Richard Garwin receiving the Presidential Medal of Freedom from President Barack Obama on 22 November 2016.

(Photo by Pat Benic/ UPI/Alamy.)

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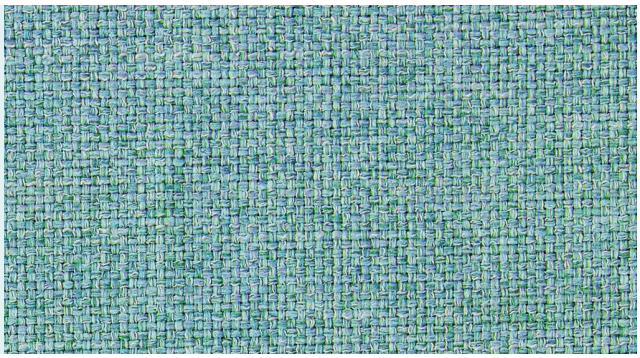
Remembering RICHARD GARWIN physicist and science adviser

John P. Holdren, Raymond Jeanloz, and Frank N. von Hippel

The polymath scientist leaves behind a monumental legacy in both the scientific and political realms.



The US physics community lost one of its most esteemed members, Richard Garwin, on 13 May 2025 at the age of 97. Known as Dick to friends and colleagues, Garwin made contributions to the development of thermonuclear weapons, reconnaissance satellites, medical and information technologies, energy technology and policy, and many areas of fundamental physics, including nonconservation of parity and gravitational waves.

One of the smartest, most diversely creative, and most productive scientists of his era, Garwin was relentlessly candid as a researcher and governmental adviser. Even if the recipients of his advice did not always love what Garwin told them, they knew it was virtually certain to be technically impeccable. During his long tenure as a senior science adviser to seven US presidents, he became famous for his willingness to go public with his advice when he thought the government was ignoring relevant scientific evidence.

Garwin also worked extensively with national and international nongovernmental organizations that address global security, nuclear arms control and nonproliferation, nuclear and nonnuclear energy options, and international cooperation in science and technology (S&T). In this remembrance for Physics Today, we offer a brief glimpse into his life's work and legacy.

The hydrogen bomb

Garwin was born in 1928, and his interest in S&T was apparent early on: As a boy in Cleveland, Ohio, he helped build and repair audio amplifiers and movie projection equipment that his father sold, serviced, and operated. After studying physics as an undergraduate at Case Institute of Technology (now Case Western Reserve University), he went to the University of Chicago, where in 1949, at age 21, he completed his PhD thesis under the supervision of Enrico Fermi. He then joined the university's physics department as an assistant professor.

Fermi invited Garwin the following year to accompany him on his annual summer consultancy at what is now Los Alamos National Laboratory, which had just been ordered by President Harry Truman to develop a hydrogen bomb. Garwin immersed himself in bomb physics and quickly mastered its intricacies. The next summer, he was asked by Edward Teller to devise an experiment showing that thermal x rays generated by a fission explosion could be used to compress and heat deuterium and induce fusion reactions.[1] Garwin's design centered on a huge dewar containing liquid deuterium. The resulting test detonation on 1 November 1952, code-named Ivy Mike, released the energy equivalent of 10 million tons of TNT—700 times the power of the Hiroshima atomic bomb—and turned the island of Elugelab in Enewetak Atoll in the western Pacific Ocean into a crater. The test device was far too bulky to be deliverable by a bomber, but it served as a proof of concept.

The development of thermonuclear weapons was still being discussed when, in 1949, Fermi declared that they would be "an evil thing considered in any light."[2] Garwin's view was more nuanced. "I think it would be a better world if the hydrogen bomb had never existed," he said in a 1984 *Esquire* article. "But I knew the bombs would be used for deterrence."[3] Nevertheless, he was appalled by the enormity of the nuclear buildup during the Cold War, and he worked to achieve deep cuts in the US and Soviet nuclear arsenals.

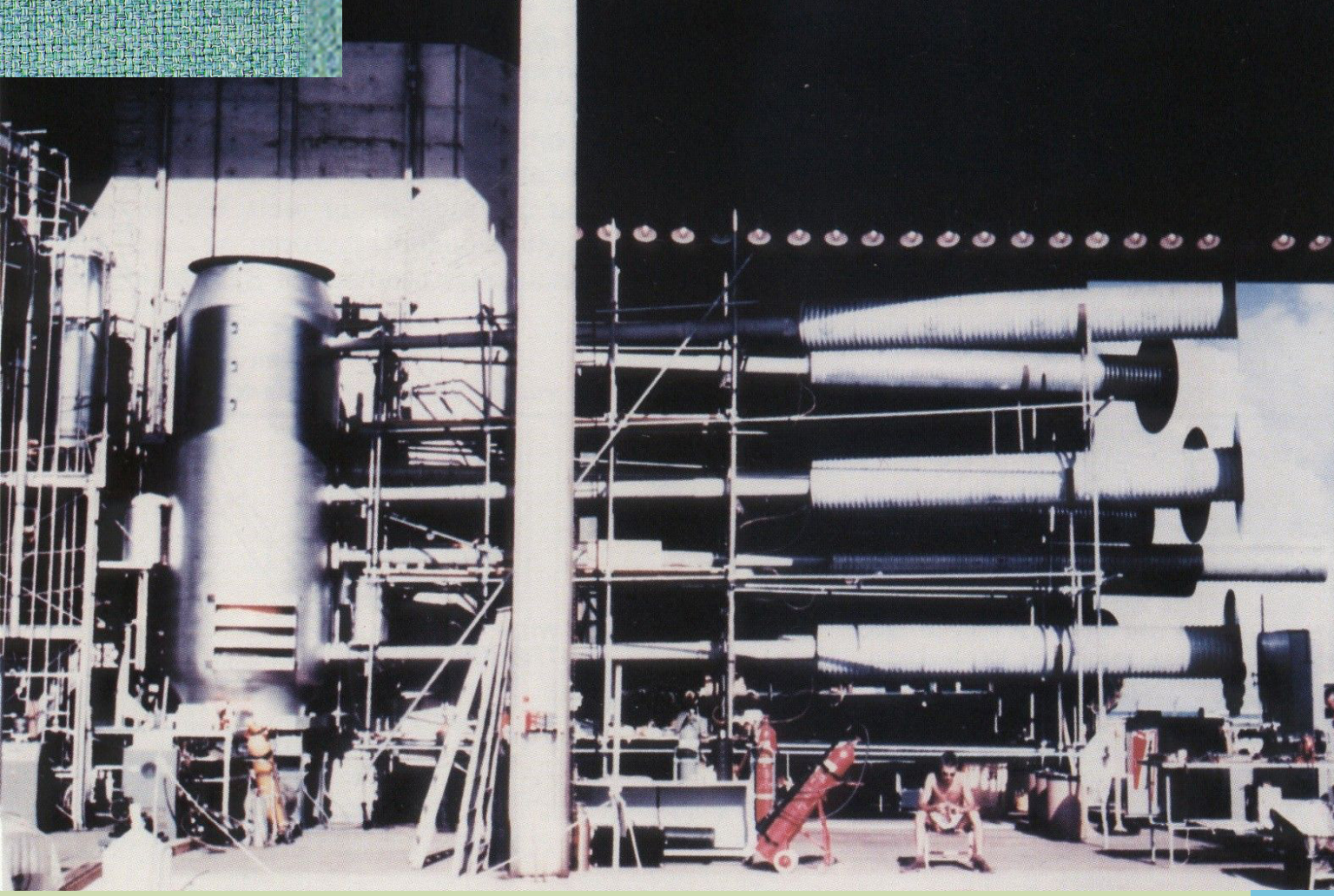
IBM

Garwin joined IBM in 1952 and would spend most of the rest of his career there. Originally at IBM's Watson Laboratory at Columbia University, he moved to the Thomas J. Watson Research Center in Yorktown Heights, New York, when it opened in 1961. In addition to being a world-class physicist, Garwin was a remarkably talented engineer, and IBM gave him the opportunity to contribute to the development of modern information technologies at a time when the company led the field. Part of Garwin's agreement with IBM stated that he could spend up to a third of his time advising the government. IBM insisted that he not inform the company about what he was working on or testifying about for the government so that the company would not be blamed for the outside work.[4]

Even though he was not a full-time employee, Garwin made many major contributions at IBM. He helped to advance the fast-Fourier-transform algorithm, which is central to the digital signal processing at the heart of modern telecommunications, music streaming, and the internet. He helped develop magnetic-core memory devices, laser printers, touch screens, and GPS. During his 41 years at IBM, he was awarded 47 patents, published more than 500 research papers, and variously served as Watson Laboratory's head at Columbia University and director of applied research at Yorktown Heights and as a member of the corporate technical committee.[5]

The joy of physics

Perhaps Garwin's most significant physics experiment was done over a long weekend in 1956 at Columbia's Nevis Laboratories cyclotron in Irvington, New York. There, he helped Leon Lederman and Marcel Weinrich establish the parity violation in muon decays, which had been postulated the year



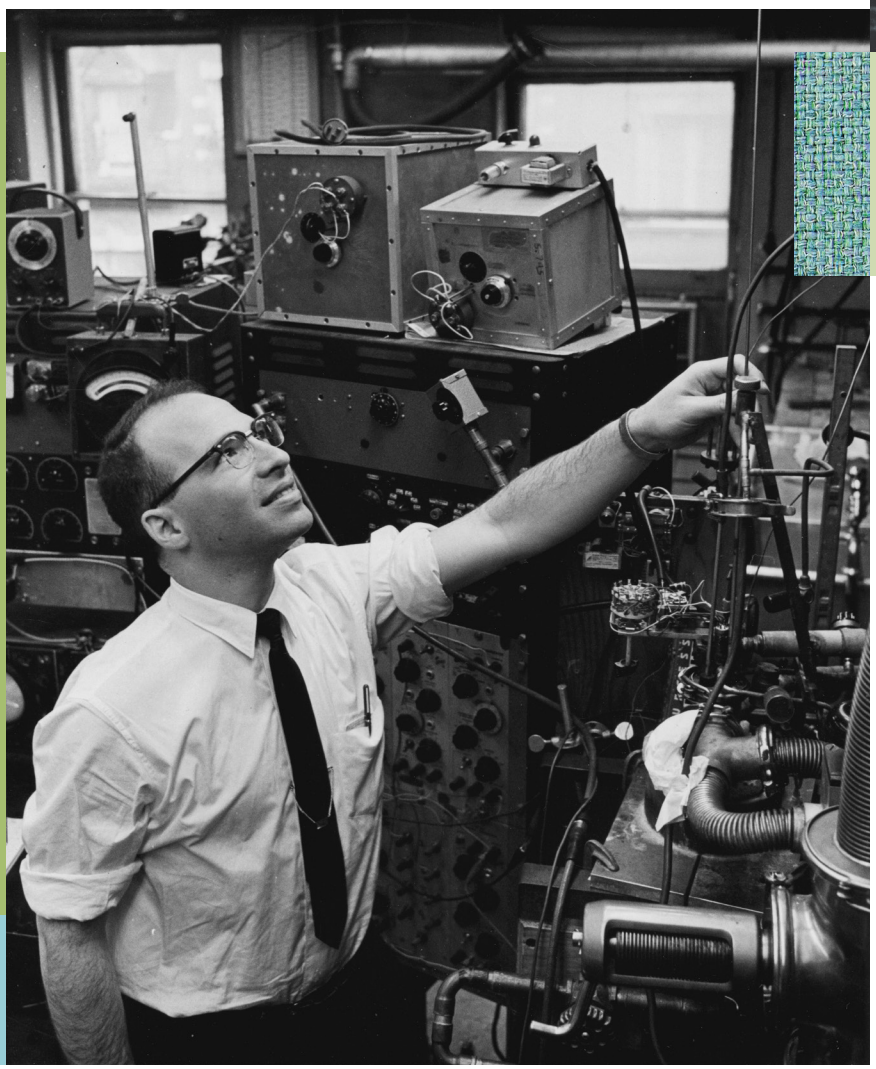
THE EXPERIMENTAL THERMONUCLEAR EXPLOSIVE designed by Garwin and assembled on Enewetak Atoll. A dewar holding the liquified deuterium was located inside the cylindrical structure on the left, which also contained the primary fission stage of the bomb. The cylinder itself reflected the x rays from the primary stage's explosion onto the dewar, where they compressed the deuterium and initiated fusion. The pipes going off to the right transmitted x rays to sensors before the explosion destroyed the structure. The seated man at the bottom right provides scale. (Image from the US Department of Energy/Wikimedia Commons.)

before by Tsung-Dao Lee and Chen Ning Yang.[6] Garwin, Lederman, and Weinrich's article was published back-to-back in *Physical Review* with Chien-Shiung Wu's paper outlining her experiment demonstrating parity violation in cobalt-60 decay (for more on that work, see the 2024 Physics Today article "Chien-Shiung Wu's trailblazing experiments in particle physics," by Chon-Fai Kam, Cheng-Ning Zhang, and Da Hsuan Feng). The two articles resulted in Lee and Yang receiving the 1957 Nobel Prize in Physics. Lederman, responding to a question on Garwin's contribution to the experiment, reportedly said, "If he hadn't been involved, it would have been a 43-day experiment rather than a 43-hour experiment."[7]

Periodically thereafter, Garwin would weigh in on controversies in fundamental physics—perhaps, most notably, claims that gravitational waves had been detected. In 1974, on the basis of his own work and that of others, he showed that a claim of the frequent detection of gravitational waves through coincidences of vibrations in two suspended bars at two widely separated locations was probably due to an error in analysis.[8] Later, Garwin helped vet plans for the Laser Interferometry Gravitational-Wave Observatory, which in 2015 ultimately detected gravitational waves from the merging of two black holes (see Physics Today's 2016 story "LIGO detects gravitational waves"). Three of the main contributors to the observatory—Rainer Weiss, Barry Barish, and Kip Thorne—were awarded the Nobel Prize in Physics in 2017 for their work.[9]

Governmental science adviser

Garwin spent a large fraction of his time serving on governmental science advisory committees. He rose quickly to the top of the establishment, serving as a consultant to the President's Science Advisory Committee (PSAC) under Dwight D. Eisenhower and then two terms as a member of the committee: 1962–65 under John F. Kennedy and Lyndon Johnson and 1969–72 under Richard Nixon. He was one of the longest-standing members of the JASON group, which provides independent technical advice to all parts of the US government, and he interacted with foreign counterparts through the National Academy of Sciences' Committee on International Security and Arms Control (CISAC).



GARWIN WORKING ON A SPIN-ECHO MAGNETIC SYSTEM at IBM in an undated photo. His research into magnetic resonance helped lead to the development of commercial MRI machines. (Photo courtesy of IBM.)

He also felt a responsibility to inform Congress, the wider S&T community, and the public of his views on policy matters of importance relating to S&T. During his long career, Garwin disclosed his opinions in books, lectures, op-eds, and congressional testimony, and he was always careful to say that he was speaking as an individual, not on behalf of the groups with which he was affiliated. When he gave testimony to Congress in 1970 and 1972 on topics on which PSAC had advised Nixon, it became clear that his views conflicted with the president's. For example, Garwin saw ballistic-missile defense as easy to defeat and likely to provoke a Soviet offensive buildup,[10] and he had chaired a PSAC review that concluded correctly that the supersonic passenger transport project would be both uneconomic and a public nuisance because of its takeoff noise and sonic boom.[11]

In a 1970 *Saturday Review* article,[12] Garwin explained how he dealt with the responsibilities of being both a presidential adviser and a public citizen:

> I'm not a full-time member of the administration, and I feel myself in the same position as a lawyer who has many clients. The fact that he deals with one doesn't prevent him from dealing with another so long as he doesn't use the information he obtains from the first in dealing with the second. Since there are so few people familiar with these programs, it is important for me to give the Congress, as well as the administration, the benefit of my experience.

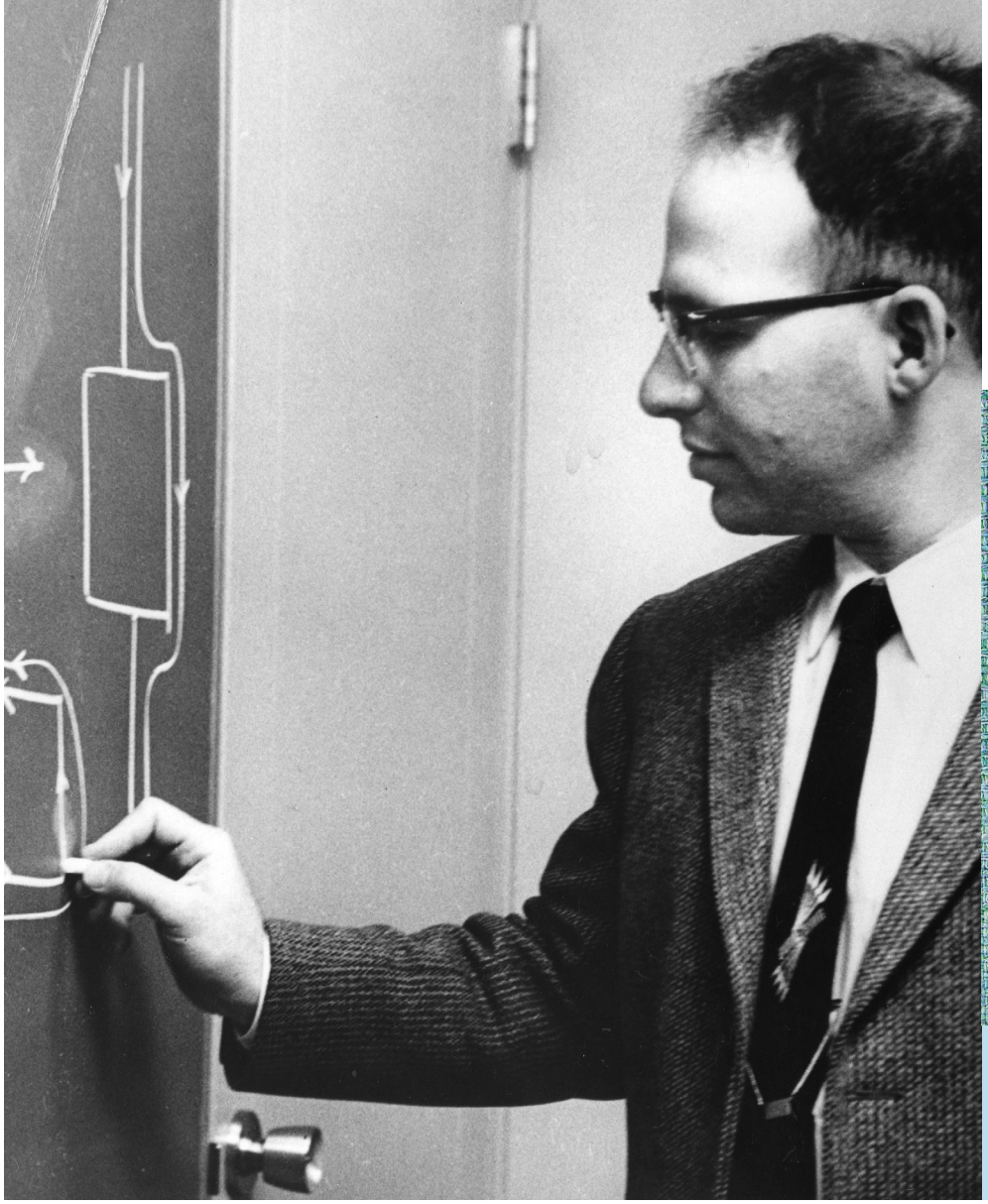
Nixon did not see it that way: Immediately after his second inauguration in January 1973, he abolished PSAC and dismantled the White House Office of Science and Technology (OST).[13]

In 1996, US President Bill Clinton and Russian President Boris Yeltsin agreed at a summit to create a bilateral panel that would advise both leaders on how to reconcile the US and Russian positions on managing the surplus plutonium left by nuclear weapons reductions on both sides. Clinton appointed Garwin as one of the five members on the US side; the Russian chair, Evgeny Velikhov, was one of Garwin's longtime collaborators in arms control efforts. Velikhov and the Russian team trusted Garwin deeply, which helped the two sides reach an agreement in June 1997 on eight of the nine points at issue.

During the Obama administration, one of us (Holdren) served as Obama's science adviser. Garwin offered to serve as a pro bono consultant to the White House Office of Science and Technology Policy (the successor to the OST). Garwin spent every other Friday in the OSTP's White House offices, offering the benefit of his unparalleled experience and deep knowledge on the technical dimensions of matters relating to defense and intelligence. For those visits, the OSTP's senior staff saved up the S&T questions that arose during the preceding two weeks that no one had been able to resolve. Garwin usually was able to answer them all in an afternoon.

Other advisory committees

Garwin served as a member on the Department of Defense's Defense Science Board under presidents Johnson and Nixon, as chair of the Arms Control and Nonproliferation Advisory Board (now the International Security Advisory Board) of the State Department, and as a member of



GARWIN AT A BLACKBOARD in an undated photo. (Photo courtesy of IBM.)

CISAC from its inception in 1980 to 2023. Two of us (Holdren and Jeanloz) served as CISAC chair during Garwin's 43 years on the committee.

During Holdren's term, Garwin was instrumental in drafting several major reports that the committee produced for the federal government, including *Management and Disposition of Excess Weapons Plutonium* (1994) and *The Future of U.S. Nuclear Weapons Policy* (1997). Garwin had an immense influence on those studies because of both his deep familiarity with every aspect of the relevant S&T and his ability to clearly convey what mattered with impeccable logic. Both studies' recommendations influenced how US and foreign policymakers managed the massive reductions of Russian and US warheads after the end of the Cold War. The studies proved influential not least because of Garwin's energetic advocacy of the findings among his extensive network of contacts, which included top US and foreign officials and their science advisers.

Garwin also served, with great effect, on a separate National Academies committee that delved into technical issues that had been advanced as objections to US ratification of the Comprehensive Nuclear-Test-Ban Treaty after it was signed by Bill Clinton in 1996. The committee's report, published in 2002, concluded that the supposed objections were unpersuasive. Those conclusions were reexamined and reaffirmed in yet another National Academies report in 2012, which Garwin was also involved in drafting. Although the Senate has not ratified the treaty, all countries except for North Korea have abided by it since 1998.

Over the past 20 years, Garwin was particularly engaged in dialogues with Russian and Chinese arms control counterparts. Having first traveled to China in the 1970s, Garwin had a long-standing interest in the country's scientific community. He was a key advocate for development of the 2008 *English–Chinese Chinese–English Nuclear Security Glossary*, which was jointly authored by US and Chinese experts to facilitate diplomatic and technical discussions about nuclear weapons. That project helped inspire the creation of the *P5 Glossary of Key Nuclear Terms*, a similar 2015 English-Chinese-French-Russian dictionary compiled by experts from the US, the UK, China, France, and Russia.

As a member of the JASON group from 1966 to 2025, Garwin contributed to innumerable studies bearing on technical

RICHARD GARWIN (center) **SPEAKS ABOUT THE PROBLEMS** with President Ronald Reagan's proposed space-based ballistic-missile defense system at a March 1984 press conference organized by the Union of Concerned Scientists. At left is Hans Bethe, and at right is Henry Kendall. (Photo by Dave MacKenzie/CC BY-NC 2.0/Flickr.)

questions of interest across the entire US government, including the census, counterterrorism efforts, nuclear security, and public health. He helped to generate experimental measurements and numerical simulations as readily as he communicated results and their implications. By taking a hands-on role in drafting reports, Garwin led by example: No matter how expertly generated, results do not exist until they are documented in writing.

After his retirement from IBM in 1993, Garwin began engaging full-time in JASON studies during the summers, when the bulk of the group's work is done.[14] Under his guidance, younger generations of scientists and engineers received a deep and rapid education in policy-relevant technical matters. He also provided a unique form of institutional memory by encouraging different parts of the government to communicate with each other and learn from past experiences.

Pugwash conferences

Starting in 1961, Garwin served for many years as an active member of the Pugwash Conferences on Science and World Affairs. The Pugwash organization's international, invitation-only annual conferences and other meetings provide venues for off-the-record discussions among senior scientists and public figures from across the world. The organization's initial focus at its founding in 1957—reducing the dangers from nuclear weapons and armed conflict—has remained its central preoccupation, but it has also addressed several other topics relating to science and security, including chemical and biological weapons, nuclear energy, and climate change.

Garwin attended many Pugwash meetings and served for some years on both the international Pugwash Council and the US Pugwash Committee at the American Academy of Arts and Sciences. In a tribute to Garwin in the *Bulletin of the Atomic Scientists*,[15] Holdren writes,

> What struck me immediately about Dick's role in Pugwash meetings was the extraordinary respect the most senior participants on all sides gave to his interventions. When Dick made a statement about the technical realities around an issue, it was generally taken as definitive on that topic. If, after hearing someone else's presentation, he commented "I didn't understand your argument," all present (usually including the presenter) knew this meant the argument had not made sense to the smartest person in the room.

Garwin accomplished far more during his long and distinguished career than we could address in the space available for this appreciation. In addition to the roles mentioned here, he served at different times as an adjunct research fellow and as a professor of public policy at Harvard University's Kennedy School of Government, an adjunct professor of physics

GARWIN (center) **IN A DISCUSSION WITH PARTICIPANTS** of a 2011 Vienna conference convened by the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization. (Photo by Marianne Weiss, the Official CTBTO Photostream/CC BY 2.0.)

at Columbia, and the Philip D. Reed Senior Fellow in Science and Technology at the Council on Foreign Relations. He also lectured widely and coauthored a number of important books on the relationship between science and society. Among his many honors are the National Medal of Science, awarded in 2002 by President George W. Bush, and the Presidential Medal of Freedom, awarded in 2016 by Obama. He was the loving husband of Lois Garwin for 70 years, until her death in 2018, and father to three children.

One of his legacies is the Garwin Archive (https://rlg.fas.org), a collection of his writings hosted on the website of the Federation of American Scientists. He wanted his work to remain easily accessible to others concerned about the problems to which he devoted his life. In a time when the world appears to be on the verge of a renewed, three-way arms race between the US, Russia, and China, his extensive work on arms control issues might be one particularly relevant place to start.

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