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Testing times

As gatekeepers to the development of nuclear weapons, physicists have a right to a seat at the table in deciding what role these weapons have in a post-cold-war world.

The stand-off between two putative nuclear states, North Korea and Iran, and the rest of the world continues unresolved. At the same time, the US and British governments are considering options to renew their own nuclear capabilities. On 2 March 2007, the US government's National Nuclear Security Administration (NNSA) chose one of two competing designs for the first new nuclear warhead in the US arsenal in over 20 years, known as the Reliable Replacement Warhead (RRW). On 14 March, the British parliament voted to replace its fleet of nuclear armed submarines (see Commentary, page 288). But the question remains, almost two decades after the end of the cold war, what is the role of nuclear weapons, and what should the contribution of physicists be to the debate?

Physicists are the intellectual progenitors of the bomb. It was physicists who first recognized the potential for harnessing nuclear energy for military ends, and who developed this potential to its inevitable conclusion. But although physicists are not monolithic in their political views, all should agree that the science on which decisions about the future of nuclear weapons are based should be rigorously scrutinized. And in this physicists are singularly responsible.

Arguments about the allocation of intellectual and economic resources often neglect the central question of what it is we are replacing, and why we are replacing it. The remit given by the US Congress for the design of the RRW is not as a better weapon of mass destruction in a changing world, but as a safer and more reliable deterrent against the use of similarly devastating weapons by other states. Central to this deterrence is confidence in operational effectiveness, but as time passes that effectiveness could become increasingly uncertain.

No one anticipated how abruptly the cold war would end, nor how soon thereafter a moratorium against nuclear testing would be ratified by all of the original nuclear powers, when the weapons in the current stockpile were built. The last new weapon was deployed in the late 1980s and the last US test was carried out in 1992. As with all things, nuclear weapons age. It was recently concluded by researchers at the Lawrence Livermore and Los Alamos national laboratories that the plutonium pit at the heart of most devices should remain operable for at least 85 years, and a study conducted by the JASON group that advises the US government on scientific matters (including stockpile stewardship) suggested that this figure could be extended beyond a century. However, the non-nuclear components that compress this pit to critical mass will need to be replaced much sooner. And without live tests following the replacement of these components, it has been argued that we cannot be certain that the weapons will continue to work as designed.

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The RRW programme was initiated to address this uncertainty by developing a new generation of weapons to replace the old. These weapons would be designed with a greater margin for error, by relaxing the need to maximize the ratio of explosive yield to size and weight, and similar operational constraints demanded during the cold war. It is anticipated that such devices would be less sensitive to changes in their construction, through maintenance over their lifetime, than those in the current stockpile — and through increased confidence it should be possible to reduce the size and cost of the stockpile even further than current weapons limitation agreements require. The RRW programme will also enable improvements in the security of weapons in the stockpile against unauthorized use, and to be built with fewer environmentally hazardous components. And perhaps just as important, the programme is expected to reinvigorate US nuclear expertise, and ensure that it not only maintains its stockpile but also its ability to enlarge it, should the need arise.

All of these arguments in favour of warhead replacement are debatable, but the most contentious of them regards our ability to design and certify a new generation of nuclear weapons without a single live test. Indeed, one of the stated reasons the NNSA gave for its particular choice of design for the RRW was its similarity to that of weapons already in the stockpile. But has our expertise at simulating the operation of a nuclear design really reached a point that is comparable to a live test? Is it such that we might have greater confidence in the outcome of such simulations for a completely new design than for a refurbished existing warhead? Certainly, any return to live testing would be a disaster for the current efforts to limit further nuclear proliferation.

The answers are unlikely to be clear cut, but most surely cannot be left to the present nuclear establishment (or indeed to politicians) alone. The future has always been, and will always be, uncertain. All citizens have a right and a duty to be involved in the debate. And physicists have a responsibility to ensure that the debate remains scientifically honest.