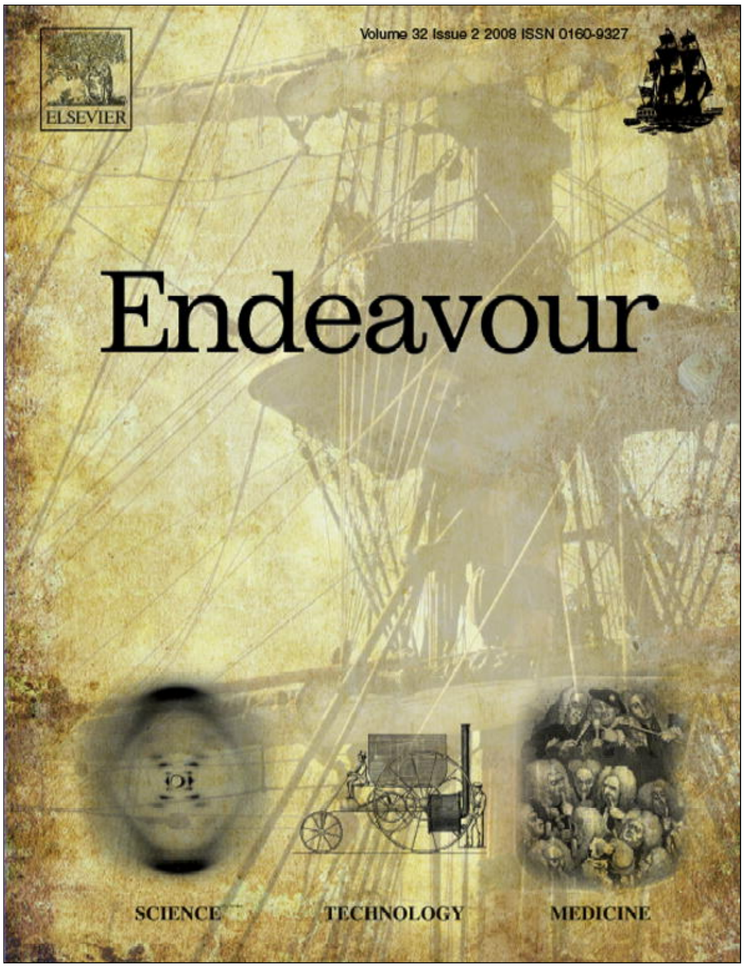
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From classified to commonplace: the trajectory of the hydrogen bomb 'secret'

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The secret of the hydrogen bomb went from being an icon of nuclear secrecy to something that could be widely reproduced on the Internet and in children's textbooks. The rise and fall of the H-bomb secret reveals both changing attitudes towards state secrecy in general and the contingent nature of secrecy, depending on an imagined threat as guidance.

The crown jewel

The hydrogen bomb. The ultimate weapon. The world destroyer. A weapon never used in anger, but long feared. Hundreds of times more powerful than the bombs that halved the populations of Hiroshima and Nagasaki, nuclear fusion weapons capable of burning the hearts out of cities and bathing people hundreds of miles away with deadly radioactive fallout. In a world based on deterrence, the first or sole possessor would have an unbelievable advantage.

For nearly 30 years, the H-bomb's construction was supposed to be the crown jewel of a true nuclear state. And yet today plans for its inner workings are readily found in children's schoolbooks and on the Internet (Figure 1). Should the world be worried at this disclosure? How did the hydrogen bomb change from an icon of nuclear secrecy and nuclear fear to being yet another banal nuclear fact? If the H-bomb was once the ultimate secret, it has now become a sign of the limitations of secrecy itself, made largely irrelevant by the changing context of the nuclear world.

State of secrecy

The atomic bombs dropped on Japan during World War II were developed in an information blackout of military secrecy. They derived their explosive power from nuclear fission, a physical process that had been discovered in Germany in 1939, the same year that Hitler invaded Poland. The leaders of the Manhattan Project feared, at least in the beginning, that they were in a neck-and-neck race with Nazi Germany to develop fission weapons. They were afraid that if information about the scope of the joint United States, United Kingdom and Canadian project became clear to the Nazis, it would encourage German scientists to speed up their own efforts.

For this reason, General Leslie Groves, the military head of the Manhattan Project, strangled public knowledge of the effort, censoring newspapers that even incidentally alluded to the presence of massive secret factories in various parts of the country. Groves also warded off occasional inquiries from US Congressmen who, kept in the dark like almost everyone else, wondered where billions of taxpayer dollars were going. Even Vice President Harry S. Truman was not informed of the nature of the project until after President Roosevelt's death in April 1945, just months before the first atomic bombs were used at Hiroshima and Nagasaki. There had been no public debate about whether such a weapon should be developed. It was a fact the world had to live with, like it or not.

The hydrogen bomb presented a different case. The scientists who had built the atomic bomb had imagined they could quickly go on to build a more powerful 'Super' bomb. Even when fission weapons were little more than equations on a chalkboard, they had assumed it would be a simple upgrade, requiring no serious technological innovation. As it turned out, the technical aspects of fusion vexed them for years after they had mastered fission. In the late 1940s, as physicists saw their dream of peaceful international control of atomic energy abandoned in the early Cold War climate, many began to feel the need for a democratic debate before creating an even more powerful weapon [1].

There were limits, however, to what could be discussed in public. Moral arguments – that the H-bomb could only be a weapon of genocide, that scientists are responsible for the technologies they create and that overkill is neither necessary nor useful – were fair game for public debate. So were political arguments – that the USSR would surely be compelled to build such weapons if the US did and that the US had little to gain and much to lose.

But more technical objections were not considered fit for public review because they could expose potential weaknesses. The fact that US cities, by virtue of their coastal clusters, were more vulnerable to such weapons than Soviet ones was discussed in high-policy meetings but not in public. The fact that building hydrogen bombs would, for technical reasons, slow the production of atomic bombs, at a time when the US stockpile was still quite small, was completely silenced [2]. And after Truman decided, in the wake of the first Soviet fission test, that a 'crash' program for the H-bomb should be pursued in 1950, all members of the US nuclear establishment were told in no uncertain terms that they were under a 'gag order'. Even though the 'gag' was meant to be only on 'technical information', the boundary between the 'technical' and the 'non-technical' was hard to define in practice [3].

For many scientists, the hydrogen bomb debate embodied their early postwar fears of secrecy run rampant, with

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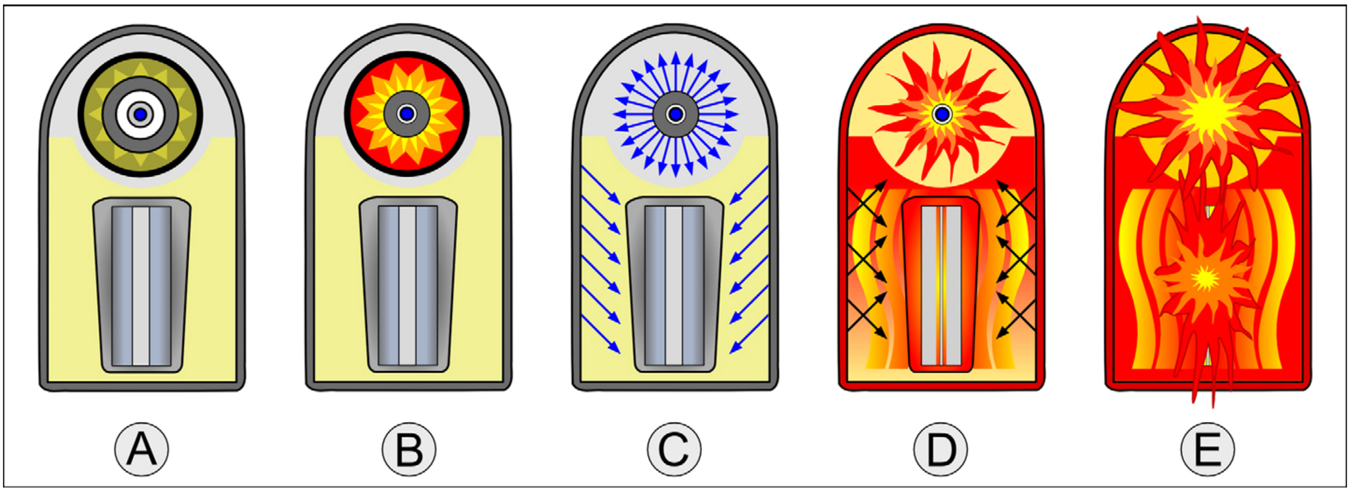

Figure 1. A version of the Teller–Ulam H-bomb 'secret', as envisioned by Howard Morland. (**A**) A warhead before firing. The primary (fission bomb) at the top and the secondary (fusion fuel) at the bottom are both suspended in polystyrene foam. (**B**) A high explosive fires in the primary, compressing the plutonium core into supercriticality and beginning a fission reaction. (**C**) The fission primary emits X-rays, which reflect along the inside of the casing, irradiating the polystyrene foam. (**D**) The foam becomes plasma, compressing the secondary and the plutonium sparkplug begins to fission. (**E**) Compressed and heated, lithium-6 deutheride fuel begins the fusion reaction. There is some debate on the Internet about the exact mechanism by which the energy from the primary transfers to the secondary (some doubt that it is caused by the 'exploding foam', and think instead the compression is caused by ablation of the secondary's surface material). Wikimedia Commons.

a cloistered group of unelected administrators making fundamentally undemocratic decisions that would affect the security of the entire world. It reinforced an idea of secrecy that scientists had been battling since 1945: that there was an 'atomic secret' that made the difference between having a bomb and not having it. The scientists had vigorously argued against this notion in initial discussions of the atomic world: atomic weapons, they argued, were in the public domain. They were based on 'facts of nature' that any scientist in any nation could discover given the proper resources [4].

As it turned out, the idea of secrecy peppered what brief public discussions of the hydrogen bomb there were: scientists routinely explained that they couldn't say much, and that they could only speak in general terms because of 'secrecy'. Without wishing to reinforce the idea of a single 'secret', their words, their protestations and their deference to the gag order gave credence to the belief that there was, in fact, a 'secret'. After the bomb was actually made, this sense of there being an overriding secret became even more pronounced. No discussion of hydrogen bombs was ever complete without a speaker dramatically indicating that he was bound by the strictest secrecy – the bomb became, through a hushed mantra of reverence, the *ultimate* secret.

This was long before anything remotely resembling a true 'hydrogen bomb secret' had come into being. For nearly a decade, theoretical physicist Edward Teller had made it his personal quest to figure out how a hydrogen bomb could be made, but all of his early ideas turned out to be unworkable. Then, in early 1951, Polish mathematician Stanislaw Ulam went to Teller with an inspired suggestion that, in Teller's hands, developed into the first workable proposal for the hydrogen bomb. Then, and only then, did the US really have a candidate for the 'H-bomb secret', what was then called the 'Equilibrium Super' but has since been known as the Teller–Ulam design. Even then, it took until 1952 to confirm the theoretical idea in an actual test [5].

The newly realized hydrogen bomb quickly transformed the public discussion of nuclear weapons in the West. If people thought the atomic bomb had ushered the world into a new age, the hydrogen bomb seemed to threaten the very concept of a future for the world. Global nuclear fallout – first publicly appreciated after the disastrous *Castle Bravo* H-bomb test in 1954 contaminated hundreds of miles of ocean, inhabited atolls, and a boatload of Japanese fishermen with radioactive ash – demonstrated that even neutral nations would suffer from a hostile exchange of thermonuclear weapons [6] (Figure 2). At the same time, the hydrogen bomb became another part of the atomic 'rite of passage': after the People's Republic of China set off its first H-bomb in 1967, French authorities felt it was important that they test one of their own soon, lest they be considered atomically inferior ('Of the five nuclear powers, are we going to be the only one which hasn't made it to the thermonuclear level?' de Gaulle asked an administrator.) [7]. A sort of fatalism took hold as the Cold War pushed into the 1950s and the 1960s. The

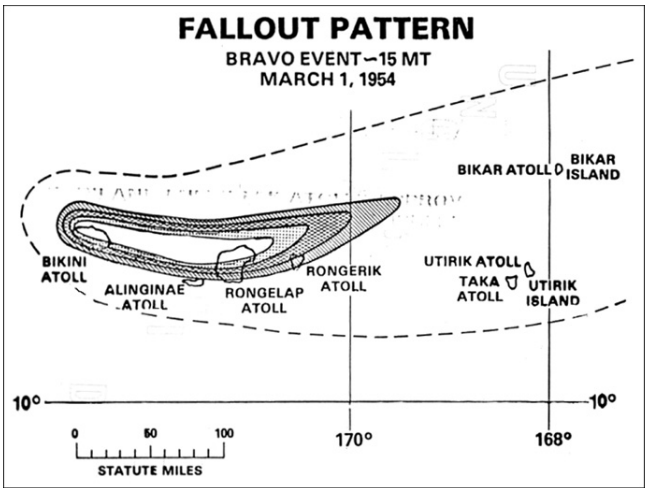

Figure 2. The path of the nuclear fallout plume following the Castle Bravo H-bomb test in 1954. US Department of Defense.

hydrogen bomb existed, it was secret from all but the most advanced nuclear states, and it made the likelihood that civilization would survive the millennium seem unlikely.

The secret's out

It was not too long after the first atomic bombs were dropped on Hiroshima and Nagasaki that their basic design became publicly known. Just days later, the Smyth Report, the first official account of the wartime development of these weapons, revealed the physics behind 'Little Boy', the bomb unleashed on Hiroshima. In essence, one sub-critical piece of enriched uranium had to be shot into another through a gun barrel, creating the super-critical mass of fissile material needed for an out-of-control fission reaction [8].

Those without insider knowledge assumed that 'Fat Man', the Nagasaki bomb, must also have had a similar 'gun-type' design. In the 1951 trial of Communist sympathizers Julius and Ethel Rosenberg, however, details of its construction emerged that suggested otherwise. Ethel's brother, David Greenglass, testified that while working as a machinist at Los Alamos during the war he had passed on information about the Nagasaki bomb to the Soviets through Julius. With the approval of the US Atomic Energy Commission, he described the bomb design in open court: a sphere of plutonium at its center had been compressed through a symmetrical arrangement of explosive lenses. This 'implosion' of the plutonium core increased its density, making what had been a sub-critical mass into a super-critical mass and allowing the explosive fission chain-reaction to take place. Although the judge in the case asked the attending press to exercise discretion, Greenglass' testimony was reported widely soon after [9].

The design of the H-bomb, by contrast, was considered top secret through the 1950s, the 1960s and most of the 1970s. It became the paradigmatic 'nuclear secret', an item so dangerous it became a benchmark against which all other questions of secrecy could be evaluated. Almost all commentators accepted that the design should remain secret. Until the 1970s, the idea of purposefully revealing the H-bomb secret was practically unthinkable – no one wanted more H-bombs in the world.

In the early 1970s, a radical skepticism of government secrecy emerged in mainstream American discourse in the wake of the 1971 Pentagon Papers trial, in which the *New York Times* successfully won the right to print a leaked internal history of the Vietnam War. Then, in 1974, a unanimous Supreme Court ruled against Richard Nixon's attempt to use executive privilege to avoid turning over information relating to the Watergate scandal. Nevertheless, in spite of this growing skepticism, representatives of the mainstream media still considered the designs for nuclear weapon and the H-bomb in particular plainly off-limits. When pressed by a member of the House of Representatives in 1974 about whether his newspaper would print the plans for a nuclear weapon should they come across them, the Executive Vice President of the *New York Times* brushed the question aside:

> Well, that is what I would call the classic case where you draw the line between information that is within the scope of the Government to protect and that which is not... I think there probably is some area as to which Congress could make it a crime to publish information... Myself, I have no difficulty whatsoever with respect to the hydrogen bomb example. And I think that would obviously apply, therefore, to the atomic bomb, Mr. Congressman [10].

But just years later, this 'classic case' was not so easily dismissed. In 1976, Herbert York, the former head of Lawrence Livermore National Laboratory, published a book on the history of the decision to build the hydrogen bomb. In it, he harshly criticized the extreme secrecy surrounding the weapon, arguing it had prevented any true debate [11]. A young journalist and Vietnam veteran named Howard Morland raced through York's book with interest but found it wanting:

> I thought he undermined his argument by admitting that there was "one truly central technological fact" that remained secret and that he was not going to tell, even though it was "less than ideal to omit it" from his book because it was part of the story. The one remaining secret was "the precise nature of the Teller–Ulam invention of 1951 [12]."

Morland took it upon himself to discover this 'one remaining secret' as a way of galvanizing support against nuclear weapons. He began to associate the horror of nuclear weapons with secrecy itself, because he felt that official secrecy predisposed people to shrink away from the key issues, and to resign their autonomy as citizens to the hands of designated 'experts'. After 2 years of research – which involved scouring publicly available sources on the hydrogen bomb, talking with former laboratory members and sharing numerous ideas with physicists without classified information – Morland reckoned he'd worked out details of the secret and made arrangements to publish it in *The Progressive*, a left-wing American magazine [13].

The US government intervened and attempted to stop publication of Morland's article. The resulting trial made media headlines. At its heart were some tricky questions: could information that had been assembled from public, unclassified sources still be 'classified'? Did the right to a free press extend to the publication of a nuclear secret?

The government alleged that Morland had, in fact, probably been privy, one way or another, to classified information from a classified source, and even if he had not the 'discovery' of the H-bomb secret from publicly available sources still constituted a 'secret'. It was a test of the controversial 'born secret' clause of the Atomic Energy Act, which held that any sensitive information relating to nuclear weapons was to be considered classified – regardless of the source – unless the US government had explicitly declassified it. In response, Morland's counsel tried to show how their client had, bit by bit, pieced together the information from unclassified sources (including children's encyclopedias), and they challenged the US government's right to classify such information.

Several well-publicized blunders on the part of the government – including the accidental release of classified material – called into question its ability to control classified information even within the limits of this trial. After a

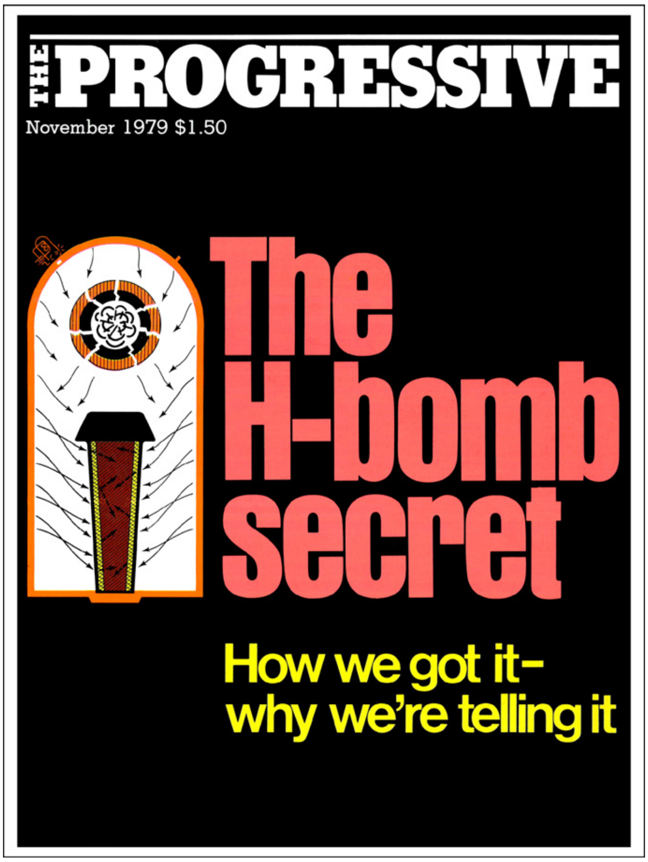

Figure 3. Cover of the November 1979 *Progressive* in which the 'H-bomb secret' was revealed. Reproduced with permission from Howard Morland.

college newspaper published another quite different account of the H-bomb secret, the government declared the case moot, backing down from the issue when it looked like they might possibly lose the case. This allowed *The Progressive* to publish Morland's story, but without ceding the 'born secret' clause (Figure 3) [14].

Morland presented his 'discovery', the idea of 'radiation implosion', to the press. An implosion-design fission bomb sat at one end of a specially made reflective casing, while a cylinder of fusion fuel, encased in a cylinder of natural uranium and surrounding another cylinder made of plutonium (known as the 'spark plug'), sat at the other. In the first microseconds of detonation, X-rays from the fission bomb would reflect off of the walls of the casing, compress the fusion fuel (potentially by means of ionizing a polystyrene-like 'channel filler' material) and start a second fission reaction in the plutonium 'spark plug'. Pushed on all sides by the force of fission reactions, the fusion fuel would become highly compressed, primed for fusion reactions when hit by the full heat of the fission bomb. Finally, the fusion reactions would generate a large number of neutrons that would in turn unleash a final fission reaction in the natural uranium cylinder around the fusion fuel, generating much of the final yield and almost all of the hazardous fallout. This was the 'technically sweet' design the US government had sought to hold on to for so long, complicated, in its way, but also quite simple: using the radiation from a fission bomb to implode and then heat the fusion fuel.

But the journalists at the press conference were, in a word, bored. 'This illumination', he later wrote, 'was received with polite uninterest' [15]. Like a magician's trick, the secret was only alluring when still secret. Once disclosed, it quickly seemed banal, even disappointing. The technical idea revealed by Morland was just another invention, just another device. Illusionists keep their trade clandestine not because they are afraid of duplication, but because knowledge kills the fun (Figure 4).

Did Morland's disclosure of the 'one remaining secret' do good or ill? Many of Morland's own allies in the antinuclear community thought his action unhelpful and rash; it did not benefit their cause. One former staff member of the US Arms Control and Disarmament Agency argued that Morland's ultimate aim failed completely: that his article increased neither public scrutiny of nuclear weapons nor pressure for arms control within the government [16].

In hindsight, though, Morland's article did demonstrate that the obstacle to building a hydrogen bomb was *not* information itself: if a single investigator from outside such a program and with no extensive scientific background could discover the secret, then it couldn't be too secretive for those governments with a pre-existing nuclear program. And anyone who wanted to create an actual H-bomb would need a well-developed nuclear program with access to fission weapons. Publicizing the H-bomb's 'secret' made

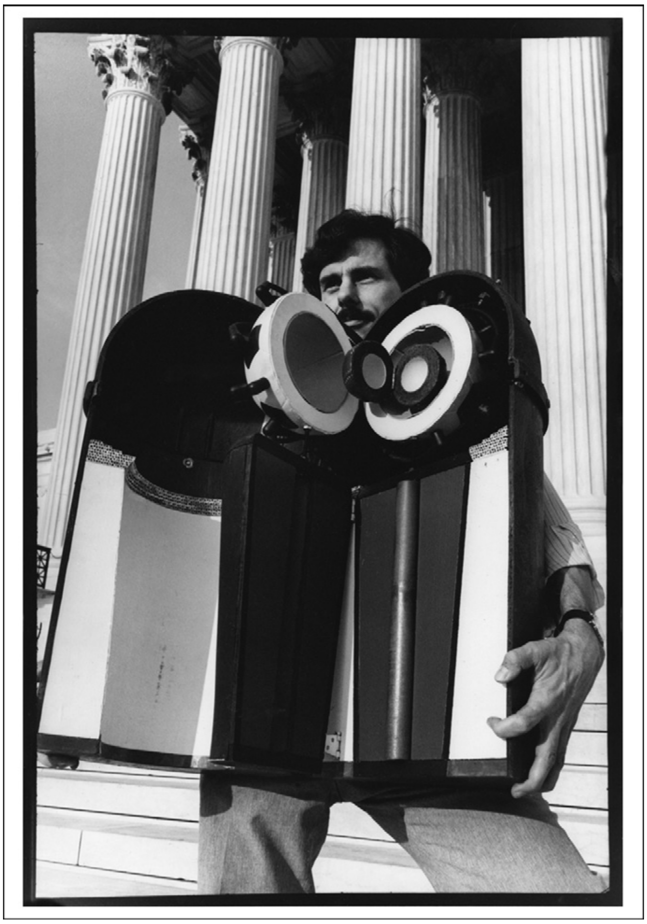

Figure 4. Howard Morland with a scale model of an H-bomb, ca. 1980. Photo by Robert Del Tredici.

Figure 5. The casing of a Mk-14 thermonuclear weapon, around 7 Mt in yield, discarded at a classified waste landfill site south of Albuquerque, New Mexico. Buried in the 1950s, the casing was unearthed in 1998, cleaned up, and put in an Air Force museum. US Department of Energy.

it clear that *knowledge*, by itself, was not the source of this ultimate power. You still needed materials, 'know-how', ample experience with fission weapons, scientific manpower, and, most of all, an extensive and well-staffed atomic infrastructure.

An irrelevant monster

For the remainder of the Cold War, no country that had not already had thermonuclear weapons before Morland's disclosure developed them (with the possible exception of Israel). In the 1980s, when fears of nuclear apocalypse reached new heights, the distinction between fission- or fusion-based weapons became increasingly unimportant (Figure 5). And when the Cold War ended, the distinction seemed to become almost irrelevant. Nuclear weapons were intolerable enough. What did the internal differences matter?

When India claimed to have detonated a thermonuclear warhead in 1998, the type of bomb received scant attention. What the world found scary was that India and Pakistan had readied themselves for nuclear war at all. The difference of a few more kilotons hardly seemed to matter. When it was reported by a Congressional committee in 1999 that the People's Republic of China had stolen advanced US hydrogen bomb designs, the fact of extensive espionage was of more concern that the substance of the theft itself. Chinese knowledge of newer models might interest a military strategist, but by itself it didn't seem to change the threat as much as China's already having been a long-time nuclear power, long-since armed with thermonuclear intercontinental ballistic missiles.

Some of this demotion in the value of the H-bomb and its secret came from the change of the world situation from the bipolar 'scorpions in a bottle' arms race between the USA and the USSR to the more amorphous post-Cold War strategic situation. Some of it may have come from stripping away the mystery of the hydrogen bomb itself. It was, after all, just another type of nuclear weapon. Simple drawings of its components now appear in most books on nuclear arms, taking their place next to the 'gun-type' and 'implosion' fission designs that were also once classified and are now commonplace. The moral and strategic differences between the different variations of 'the bomb' seemed less distinct than they had in the 1950s and 1960s.

When the focus of the 'threat' to the United States changed from the strategic nation-state to the non-state actor, beginning in the late-1990s but escalating after the 11 September attacks of 2001, the priorities of nuclear secrecy also radically changed. The nuclear designs that had seemed most important in the 1990s – hydrogen bombs miniaturized to fit onto submarine-based missiles – were obviously not within the reach of a new, decentralized enemy. Old, clunky fission technology from World War II, the physically large and heavy weapons dropped on Japan, were technically primitive compared to the warheads developed during the late-Cold War, but they had more relevance to modern fears of nuclear terrorism than did fancier varieties like the H-bomb. Information previously considered so low-tech as to lack strategic value, available to any nation with a research reactor or a particle accelerator, suddenly looked much more dangerous.[1]

[1] This is not to say that information relating to thermonuclear weapons has been released with any more regularity by the US government in the post-9/11 era, but instead to say that the focus of classification has widened. In the 1990s, however, much relevant information was declassified in relation to Inertial Confinement Fusion technology, which has some basic similarities to the Teller-Ulam design concept.

In the dust of the Twin Towers, the hydrogen bomb became an indulgence of another period, a piece of technical sophistication that could never be used, a luxury of highly developed nations that wanted to destroy each other. The focus could no longer be exclusively on the high-tech. The relatively low-tech, like the much-discussed radiological weapons or 'dirty bombs', simple combinations of radioactive materials with regular explosives, now became the principle nuclear threats, while even lower technologies – like the box cutters thought to have been used on 11 September 2001 – were responsible for much of the real damage.

The history of the hydrogen bomb secret throws up three distinct moments. First, during the genesis of the H-bomb itself, there was affirmation that a secret existed, which enhanced the authority of the nuclear program and the Cold War state. Second, following the post-Nixon backlash against state secrecy, the ordinary nature of the H-bomb secret emerged, which drastically reduced the perceived power of this weapon and diminished the differences between categories of nuclear weapons. Third, in the wake of the 9/11 attacks, the H-bomb became a Cold War relic, unused and unusable, rendered as irrelevant to the modern world as the cavalry attack had been by the machine gun.

Secrecy policies depend on a vision of the enemy, an idea of what there is to fear and the role of information in creating that threat. When that enemy was the USSR, different information was regarded as 'dangerous' than when the enemy became al-Qaeda and other terrorist groups. The secrets of one era become banal and unimportant, while the basic facts of another – the vulnerability of a public works system, the inefficiencies of airplane security – suddenly take on new weight. The multi-megaton weapon deliverable to a target only through long-range bombers no longer seems as immediate a threat as the crude weapon made of stolen materials smuggled out of some unstable nuclear state. At least, until the next shift in perspective, which will no doubt be as uninvited and unpredictable as the last.

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5 The exact facts of the "paternity" of the hydrogen bomb have been debated for over 50 years by historians in the open and weapons workers in the classified domain. The account given here is the most common basic account. For a survey of other accounts, see Rhodes, *Dark Sun* (Ref. [1]) (Chapter 23)

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7 Richelson, J.T. (2006) *Spying on the Bomb: American Nuclear Intelligence from Nazi Germany to Iran and North Korea*. W.W. Norton and Co., (New York), p. 208

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see also Radosh, R. and Milton, J. (1983) *The Rosenberg Trial: A Search for the Truth*. Holt, Rinehart, and Winston, (New York) (Chapter 30)

10 Statement of James C. Goodale, in Hearings on H.R. 12004 before a Subcommittee of the Committee on Government Operations, House of Representatives, 93rd Congress, 2nd Session (11 and 25 July, and 1 August 1974): 396–413, on 409 and 411. Ironically, the *New York Times* had been one of the major papers to reprint Greenglass' testimony about the implosion bomb, showing little discretion compared to, say, *The Washington Post*, which did not reprint much of the technical information

11 York. *The Advisors* (Ref. [2]), p. 10.

12 Morland, H. (1981) *The Secret that Exploded*. Random House, (New York), p. 40

13 This is naturally an oversimplification; Morland's autobiography (Ibid.) contains much more detail about his information-gathering practices. Other information can be found in De Volpi, A. *et al.* (1981) *Born Secret: The H-bomb, the Progressive Case and National Security*. Pergamon Press, (New York)

14 Morland, H. (November 1979) The H-bomb secret: to know how is to ask why. *The Progressive* , pp. 3–12

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16 Williamson, R.L., Jr (1995) Law and the H-Bomb: strengthening the nonproliferation regime to impede advanced proliferation.. *Cornell International Law Journal* 28, pp. 71–168 (note 243 on p. 135)