Vannevar Bush

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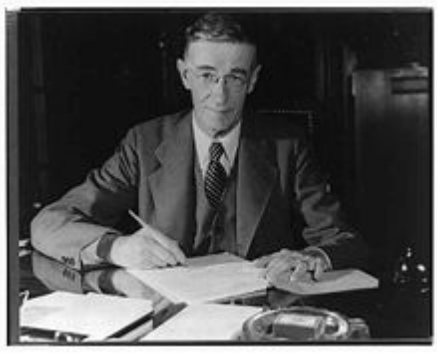
Vannevar Bush (March 11, 1890 – June 28, 1974; pronounced /væˈniːvɑr/ *van-NEE-var*) was an American engineer and science administrator known for his work on analog computing, his political role in the development of the atomic bomb as a primary organizer of the Manhattan Project, and the idea of the memex, an adjustable microfilm-viewer which is somewhat analogous to the structure of the World Wide Web. As Director of the Office of Scientific Research and Development, Bush coordinated the activities of some six thousand leading American scientists in the application of science to warfare.[1]

Bush was a well-known policymaker and public intellectual during World War II and the ensuing Cold War [2], and was in effect the first presidential science advisor. Bush was a proponent of democratic technocracy and of the centrality of technological innovation and entrepreneurship for both economic and geopolitical security.

Seeing later developments in the Cold War arms race, Bush became troubled. "His vision of how technology could lead toward understanding and away from destruction was a primary inspiration for the postwar research that led to the development of New Media." [1]

Vannevar Bush



Vannevar Bush, ca. 1940-44

Born	March 11, 1890 Everett, Massachusetts
Died	June 28, 1974 (aged 84) Belmont, Massachusetts
Institutions	MIT
Alma mater	B.A. Tufts College 1913 Ph.D. MIT 1917
Doctoral students	Claude E. Shannon
Known for	Helped create the National Science Foundation
Influenced	Ted Nelson

Contents

Life and work

Vannevar Bush was born in Everett, Massachusetts. He was educated at Tufts College (now Tufts

University), graduating in 1913. From mid-1913 to October 1914, Bush worked at General Electric (where he was a supervising "test man"); during the 1914-1915 academic year, Bush taught mathematics at Jackson College (the partner school of Tufts). After a summer working as an electrical inspector and a brief stint at Clark University as a doctoral student of Arthur Gordon Webster, Bush entered the Massachusetts Institute of Technology (MIT) electrical engineering program. Bush was vice-president and dean of engineering at MIT from 1932 to 1938. In June 1940 he convinced Franklin Delano Roosevelt to give him funding and political support to create a new kind of collaborative relationship between military, industry, and academic researchers--without congressional, or nearly any other, oversight.[1] This post included many of the powers and functions subsumed by the Provost when MIT introduced this post during 1949 including some appointments of lecturers to specific posts. While at MIT, Bush urged Col. Edward C. Harwood to found the American Institute for Economic Research as an independent, scientific research institute.

Spurred by the need for enough financial security to marry, Bush finished his thesis in less than a year. During August 1916 he married Phoebe Davis, whom he had known since Tufts, in Chelsea, Massachusetts. He received a doctorate in engineering from MIT and Harvard University, jointly, in 1917—after a dispute with his adviser Arthur Edwin Kennelly, who tried to demand more work from Bush.[3]

During World War I he worked with the National Research Council with about six thousand leading American scientists in the application of science to warfare (such as developing submarines, trip hammers, and better microscopes). He joined the Department of Electrical Engineering at MIT in 1919 and was a professor there from 1923–32.

During 1922, Bush and his college roommate, Laurence K. Marshall, set up the American Appliance Company to market a device called the S-tube. This was a gaseous rectifier invented by C. G. Smith that greatly improved the efficiency of radios. Bush made much money from the venture. The company, renamed Raytheon, became a large electronics company and defense contractor.

Starting in 1927, Bush constructed a *Differential Analyser*, an analog computer that could solve differential equations with as many as 18 independent variables. An offshoot of the work at MIT was the beginning of digital circuit design theory by one of Bush's graduate students, Claude Shannon.

World War II period

During 1939 Bush accepted a prestigious appointment as president of the Carnegie Institution of Washington, which awarded large sums annually for research. As president, Bush was able to influence research in the U.S. towards military objectives and could informally advise the government on scientific matters. During 1939 he became fully involved with politics with his appointment as chairman of National Advisory Committee for Aeronautics, which he directed through 1941. Bush remained a member of NACA through 1948.

A 1940 meeting at Berkeley with (from left to right) Ernest O. Lawrence, Arthur H. Compton, Bush, James B. Conant, Karl T. Compton, and Alfred L. Loomis

During World War I, Bush had known the lack of cooperation between civilian scientists and the military. Concerned about the lack of coordination in scientific research in the U.S. and the need for mobilization for defense, Bush in 1939 proposed a general directive agency in the Federal Government, which he often discussed with his colleagues at NACA, James B. Conant (President of Harvard University), Karl T. Compton (President of M.I.T.) (both pictured with Bush

in photo right), and Frank B. Jewitt, President of the National Academy of Sciences.

Bush continued to urge for the agency's creation. Early in 1940, at Bush's suggestion, the secretary of NACA began preparing a draft of the proposed National Defense Research Committee (NDRC) to be presented to Congress. But when the Germans invaded France, Bush decided speed was important and signalled President Roosevelt directly. He managed to get a meeting with the President on 12 June 1940 and took a single sheet of paper describing the proposed agency. Roosevelt approved it in ten minutes.

NDRC was functioning, with Bush as chairman and others as members, even before the agency was made official by order of the Council of National Defense on June 27, 1940. Bush quickly appointed four leading scientists to NRDC: NACA colleagues Conant, Compton, and Jewitt, and also Richard C. Tolman, dean of the graduate school at Caltech. Each was assigned an area of responsibility. Compton was in charge of radar, Conant of chemistry and explosives, Jewitt of armor and ordnance, and Tolman of patents and inventions. Government officials then complained that Bush was attempting to by-pass them and to acquire more authority for himself. Bush later agreed: "That, in fact, is exactly what it was." This co-ordination of scientific effort was instrumental for the Allies winning the Second World War. Alfred Loomis (photo above) said that "Of the men whose death in the summer of 1940 would have been the greatest calamity for America, the President is first, and Dr. Bush would be second or third."

During 1941 the NDRC was subsumed into the Office of Scientific Research and Development (OSRD) with Bush as director, which controlled the Manhattan Project until 1943 (when administration was assumed by the Army) and which also coordinated scientific research during World War II. In all, OSRD directed 30,000 men and oversaw development of some 200 weapons and instrumentalities of war, including sonar, radar, the proximity fuze, amphibious vehicles, and the Norden bomb sight, all considered critical in winning the war. At one time, two-thirds of all the nation’s physicists were working under Bush’s direction. In addition, OSRD contributed to many advances of the physical sciences and medicine, including the mass production of penicillin and sulfa drugs.

Of the war, Bush said in "As We May Think", "This has not been a scientist's war; it has been a war in which all have had a part. The scientists, burying their old professional competition in the demand of a common cause, have shared greatly and learned much." [1]

Another good example of the close working relationship between Bush and President Roosevelt was in a brief memo, dated March 20, 1942, providing approval for development of the atom bomb and what became the Manhattan Project. Roosevelt wrote Bush, "I have read your extremely interesting report and I agree that the time has come for a review of the work of the Office on New Weapons.... I am returning the report for you to lock up, as I think it is probably better that I should not have it in my own files."[4]

Bush's method of management at OSRD was to direct overall policy while delegating supervision of divisions to qualified colleagues and letting them do their jobs without interference. He attempted to interpret the mandate of OSRD as narrowly as possible to avoid overtaxing his office and to prevent duplicating the efforts of other agencies. Other problems were obtaining adequate funds from the President and Congress and determining apportionment of research among government, academic, and industrial facilities. However, his most difficult problems, and also greatest successes, were keeping the confidence of the military, which distrusted the ability of civilians to observe security regulations, and opposing conscription of young scientists into the armed forces. The New York Times in its obituary described him as “a master craftsman at steering around obstacles, whether they were technical or political or bull-headed generals and admirals.” Dr. Conant commented, “To see him in action with the generals was an exhibit.”

Post-war years

OSRD continued to function actively until some time after the end of hostilities, but by 1946 and 1947 it had been reduced to a minimal staff charged with finishing work remaining from the war period.

Bush and many others had hoped that with the dissolution of OSRD, an equivalent peacetime government research and development agency would replace it. Bush felt that basic research was important national survival for both military and commercial reasons, requiring continued government support for science and technology. Technical superiority could be a deterrent to future enemy aggression. During July 1945, in his report to the President *Science, The Endless Frontier* (http://www.nsf.gov/about/history/vbush1945.htm) , Bush wrote that basic research was: "the pacemaker of technological progress" and "New products and new processes do not appear full-grown. They are founded on new principles and new conceptions, which in turn are painstakingly developed by research in the purest realms of science!" He recommended the creation of what would eventually become in 1950 the National Science Foundation (NSF).

Simultaneously during July 1945, the Kilgore bill was introduced in Congress proposing a single science administrator appointed and removable by the President, with emphasis on applied research, and a patent clause favoring a government monopoly. In contrast, the competing Magnuson bill was similar to Bush's proposal to vest control in a panel of top scientists and civilian administrators with the executive director appointed by them, to emphasize basic research, and to protect private patent rights. A compromise Kilgore-Magnuson bill of February 1946 passed the Senate but expired in the House because Bush favored a competing bill that was a virtual duplicate of the original Magnuson bill.

During February 1947, a Senate bill was introduced to create the National Science Foundation to replace OSRD, favoring most of the features advocated by Bush, including the controversial administration by an autonomous scientific board. It passed the Senate on May 20 and the House on July 16, but was vetoed by Truman on August 6 on the grounds that the administrative officers were not properly responsible to either the President or Congress.

In the meantime Bush was still director of what was left of OSRD and fulfilling his duties as president of the Carnegie Institution of Washington. In addition, Bush postwar had helped create the Joint Research and Development Board (JRDB) of the Army and Navy, of which he was chairman. With passage of the National Security Act, signed into law during late July 1947, the JRDB became the Research and Development Board (RDB). It was to promote research through the military until a bill creating the National Science Foundation finally became law.

It was assumed President Truman would naturally appoint Bush chairman of the new agency, and behind the scenes Bush was lobbying for the position. But Truman was displeased with the form of the just-vetoed NSF bill favored by Bush, considering it an attempt by Bush to acquire power. His misgivings about Bush were revealed publicly on September 3, 1947: He wanted more time to think about it and reportedly told his defense chiefs that if he did appoint Bush, he planned to keep a close eye on him. However, Truman finally relented. On September 24 Bush met with Truman and Secretary of Defense James Forrestal, where Truman offered the position to Bush.

Initially the RDB had a budget of 465 million dollars to be spent on "research and development for military purposes." Late during 1947, a directive issued by Forrestal further defined the duties of the board and assigned it the responsibility and authority to "resolve differences among the several departments and agencies of the military establishment."

However, the authority Bush had as chairman of the RDB was much different from the power and influence he enjoyed as director of OSRD and the agency he hoped to create postwar almost independent of the Executive branch and Congress. Bush was never happy with the position and resigned as chairman of the RDB after a year, but remained on the oversight committee.

Despite his later ambiguous relationship with Truman, Bush's advice on various scientific and political matters was often sought by Truman. When Truman became President and first learned of the atomic bomb, Bush briefed him on the scientific aspects. Soon after, during June 1945, Bush was on the committee advising Truman to use the atomic bomb against Japan at the earliest opportunity. In *Pieces of the Action*, Bush wrote that he thought use of the bomb would shorten the war and prevent many American casualties. Bush's vision

of how to apply the lessons of OSRD to peacetime, *Science, The Endless Frontier*, was commissioned by Roosevelt in a letter of Nov 1944, was written during the following months, and—Roosevelt having died in the meantime—delivered to Truman in July 1945.

Immediately after the war, there were debates about future uses of atomic energy and whether it should be placed under international control. During early 1946, Bush was appointed to a committee to develop a plan for United Nations control. According to Truman in his memoirs, Bush advised him that a proposal to Russia for exchange of scientific information would promote to international collaboration and eventually to effective control, the alternative being an atomic bomb race. Bush wrote in a memo, "The move does not involve 'giving away the secret of the atomic bomb'. That secret resides principally in the details of construction of the bombs themselves, and in the manufacturing process. What is given and what is received is scientific knowledge." Bush felt that attempts to maintain scientific secrets from the Russians would be of little benefit to the U.S. since they would probably obtain such secrets anyway through espionage while most American scientists would be kept ignorant of Soviet science.

During September 1949, Bush was also appointed to a scientific committee reviewing the evidence that Russia had just tested its first atomic bomb. The conclusions were relayed to Truman who then made the public announcement.

Bush continued to serve on NACA through 1948 and expressed annoyance with aircraft companies for delaying development of a turbojet engine because of the huge expense of research and development plus retooling from older piston engines. [4] (http://history.nasa.gov/SP-4306/ch4.htm)

From 1947 to 1962 Bush was also on the board of directors of American Telephone and Telegraph. During 1955 Bush retired as President of the Carnegie Institution and returned to Massachusetts. From 1957 to 1962 he was chairman of the large pharmaceutical corporation Merck & Co..

Miscellaneous

One of Bush's PhD students at MIT was Frederick Terman, who was later instrumental in the development of "Silicon Valley".

Canadian government documents from 1950 and 1951 involving the Canadian Defence Research Board, Department of Transport, and Embassy in Washington D.C., implicate Bush as directing a very secret UFO study group within the U.S. Research and Development Board.[5] (See also Majestic 12) Bush's participation in this group is further documented by Stanton Friedman in his book "Top Secret/Majic" (Marlowe & Company, New York, NY 1996).

Bush was opposed to the introduction of Nazi scientists into the U.S. under the secretive Project Paperclip, thinking that they were potentially a danger to democracy.

Bush believed in a strong national defense and the role that scientific research played in it. However in an interview on his 80th birthday he expressed reservations about the arms race he had helped to create. "I do think the military is too big now—- I think we've overdone putting bases all over the world." He also expressed opposition to the antiballistic missile (ABM) because it would damage arms limitation talks with the Soviets and because "I don't think the damn thing will work."

Bush and his wife Phoebe had two sons: Richard Davis Bush and John Hathaway Bush. Vannevar Bush died at age 84 from pneumonia after suffering a stroke during 1974 in Belmont, Massachusetts. A lengthy obituary was published on the front page of the *New York Times* on June 30.

The Memex

Bush introduced the concept of what he called the memex (possibly derived from "memory extension") during the 1930s, which is a microfilm-based "device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory." He wanted the memex to behave like the "intricate web of trails carried by the cells of the brain"; essentially, causing the proposed device to be similar to the functions of a human brain. It was also important that it could be easily accessible "'a future device for individual use... a sort of mechanized private file and library" in the shape of a desk'. The important feature of the memex is that it ties two pieces together. Any item can lead to another immediately. Bush explains how the human mind works differently that traditional storage paradigms. For example oftentimes data is stored alphabetically, and to retrieve it one must trace it down, from subclass to subclass. The brain rather, Bush explains, works by association, rather than index, and with the brain being one of the "awe-inspiring" phenomena in nature one should learn from it. [1]

After thinking about the potential of augmented memory for several years, Bush set out his thoughts at length in the essay "As We May Think" in the *Atlantic Monthly*, which was published July 1945. In the article, Bush predicted that "*Wholly new forms of encyclopedias will appear, ready made with a mesh of associative trails running through them, ready to be dropped into the memex and there amplified.*" A few months later (10 September 1945) *Life* magazine published a condensed version of "As We May Think," accompanied by several illustrations showing the possible appearance of a memex machine and its companion devices.

Michael Buckland, a library scientist, regards the memex as severely flawed and blames it on a limited understanding by Bush of both information science and microfilm. Bush did not refer in his popular essay to the microfilm-based workstation proposed by Leonard Townsend during 1938, or the microfilm- and electronics-based selector described in more detail and patented by Emanuel Goldberg during 1931[6].

Shortly after "As We May Think" was published Douglas Engelbart would come across Bush's piece. With the concepts of Bush's visions in mind, he would begin work that would later on lead to the invention of the mouse, word processor, and hyperlink.[1]

Ted Nelson, who coined the terms "hypertext" and "hypermedia", also became greatly influenced by Bush's essay. He would also discover the hyperlink separate from Engelbart's discovery.[1]

Contributions to Digital Media

Due to the linear fashion of the memex machine, the term "Bushian" has been coined to express the linearity of html structure and also text. The "Bushian" philosophy of digital media is more focused on using facts to build something creative that will better our world. Bush sees art as a tool to help with that process. Instead of using emotion as a base, the "Bushian" view uses reason and logic. His goal is to untangle the labyrinth-shaped book and then mold it into something linear and reasonable. Bush is constantly in search of a shortcut to the end of the trial. The "Bushian" concept of linearity is the opposite of "Borgesian" which was coined to express the non-linear philosophy as mentioned by Jorge Luis Borges's.[1]

Honors, memberships, and affiliations

- As of 1947, Bush had received fourteen honorary degrees and ten medals.
- In 1943, he received the AIEE's Edison Medal 'For his contribution to the advancement of electrical engineering, particularly through the development of new applications of mathematics to engineering problems, and for his eminent service to the nation in guiding the war research program.'
- In 1928, he was awarded the Franklin Institute's Louis E. Levy Medal.
- After World War II, President Truman awarded Bush the Medal of Merit.
- President Lyndon Johnson awarded Bush the National Medal of Science.
- During 1970, he received the Atomic Pioneers Award from the Atomic Energy Commission .
- The Vannevar Bush Award was created by the National Science Foundation in 1980 to honor

contributions to public service.
- Fellow of the American Academy of Arts and Sciences, National Academy of Sciences, American Institute of Electrical Engineers, American Physical Society, and National Science Foundation.
- Member of the American Association for the Advancement of Science, the Society for the Promotion of Engineering Education, the American Philosophical Society, and the American Mathematical Society.
- Trustee of Tufts College, the Woods Hole Oceanographic Institution, Johns Hopkins University, and the Brookings Institution.
- Life member of the M.I.T. corporation and a regent of the Smithsonian Institution.

Quotes

- "A belief may be larger than a fact."
- "Fear cannot be banished, but it can be calm and without panic; it can be mitigated by reason and evaluation. "
- "If scientific reasoning were limited to the logical processes of arithmetic, we should not get very far in our understanding of the physical world. One might as well attempt to grasp the game of poker entirely by the use of the mathematics of probability."
- "Science has a simple faith, which transcends utility. It is the faith that it is the privilege of man to learn to understand, and that this is his mission."
- "The scene changes but the aspirations of men of good will persist."
- "To pursue science is not to disparage the things of the spirit. In fact, to pursue science rightly is to furnish the framework on which the spirit may rise."
- "The camera hound of the future wears on his forehead a lump a little larger than a walnut." - *As We May Think*

Publications

- 1922, *Principles of Electrical Engineering*.
- 1929, *Operational Circuit Analysis.*
- 1945, July, "As We May Think", *Atlantic Monthly*.
- 1945, *Science: The Endless Frontier* (http://www.nsf.gov/about/history/vbush1945.htm) , a report to president Truman outlining his proposal for post-war U.S. science and technology policy
- 1946, *Endless Horizons,* a collection of papers and addresses.
- 1949, "Modern Arms and Free Men", a discussion of the role of science in preserving democratic institutions.
- 1967, *Science Is Not Enough,* essays.
- 1970, *Pieces of the Action,* an examination of science and the state.

See also

- As We May Think
- Douglas Engelbart
- Hypertext
- Majestic 12
- Memex
- Paul Otlet, considered one of the fathers of information science, helped established the Mundaneum and created the Universal Decimal Classification
- Ted Nelson
- Vannevar Bush Award
- Victorian Internet
- [Television DVD release] of the World at War 30th anniversary edition. Vannevar Bush is interview at length during the filming of the series between 1971 and 1973.The interview is contain in the World at

War archives. This interview was not a part of the original series. It appears on Disc 11 of the World at War 30th Anniversary edition[7].

Notes

1. ^ ***a b c d e f g h*** Wardrip-Fruin, Noah and Nick Montfort, ed (2003). The New Media Reader. The MIT Press. ISBN 0-262-23227-8.
2. ^ Zachary, *Endless Frontier*, p 3. Full quotation: "To the public, Bush was the patron saint of American science, 'one of the most important men in America.'"
3. ^ Zachary, *Endless Frontier*, pp 11-34
4. ^ "Memorandum for Dr. Vannevar Bush" (http://www.fdrlibrary.marist.edu/psf/box2/a13c01.html) . Franklin D. Roosevelt Presidential Library. http://www.fdrlibrary.marist.edu/psf/box2/a13c01.html.
5. ^ Arthur Bray, *The UFO Connection*, 1979, Jupiter Publishing, ISBN 0-9690135-1-5, 46-75; Grant Cameron & T. Scott Crain, *UFOs, MJ-12, & the Government*, 1991, MUFON, 4-7, 55-60; Timothy Good, *Beyond Top Secret'', 1996, Pan Books, 183-188, 464-66, ISBN 0-330-34928-7 [1] (http://209.132.68.98/pdf/smithmemo-21nov51.pdf) [2] (http://www.presidentialufo.com/top_secret_text.htm) [3] (http://www.presidentialufo.com /embassy.htm)*
6. ^ Buckland, Michael. "Emanuel Goldberg, Electronic Document Retrieval, And Vannevar Bush's Memex." *Journal of the American Society for Information Science* **43**, no. 4 (May 1992): 284–294.
7. ^ World At War 30th Aniversary edition only ISBN: 0-7670-6575-1 UPC 7 33961713749

References

- Nyce, James M.; Kahn, Paul (eds.) "From Memex to Hypertext: Vannevar Bush and the Mind's Machine". San Diego, London (...) 1991. [A reprint of all of Bush's texts regarding Memex accompanied by related Sources and Studies]
- Waldthorp, MItchell, 2001. *The Dream Machine: J. C. R. Licklider and the Revolution that Made Computing Personal*. Penguin Books. Ch. 2.
- Zachary, G. Pascal. *Endless Frontier: Vannevar Bush, Engineer of the American Century*. The Free Press, 1997. ISBN 0-684-82821-9
- Vannevar Bush biography in *Current Biography 1947*, 80–82
- *New York Times* Bush obituary, June 30, 1974, p. 1

External links

- Internet Pioneers – Vannevar Bush (http://www.ibiblio.org/pioneers/bush.html)
- Living Internet – Vannevar Bush and Memex (http://www.livinginternet.com/i/ii_bush.htm)
- Carnegie Institution for Science (http://www.ciw.edu/)
- *The Computer at Nature's Core* by David F. Channell (http://www.wired.com/wired/archive/12.02 /view.html?pg=2?tw=wn_tophead_5)
- Pioneers: Vannevar Bush (1890–1974) (http://www.kerryr.net/pioneers/bush.htm)
- Links to Vannevar Bush References (http://www.ausbcomp.com/~bbott/wik/bushref.htm)
- *Events in the Life of Vannevar Bush* (http://graphics.cs.brown.edu/html/info/timeline.html)
- *Foreseeing the Future: The legacy of Vannevar Bush* by Erin Malone (http://www.boxesandarrows.com/archives/foreseeing_the_future_the_legacy_of_vannevar_bush.php)
- As We May Think – Published July 1945, *The Atlantic Monthly* (http://www.ps.uni-sb.de/~duchier /pub/vbush/vbush.txt)
- Observer UK article, June 2005 (http://observer.guardian.co.uk/business/story /0,6903,1499292,00.html)
- Remarks at the Presentation Ceremony for the National Medals of Science and Technology in 1990 by President George Bush using a quote from Vannevar Bush (http://web.archive.org /web/20060308212141/http://bushlibrary.tamu.edu/research/papers/1990/90111300.html)
- Annotated bibliography for Vannevar Bush from the Alsos Digital Library (http://alsos.wlu.edu /qsearch.aspx?browse=people/Bush,+Vannevar)

- YouTube video demonstrating the ideas behind the Memex system (http://www.youtube.com/watch?v=c539cK58ees)
- Pictures of Vannevar Bush from the Tufts Digital Library (http://dl.tufts.edu/search_basic.jsp?keywords=Bush,%20Vannevar&basic-meta-sort=type&type=metadata&returns=10&querymode=phrase&type_image=yes&type_text=yes&fulltext=no&type_dataset=yes&type_oral_history=yes&type_collection_guides=yes)

Government offices		
Preceded by **New office**	**Chairman, Research and Development Board** 1947–1948	Succeeded by **Karl T. Compton**

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Categories: 1890 births | 1974 deaths | American electrical engineers | Computer pioneers | Futurologists | New encyclopedism | Harvard University alumni | IEEE Edison Medal recipients | Massachusetts Institute of Technology alumni | Massachusetts Institute of Technology faculty | Manhattan Project people | National Inventors Hall of Fame inductees | National Medal of Science laureates | People from Middlesex County, Massachusetts | Presidential Medal for Merit recipients | Raytheon people | Tufts University alumni | People associated with the atomic bombings of Hiroshima and Nagasaki