A hypersonic cruise missile engine developed for the US Defense Advanced Research Projects Agency.

US NAVY — DIGITAL VERSION COPY/SCIENCE FACTION/CORBIS

MILITARY SCIENCE

Inventions of war

Ann Finkbeiner assesses a study of DARPA, the agency that readies US technologies for coming conflicts.

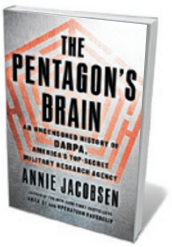
The research arm of the US Department of Defense is called the Defense Advanced Research Projects Agency — a disconcerting combination of words. DARPA is small, but it predicts what future wars might look like and gets the necessary technologies ready. It has had stunning successes, including the foundations of the Internet, satellites for reconnaissance and global positioning (called Corona and Transit, respectively) and stealth technology. DARPA also has a particular character: created in reaction to the Soviet Union's surprise launch of the Sputnik satellite, it is meant to prevent "technological surprises" through high risk, high pay-off research. The story of this entity, in business for 57 years, should be all kinds of interesting.

But how to tell it? Much of DARPA's work is classified, so any history will necessarily be gappy. And whereas the agency's virtue is its responsiveness to changes in warfare, that flexibility means that its history goes off in all directions. DARPA does not do research itself: it funds and works through a confusing variety of research centres, as well as industrial and academic bodies. The missions and titles of its internal offices vary with time. Even its name has switched periodically from ARPA to DARPA ('Defense' was first added in 1972, to emphasize the military nature of the agency's research). The result is a writer's nightmare, a story with a limitless cast of characters and no obvious storyline. In *The Pentagon's Brain*, journalist Annie Jacobsen has tackled the job by telling successive stories, focusing mostly on one programme at a time. Given DARPA's inherent complexity, this piecemeal approach leads to a struggle to capture the whole.

The bare bones of DARPA's story are as follows. It began in 1958, with two physics-based cold war programmes: VELA, meant to detect nuclear explosions as verification for a treaty banning nuclear tests; and DEFENDER, which worked on defences and counter-defences against enemy missiles. By the time of the Vietnam War in the 1960s, war had become transformed into counter-insurgency, combating guerillas and converting citizens into collaborators. DARPA responded with AGILE, a programme that, in part, deployed psychology, sociology and anthropology to seek information on Vietnamese culture. When battlegrounds moved from jungles to cities, DARPA branched out into sensors and drones, then into computer-networked military operations, combating bioterrorism, robotics, artificial intelligence, human–machine interfaces and war simulations (C. Herzfeld *Nature* **451,** 403–404; 2008).

In Jacobsen's piece-by-piece telling, some of the stories are straightforward and firmly linked to DARPA. Others have gaps, probably resulting from information being classified, that she bridges with potentially related facts and speculation. In one of the straightforward tales, DARPA backed Project 137, a 1958 advisory meeting of academic scientists. One researcher, physicist Nick Christofilos, proposed an outlandish test to see whether nuclear explosions in the atmosphere could create a cloud of electrons that would be held by Earth's magnetic field for long enough to stop incoming missiles. (The test was done in 1958; the cloud lasted for weeks.) Another unambiguous example is SIMNET, a multiplayer digital war game that DARPA created in the early 1980s to simulate realistic air and land battles. By mid-1990, SIMNET had become a rehearsal for a war in the Middle East, with desert terrain, cities, tanks, aircraft and armies; according to General Norman Schwartzkopf, it "eerily paralleled" the actual Gulf War, which started later that year.

For stories with holes, Jacobsen relies on implication, juxtaposing pieces of information that may or may not be related and trusting the reader to make the connections. Discussing DARPA's involvement in bioweaponry, for instance, she assembles the following elements. In 1992, Ken Alibek, a highly placed refugee from Soviet bioweapons programme Biopreparat, briefed the Pentagon. DARPA recognized a need to invest in biology. In 1996, the agency kick-started a biowarfare programme. In 1997, it asked the group of academic science advisers known as JASON ▶



The Pentagon's Brain: An Uncensored History of DARPA, America's Top-Secret Military Research Agency
ANNIE JACOBSEN
Little, Brown: 2015.

(A. Finkbeiner *Nature* **477,** 397–399; 2011) to report on whether it was feasible to engineer pathogens to become more lethal (for example, by making aerosolized anthrax); an unclassified summary of JASON's report says it was. In 1999, Alibek became president of a company that aimed to find antidotes to bioweapons, which got a one-year contract from DARPA. I am unsure what I am meant to make of all this.

I am sure, however, that I am intended to view as ethically dubious DARPA's decade-old launch of programmes combining artificial intelligence, autonomous robots and brain–computer interfaces. Jacobsen cites a JASON report saying that any research in this area would be subject to ethical regulation. Then, referring to work published in *Nature* on the capacity of the hormone oxytocin to foster trust (M. Kosfeld *et al. Nature* **435,** 673–676; 2005), Jacobsen wonders whether soldiers might be injected with the chemical to encourage them to trust robots. And after discussing DARPA's sponsored research into limb regeneration and perhaps even human cloning, Jacobsen speculates on whether DARPA is trying to create autonomous hunter-killer robots. Such argument-by-juxtaposition is effective in fiction. In non-fiction, it is unconvincing.

Ultimately, Jacobsen's focus on DARPA's programmes sidesteps the more intractable subject of what DARPA is. She never addresses such obvious questions as how DARPA stays ahead of the next war, and whether its flexibility and responsiveness have drawbacks, for example in the ratio of risk to pay-off. Furthermore, the book promises to "shine a light on DARPA's secret history" — secret because so many of the projects are classified. Yet the text, checked against sources, shows a certain amount of creative interpretation. I know from my own reporting on JASON that Jacobsen's chapter on the electronic fence in Vietnam inspired by the group has little to do with DARPA, and that her assessment of JASON as generally central to DARPA's programmes is exaggerated.

However flawed, *The Pentagon's Brain* is an exciting read that asks an important question: what is the risk of allowing lethal technologies to be developed in secret? Jacobsen worries that the technology that DARPA helps to create "may itself outstrip DARPA as it is unleashed into the world". The prose might be caffeinated, but the message is serious, and has been since the first human picked up a rock and thought that it might be good for killing. ■

Ann Finkbeiner *wrote* The Jasons *and is co-proprietor of a science blog,* The Last Word on Nothing.
e-mail: anniekf@gmail.com

An ejection seat and suit used on the Soviet Vostok missions from 1961 to 1963.

STATE MUSEUM AND EXHIBITION CENTER ROSIZO

SPACE TRAVEL

When Soviets ruled the great beyond

Tim Radford is thrilled by an unprecedented exhibition marking the USSR's cold war feats in space.

Between the cold war years of 1957 and 1966, the Soviet Union established primacy in space. Its heady list of triumphs embraces, in the 1950s alone, the first artificial object and first animal in orbit, and the first image of the far side of the Moon. In the next decade, it grew to include the first attempt on Venus, the first man in space, the first woman in space, the first three-man mission in space, and the first spacewalk, automaton touchdown on the Moon, lunar rover (1970), and scoop of Moon rock brought back to Earth by an automaton. Reflecting the significance and extent of those triumphs, the long-awaited Cosmonauts at the Science Museum in London assembles memorabilia and engineering marvels borrowed from around a score of Russian institutes.

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It opens with dreams: of high orbit, free fall and exit through an airlock, sketched on paper in 1933 by schoolmaster and rocket visionary Konstantin Tsiolkovsky. It concludes with a recumbent mannequin in a cradle (a "tissue equivalent phantom" flown in 1969 to absorb and measure space radiation), representing the Soviet dream of a crewed mission to Mars, and a quotation attributed to Tsiolkovsky: "Earth is the cradle of humanity, but one cannot live in a cradle forever." In between is a parade of hardware that none of us who followed the news greedily in those years had ever dreamed we might see assembled in one place, let alone in South Kensington.

Cosmonauts: Birth of the Space Age
Science Museum, London. Until 16 March 2016.

The models are marvels. Here is a highly polished display model of Sputnik 1, launched in October 1957 (its chief designer, Sergei Korolev, reportedly said, "This ball will be exhibited in museums"). There are two engineering models: one of the two Lunokhod lunar rovers, the other of the once-secret lander *Lunniy Korabl*, designed to deliver