Andrew Robinson

The great high-energy write-off

SSC

Deeper and down The tunnel excavated in Texas for the Superconducting Super Collider remains empty.

Tunnel Visions: the Rise and Fall of the Superconducting Super Collider
Michael Riordan, Lillian Hoddeson and Adrienne W Kolb
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The US Congress wrote off $2bn and 10 000 person-years of effort in 1993 when it cancelled the giant, high-energy particle accelerator project known as the Superconducting Super Collider (SSC), approved in 1987. The repercussions of this decision have been severe and long-lasting. Five years later, when I interviewed one of the abandoned project's keenest advocates, particle physicist and Nobel laureate Steven Weinberg, he was still mourning its loss. "In a way, the vote that cancelled it was democracy in action," Weinberg told me. "The public has always been interested in things that are directly important to them – medical cures, national defence – and they have a certain general interest in cosmology. Our big failure was that we did not succeed in making the public feel excited about learning the laws of nature." This was true despite Weinberg's own general-interest book, *Dreams of a Final Theory*, which was conceived as an inspiring argument for the SSC and published in 1992. "They felt excited about putting a man on the Moon," he reflected ruefully.

But it was not only the public and its political representatives in Washington DC who failed to support the completion of the SSC. Many US physicists, too, had reservations about the importance of its scientific agenda, its military-industrial organization and, especially, its enormous and ever-growing price tag. The last of these had the inevitable knock-on effect of reducing the funding for other fields of science. In 1989 Weinberg's fellow physics Nobel laureate, Philip W Anderson, testified against the SSC before a Senate committee as follows: "Scientists like myself in the fields of condensed-matter physics…are caught between the Scylla of the glamorous big-science projects like the SSC, the genome and the Space Station, and the Charybdis of programmed research with 'deliverables' aimed at some misunderstood view of 'competitiveness' or at some unrealistically short-term goal." This emboldened other condensed-matter physicists, including two Nobel laureates (Nicolaas Bloembergen and J Robert Schrieffer), to speak out against the SSC. Indeed, in 1990 feelings were running so high that condensed-matter physicists threatened, as a community, to leave the American Physical Society because of its unequivocal support for the project.

The Anderson quote comes from the brilliantly titled *Tunnel Visions*, an anatomy of the SSC's failure that its authors describe as "three decades in the making". Michael Riordan, Lillian Hoddeson and Adrienne Kolb are experienced US historians of science; the latter two recently collaborated on a history of Fermilab, the flagship US particle-physics laboratory (see August 2009 p36). Their book is based partly on oral interviews with more than 100 participants in the SSC project, including politicians, political advisers, physicists and science journalists (but not including former presidents George H W Bush and Bill Clinton, or, surprisingly, Anderson). Other facts are drawn from published statements dating from the 1970s to the present, or from the many archives of unpublished evidence. It is not the first history of the SSC, but it is likely to be the last word on the subject. Although too lengthy and detailed for a general reader, and sometimes needlessly repetitious, *Tunnel Visions* will unquestionably be vital reading for anyone interested in the complications of funding "big science", especially projects requiring international contributions.

The authors identify five chief factors directly responsible for the SSC's cancellation, if we leave aside the project's underlying failure to inspire the public. The first was beyond the control of the SSC's supporters. After the end of the Cold War in 1991, the incoming Clinton administration shifted the government's decades-long support for physics (and its possible military spin-offs) towards other kinds of science, such as genetics and climate science. The second factor was the rhetoric of the Reagan administration, which approved the SSC as an essentially national project, unlike its lower-energy European equivalent at CERN. This, combined with the subsequent failure of the first Bush administration to attract a substantial contribution to the project from any foreign government (despite Bush's public commitment to do so and his wooing of the Japanese) meant that few non-Americans had much invested in its completion. The third factor was the choice of an unprepared site in Texas, far from any centres of high-energy physics, rather than a site in Illinois, where the project could have benefited from Fermilab's long experience. The fourth was the poor management of the construction phase, in which there was no single project manager. Instead, a dysfunctional clash between academic physicists inexperienced in project management and engineers habituated to a military-industrial ethos produced chaos on site.

Finally, and probably most fatally, there was the escalating cost. The finished project was projected to cost $4.4bn in 1987, but by 1993 the revised estimate was running at over $10bn and heading, some feared, for $15bn – all this at a time of government cutbacks in science funding. Because of its cost, the authors report, "the SSC had crossed an invisible line beyond which sole-sourcing its management contract was politically impossible". Its construction had become "more like building an aircraft carrier than a high-energy physics laboratory".

Why did the Large Hadron Collider at CERN succeed, where the SSC failed?

Why did the later Large Hadron Collider (LHC) at CERN succeed, where the SSC failed? Parts of *Tunnel Visions*, especially its epilogue ("The Higgs boson discovery"), address this important question in considerable and revealing detail. In the first place, the management of CERN was not subjected to direct political interference by the European Union or national governments. Second, the LHC benefited from the contributions of more than 20 nations worldwide. Third, it was built in the same tunnel as the previous Large Electron–Positron Collider, so lessons could be learnt from the latter's construction and operation. Fourth, it was project-managed from 1993 until its completion in 2008 by a single physicist, Lyn Evans (the son of a Welsh coal miner), who was assisted by the burgeoning World Wide Web platform invented at CERN. Finally, although the LHC certainly suffered from cost overruns – and eventually cost more than $10bn – its physicists and engineers enjoyed the strong support of CERN's management.

As *Tunnel Visions* is driven to conclude: "pure-science projects at the multibillion-dollar scale should henceforth be attempted only as international enterprises involving interested nations from the outset as essentially equal partners" – as with the LHC. "Nations that attempt to go it alone on such immense projects are probably doomed to failure like the Superconducting Super Collider."

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