Gerald Holton Bio

Gerald Holton is an American physicist, historian of science, and educator, whose professional interests also include philosophy of science and the fostering of careers of young men and women. He is *Mallinckrodt Professor of Physics and Professor of History of Science, Em,* at Harvard University[1]. His contributions range from physical science and its history to their professional and public understanding, from studies on gender problems and ethics in science careers to those on the role of immigrants. These have been acknowledged by an unusually wide spectrum of appointments and honors, from physics to initiatives in education and other national, societal issues, to contributions for which he was selected, as the first scientist, to give the tenth annual Jefferson Lecture that the National Endowment for the Humanities describes as, "the highest honor the federal government confers for distinguished achievement in the humanities"[2]. However, his life story is also punctuated by improbable rescues during the dark time of the 20th century.

EARLY LIFE AND EDUCATION

Holton was born on May 23, 1922 in Berlin[3], when Germany was in turmoil and sliding toward disaster. In June, the Foreign Minister, Walter Rathenau, was one of the more than 350 politicians and intellectuals assassinated by fascist gangs that already commanded the streets. [4] Albert Einstein was told he was next on the list, so he fled the country.

Holton's parents were Austrians: Emanuel, an Attorney-at-Law specializing in International Law, and Regina, a physiotherapist. Forced by the rise of fascism in Germany, and one physical attack on the young family, they returned early to Vienna. Growing up in Vienna, Holton received his education through most of the *Humanistische Gymnasium*. Family life was typically that of professionals enamored of Germanic *Kultur*; indeed, his parents had met first in a Poetry Club.

But in 1938, the annexation of Austria by Germany made life for Jews there also life-threatening, as was widely understood after the nation-wide Pogrom of November 8-9.[5] Yet, soon thereafter he and his younger brother, Edgar, were luckily granted a place on the British Quakers' *Kindertransport*[6], to flee to England. There, Holton studied at the School of Technology, City of Oxford, receiving the Certificate of Electrical Engineering in June 1940. At that point, he was able to leave for America with his luckily rejoined family, just days before having to report for incarceration for the duration, as was required for all male adult German refugees, by Prime Minister Churchill's directive.

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[1] *Holton, Gerald J. "United States Public Records Inde"*. See also: http://holton.physics.harvard.edu/
[2] https://www.neh.gov/about/awards/jefferson-lecture. See also: Gerald Holton, *Advancement of Science, and its Burdens* (1986), Chapter 14.
[3] *Holton, Gerald J. "United States Public Records Inde"*.
[4] See Wikipedia for Walther Rathenau: https://en.wikipedia.org/wiki/Walther_Rathenau
[5] Only 7% of the targeted children in Nazi Europe survived. See: Tec, N. (1993). A Historical Perspective: Tracing the History of the Hidden-Child Experience. In Marks, J., *The Hidden Children: The Secret Survivors of the Holocaust*, New York: Fawcett Columbine, 273-91.
[6] http://www.kindertransport.org/

Shortly after arriving in the U.S., out of the blue, Wesleyan University in Middletown, CT offered Holton a place as a refugee from Europe (as many American Colleges and University did similarly[7]). At Wesleyan, studying under his mentor, Professor Walter G. Cady, he received a B.A. in 1941 and an M.A. in 1942. From the outbreak of the war he found himself officially among the "Enemy Aliens", as marked by President Roosevelt's directive for all holders of German passports. Yet, he was asked to join the Harvard-based war-time research unit, the Electric-Acoustic Laboratory, OSRD, and also was Teaching Assistant on the staff to train Naval Officers in the use and repair of Radar equipment.

Upon the end of WWII, he enrolled as a graduate student at Harvard. In 1947 he received his Ph.D. for research on the structure of matter at high pressure, as a student under Professor Percy Williams Bridgman, who in 1946 was awarded the Nobel Prize in Physics for his remarkable research in the field he effectively founded. Upon Holton's graduation he was asked to remain at Harvard as Instructor in the Physics Department. His academic professional life had begun, and his association with Harvard has lasted for over 70 years. So has also his marriage to Nina, a sculptor.[8] They have two sons, Thomas and Stephan.

CAREER

Holton went through various faculty ranks at Harvard, starting in 1947, and was tenured in 1952 at age 30. For 30 years, starting from his thesis, he ran a high-pressure laboratory, specializing on the structure of liquids, and having the usual flow-through of research students and publications.

Among the courses he taught in the Physics Department was an unusual one – an introduction to Physics seen as part of a cultural tapestry that included astronomy, chemistry and technology as well as history and philosophy of science. It resulted in his publication of his first book, *Introduction to Concepts and Theories of Physical Science* (Addison Wesley: 1952, and later editions and adaptations), which has been called a seminal work. Its approach and structure was later incorporated in the National Curriculum Project requested by the NSF, called *The Project Physics Course*[9]. He headed it with colleagues F. James Rutherford and Fletcher Watson. It was also adapted in a number of foreign countries.

In these, as in Holton's other educational opportunities, he has been guided by the advice of Alfred North Whitehead, that "In the conditions of modern life, the rule is absolute, the race which does not value trained intelligence is doomed". As well, he is based on his firm belief that in education a multi-cultural approach is necessary, both to help immunize against the seduction of narrowness, and to obey the moral imperative to foster a liberal education. For the same

[7] See Holton, G. and Sonnert, G., "The Grand Wake for Harvard Indifference: How Harvard and Radcliffe students aided young refugees from the Nazis." *Harvard Magazine*., Sept.-Oct. 2006. 50-55.
[8] See Holton, Nina. "Sculpture," in *Leonardo*, vol. 8, 2. (Great Britain: Pergamon Press, 1975), 133-135. and also Holton, Nina. "My Clay Sculpture Series", in *Leonardo*, vol. 14, 2. (Great Britain: Pergamon Press, 1981), 125-127.
[9] The entire collection of texts from the Project Physics Course can be accessed and downloaded for free at https://archive.org/details/projectphysicscollection. See also the dissertation by Meshoulam, David. *Teaching Physics as One of the Humanities: The History of (Harvard) Project Physics*, 1961-1970, (University of Wisconsin-Madison, 2014).

reason, Holton wrote extensively against the destructive excesses of Structuralists and Postmodernists in their writings against science.[10]

Holton's service at Harvard included chairmanship of the Concentration on Physics and Chemistry, of the initial General Education Course, membership on the Faculty Council, and on the Advisory Board of the Radcliffe Institute for Independent Study. From 1976 to 1982 he was concurrently Visiting Professor at the Massachusetts Institute of Technology, as a founding faculty member of the Program on Science, Technology and Society. At various times he was visiting professor (or similar title) at the Institute for Advanced Study at Princeton; New York University; Leningrad University; Imperial College, London; University of Rome; CNRS-Paris; and invited lecturer in China and Japan.

Here it is appropriate to mention two of Holton's other educational efforts. In 1956, having been elected as Fellow of the American Academy of Arts and Sciences[11], he was asked to be its Editor. For a couple of years before, the Academy had been publishing an experimental, annual, in-house volume called *Daedalus*, distributed to its members. But Holton realized the opportunity to change *Daedalus* to a publicly, widely available, quarterly journal. As he put it in his first issue (Winter 1958)[12], the new journal aimed "to give the intellectual community a strong voice of its own", and to lift each of us above our individual cell in the labyrinth, so as "to see the entire structure".

In addition for the journal serving as a sort of Adult Education, several issues looked ahead at problems that were coming over the horizon and had an effect on public policy--such as those on "Arms Control and Disarmament" (Fall 1960), on "The Woman in America" (Spring 1964), on African Americans (Fall 1965, with a Foreword by President L.B Johnson), and on "Ethical Aspects of Experimentation with Human Subjects" (Spring 1969).

In 1955, another unexpected event occurred, one which caused Holton to make an important turn in his studies. When Albert Einstein died on April 18, 1955, Professor Philipp Frank, Holton's colleague in the Physics Department and proponent of the American continuation of the *Vienna Circle* philosophy[13], suggested that a memorial occasion should be arranged, and that as one part Holton should present the *history* of Einstein's achievements. But Holton found that apart from Einstein's own essays there was then still little solid scholarship on this topic.

With Professor Frank's recommendation, Holton went to the Institute of Advanced Study, where Einstein's enormous and largely unstudied correspondence and manuscripts were kept, still under the supervision of Einstein's long-time secretary, Helen Dukas[14]. This excursion resulted in Holton, on and off for two years, helping to make the haphazard collection into an Archive

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[10] See Holton, Gerald James, *Science and anti-science*. Cambridge, Mass.: Harvard University Press, 1993. http://nrs.harvard.edu/urn-3:FHCL:19365133. Chapters 5 and 6. Also *Journal of the History of Jdeas*, v.61.2 (2000), 327-341).

[11] *Book of Members, 1780–2010: Chapter H"*. *American Academy of Arts and Sciences.*

[12] Later issued also as a book - *Science and the Modern Mind.* (Boston: Beacon Press), 1958 - as were most of his issues.

[13] Holton, Gerald. "On the Vienna Circle in Exile: An Eyewitness Report," in *The Foundation Debate*, (Kluwer Academic: 1995), 269-292.

[14] Holton, Gerald. "The Woman in Einstein' s Shadow", Chapter 2 in *Victory and Vexation in Science: Einstein, Bohr, Heisenberg and Others*. (Cambridge: Harvard Unversity Press), 2005.

usable by scholars, while he, reading through the collection, was learning from it how to see its historical value. Over the years that followed, Holton's researches on Einstein have occupied a large part of his publications[15]. Eventually, this initiative helped launch an academic industry, analogous to the ones concerned with Newton and Darwin. But as the scholar in this field, Tesu Hiroshige, wrote, someone had to take a "first step"[16].

While studying the rich contents of Einstein's collection, Holton came to realize a fact that led to a new and fruitful part of his researches on this and other scientists. As shown in Einstein's work, Einstein brilliantly but silently drew again and again from a set of fundamental guiding concepts that were neither verifiable nor falsifiable. These concepts included, in his theory construction, the primacy of the search for unity; invariance; formal rather than materialistic explanation; logical parsimony; symmetry; the continuum, causality, and completeness. In addition, their contraries held by other scientists, such as acausality and uncertainty, were strongly opposed.

Holton called all such motivating concepts *Themata* (sing. *Thema*). He found these crucial, style-defining and differing thematic sets to be also at the core of research of many other scientists, from antiquity to Johann Kepler to Niels Bohr.[17] This insight was later used as well by other historians of science, and by scholars in other fields[18]. His findings led Holton to the publication of his book, *The Thematic Origins of Scientific Thought* (Harvard University Press, 1973, revised edition 1988).

Different sets of themata were and are being held by individual scientist so inclined, as their subjects advanced over time. In that respect, this concept differs profoundly from the idea of a series of incommensurable, non-progressive, so-called "paradigms". Each of those, in turn, was said to infect the whole social group of scientists at a given time and in the same way—as is disproved even by the famous mutual oppositions between contemporaries such as Einstein, Schroedinger, and Heisenberg.

Occasionally, a public issue became so important that Holton felt he could contribute to its deeper understanding and amelioration. One of these was the general realization that among working scientists in most fields, women were underrepresented and often not sufficiently valued. Therefore, with his colleague Dr. Gerhard Sonnert, a sociologist of science, he initiated a long-term research effort, called *Project Access*. It yielded two books, *Who Succeeds in Science?: The Gender Dimension* (Rutgers University Press, 1995), and *Gender Differences in Science Careers: The Project Access Study* (Rutgers University Press, 1995, with a Foreword by Robert K. Merton).

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[15] One of Holton's early indications of his findings in the Einstein collection was published in "Continuity and Originality in Einstein's Special Relativity Theory," in *Actes du IX Congrès International d'Histoire des Sciences*, September 1959, vol. 1. (an "abbreviated version"). Also relevant are: Holton, Gerald. "Einstein, Michelson, and the "Crucial" Experiment" in *Thematic Origins of Scientific Thought: Kepler to Einstein* (Cambridge: Harvard University Press), 1988. Chapter 8., as well as Holton, Gerald. "Einstein's model for constructing a scientific theory"". "Einstein and the cultural roots of modern science," and "Einstein and the shaping of our imagination" , all in *The Advancement of Science and Its Burdens*. (Cambridge: Harvard University Press), 1998.

[16] Holton, *The Advancement of Science*, xvi.

[17] Holton, "The Roots of Complementarity," in *Thematic Origins*, 1988.

[18] Holton, "Postscript to the Revised Edition" in *Thematic Origins*, 1988, 473-481.

A second occasion for engaging in a thorough study arose when it became of general interest to explore what immigrants can bring to the betterment of society in the U.S.A. Dr. Sonnert and Holton committed to a several-years study, called *Second Wave*, to determine, by questionnaires and face-to-face interviews, what was achieved by a particular group-- immigrants who had come as children to the U.S.A. as refugees from Nazi persecution-- compared to American-borns. The startling results were published by them in a book, *What Happened to the Children Who Fled Nazi Persecution* (Palgrave Macmillan, 2006, with a Preface by Bernard Bailyn; German translation, *Was geschah mit den Kindern*, Lit Verlag, Muenster, 2008). Noting that the findings in that book appeared to have applications for immigrants to the U.S. in our time, Dr. Sonnert and Holton published another book, *Helping Young Refugees and Immigrants Succeed* (Palgrave Macmillan, 2010).

Holton's researches in the history and philosophy of science as well as in education were published in a number of works, most of them available online and many of them translated into other languages. They include:

Holton, Gerald (1952, and later editions). *Introduction to Concepts and Theories in Physical Science.* Reading: Addison-Wesley.

Holton, Gerald; Rutherford, F. James; Watson, Fletcher G. (1970). *The Project Physics Course.* New York: Holt, Rinehart and Winston.

Holton, Gerald (1978). *The Scientific Imagination: Case Studies.* Cambridge: Harvard University Press.

Holton, Gerald (1986). *The Advancement of Science, and Its Burdens: The Jefferson Lecture and Other Essays.* Cambridge: Harvard University Press.

Holton, Gerald (1973, rev. 1988). *Thematic Origins of Scientific Thought: Kepler to Einstein.* Cambridge: Harvard University Press.

Holton, Gerald (1993). *Science and Anti-Science.* Cambridge: Harvard University Press.

Gerhard Sonnert and Gerald Holton (1995), *Who Succeeds in Science? The Gender Dimension*. New Brunswick, New Jersey: Rutgers University Press.

Holton, Gerald (1996). *Einstein, History, and Other Passions.* Cambridge: Harvard University Press.

Gerhard Sonnert and Gerald Holton (2002), *Ivory Bridges*: *Connecting Science and Society*. Cambridge: MIT Press.

Gerald Holton (2005), *Victory and Vexation in Science: Einstein, Bohr, Heisenberg, and Others*. Cambridge: Harvard University Press.

Gerhard Sonnert and Gerald Holton (2006), *What Happened to the Children Who Fled Nazi Persecution*. New York: Palgrave Macmillan.

Gerhard Sonnert and Gerald Holton (2010), *Helping Young Refugees and Immigrants Succeed*. New York: Palgrave Macmillan, New York.

Holton, Gerald; Galison, Peter; Schweber, Silvan S. (2008). *Einstein for the 21st Century: His Legacy in Science, Art, and Modern Culture.* Princeton: Princeton University Press.

David Cassidy, Gerald Holton, and James Rutherford (2014), *Comprendre la physique*. Lausanne: Presses polytechniques et universitaires romandes.

A selection of Holton's books and essays can be downloaded on *DASH* (Digital Access to Scholarship at Harvard). Among the essays are those in which Holton called for the wider adoption of what he called Jeffersonian Research—one with the double purpose of serving both basic investigation and the needs of society, as Thomas Jefferson had done repeatedly.

Holton also engaged in considerable editorial work apart from *Daedalus.* It included, as General Editor, the series of books on history of science by the Arno Press, and another, called *Classics of Science*, by Dover Publications, Inc. He also served for some years, from its beginning, on the Editorial Advisory Board and Editorial Committee of *The Collected Papers of Albert Einstein* (Princeton University Press, 1987 ff.). In 1972 he founded the *Newsletter on Science, Technology, and Human Values*, known since 1976 as the journal *Science, Technology and Human Values.*

While his professional memberships are collected below, one such service required a great deal of time and energy: the Presidency of the History of Science Society (1983-1984), after two years as Vice President. This Society, founded by George Sarton, was highly distinguished in its essential mission; but he found on election that a great deal of work, managerially and financially, had to be done[19].

PROFESSIONAL MEMBERSHIPS, FELLOWSHIPS AND OTHER HONORS

PROFESSIONAL EXPERIENCE:

American Physical Society: Fellow; American Philosophical Society: Fellow; American Academy of Arts and Sciences: Fellow, Editor of the Academy, 1956-63, Founding Editor of the quarterly journal, Daedalus,1958, member of Council (to 1997). Académie Internationale d'Histoire des Sciences, Vice President, 1981-88. Académie Internationale de Philosophie des Sciences. Deutsche Akademie der Naturforscher, Leopoldina. History of Science Society: Council, 1959-61, 1963-65, President, 1983, l984. American Association for the Advancement of Science: Fellow, member, Board of Directors, 1970s; American Association of Physics Teachers, member; American Institute of Physics, founding chairman of its Committee for the Center for History of Physics. New York Academy of Sciences, Honorary Life Member. National Associate, the National Academies, 2003. Member of: National Academies of Sciences Committee on

[19] See "1984 Presidential Address," in *History of Science Society Newsletter*, v. 14, 2, April 1985, and "Some Lessons from History in the History of Science," in *Isis, Journal of the History of Science Society*, v. 90, 52, 1999.

Communication with Scholars in the People's Republic of China, 1969-72; Center for Advanced Study in the Social Sciences, 1976; Department of State's U.S. Committee on Science in UNESCO, 1977-80; Member, Selection Board, Albert Einstein Peace Prize, 1980-1985; International Union on History and Philosophy of Science, 1982-88, Chair, 1988; National Academies' Committee on Facilitating Interdisciplinary Research, 2003. National Research Council Committee on Indicators of Precollege Science Education, 1984-87; National Academies' Committee on the Conduct of Science, 1989-91; AAAS Committee on Public Understanding of Science (OPUS), 1997-2001. National Science Foundation, Advisory Committee on Ethical and Values Impact of Science and Technology (EVIST), 1973-78; NFS' Advisory Committee on Directorate for Science and Engineering Education, 1985-93, Chair, 1986-88. Massachusetts Board of Education, Advisory Committee on Science and Mathematics, 1997-2000. Member, Kuratorium of the German-American Academic Council, 1997-2000.

COMMISSIONS and TRUSTEESHIPS:

Trustee, Boston Museum of Science, 1965-67, Member of the Corporation, 1978-81; Trustee, Science Service, 1972-78; Trustee, Wesleyan University, 1975-89. Member of: U. S. Department of State's National Commission for UNESCO, 1975-80. Member, Council of Scholars, Library of Congress, 1979-1995; President Ronald Reagan's National Commission on Excellence in Education, 1981-83, co-author of *A Nation At Risk* report. Trustee, National Humanities Center, 1989-93.

AWARDS:

American Association of Physics Teachers, Distinguished Service Citation, 1962. George Sarton Memorial Lecturer, 1962. Robert A. Millikan Medal, 1967. Herbert Spencer Lecturer, Oxford University, 1979. Oersted Medal, 1980. Guggenheim Fellowship, 1980-81. Jefferson Lecturer, 1981. John P. McGovern Medal of Sigma Xi, 1985. Andrew Gemant Award, American Institute of Physics, 1989. Sarton Medal, History of Science Society, 1989. J. D. Bernal Prize, Society for Social Studies of Science, 1989. Joseph Priestley Award, 1994. Rothschild Lecturer (Harvard University), 1997. Joseph H. Hazen Prize of the History of Science Society, 1998. Festschrift: *Science and Culture*, Transaction Publishers, New Brunswick and London, 2001. Abraham Pais Prize of the American Physical Society, 2008; Republic of Austria's Ehrenkreuz für Wissenschaft und Kunst, 2008; member, Austrian Academy of Sciences, 2016. Eight honorary degrees.

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