisor, MIT Security Studies Programme, Cambridge, MA. She is the author of *Anthrax: The Investigation of a Deadly Outbreak* (California UP, 1999), which chronicles her research on the 1979 inhalation anthrax outbreak in Sverdlovsk, USSR. She has written widely on biological weapons and on innovations in medical technology. For 2002–2003, she is a Fellow at the Dibner Institute for the History of Science and Technology, MIT.

Address: Department of Sociology, Boston College, Chestnut Hill, Massachusetts 02167, USA; fax:+ 1 617 552 4283; email: guilleje@bc.edu