and died of apparent cardiac arrest as he was awaiting discharge.

Alvin was born on 30 June 1915 in Elizabeth, New Jersey, and graduated from the City College of New York in 1935 with a bachelor's degree in electrical engineering. He had planned to major in mathematics or physics, but was advised that it would be easier for an electrical engineer to find work during the depression. Still, Alvin had to work in transient jobs (such as being a bellhop) before he landed an engineering post with the US Navy's Bureau of Ships in Washington, DC, in 1938. He continued working for the navy for 34 years, until his retirement and relocation to Israel.

While working full time for the navy, Alvin pursued his graduate studies at night, and obtained an MS in physics in 1941 from George Washington University, where his adviser was Edward Teller. He then received his PhD in physics from the Catholic University of America in 1948 under the guidance of Karl Herzfeld. Alvin's thesis, "Temperature Dependence of Electron Energy Levels in Solids," gave rise to the "Radkowsky effect," which is a broadening of the electron energy levels in crystalline insulators; that broadening results from collisions with the lattice. The broadening leads to a reduction in the width of the "forbidden" energy region between the valence and conduction bands.

Hyman Rickover recruited Alvin in 1948 to work in the naval reactors program, initially at the recently established Argonne National Laboratory. In order to learn reactor physics, Alvin traveled to Schenectady, New York, where he soon became Rickover's chief physicist and the de facto overseer of the physics efforts at General Electric Co's Knolls Atomic Power Laboratory and Westinghouse Corp's Bettis Laboratory, both of which designed submarine reactors under contract to the navy. Those programs, although successful in their own rights, also led to the eventual development of commercial light-water moderated reactors, pressurized water reactors by Westinghouse, and boiling water reactors by GE.

Although Alvin was not involved in the day-to-day R&D in the naval reactor program, he nonetheless made important technical contributions to that program and to the subsequent development of commercial nuclear power. Perhaps his significant contribution was adding burnable "poisons" to the fuel. As the fuel in a reactor is depleted and fission products build up, the reactivity decreases. If a neutron absorber (a poison) is appropriately incorporated into the reactor, its depletion through neutron absorption yields positive reactivity to partially compensate for the fuel burnup. Such reactivity compensation allows the number of moving control rods to be minimized and thus enhances the reactor's reliability and increases its lifetime. Since the 1950s, some form of burnable poison has been a constant in light-water reactors.

Alvin Radkowsky

During the 1950s, Alvin proposed the use of the "seed-and-blanket" core, in which fissionable material (enriched uranium) was inserted in lumps (the "seeds") into a "blanket" of natural uranium (later thorium) to breed plutonium-239 or uranium-233, both fissionable isotopes. The improved neutron economy inherent in that design surprisingly gave a breeding ratio greater than unity, thus belying the conventional wisdom that breeding could occur only in fast reactors, which have serious coolant and control problems. In 1960 and later in 1977, Westinghouse built two seed-and-blanket cores in Shippingsport, Pennsylvania, although the design was shelved as nuclear power became politically incorrect in the US.

After Alvin's emigration to Israel in the early 1970s, he became a professor of nuclear engineering at Tel Aviv University. In addition to the typical professorial duties, he embarked on an ambitious research program to develop a proliferation-free thorium breeder based on the seed-and-blanket concept. The thorium would contain a sufficient amount of depleted uranium to make reprocessing of the ^{233}U unfeasible. Thus all the bred fuel would be consumed in situ, which would reduce both proliferation and waste storage problems and also would allow extraordinarily long burnups. Considerable interest in this design subsequently developed around the world; Alvin was engaged in a design project with the Russians at the time of his death.

During the early 1990s, Alvin served as consultant to the Taiwanese nuclear program, and his frequent travel there enabled him and his wife, Annette, to make side trips to exotic locales like Nepal, Bali, Hong Kong, and Tokyo. The Radkowskys were Orthodox Jews who adhered to their beliefs despite the complications those beliefs added to travel: They had to carry virtually all of their food (mostly canned fish) with them in suitcases. During his years with the navy, Alvin also had to travel, and generally ate only food he had brought from home. Twice he was forced to remain in airports to avoid flying on the Sabbath. Eventually, Alvin's struggle with scoliosis forced him to retire in the late 1990s, but he continued to go to his office at Tel Aviv University regularly.

Alvin's two great loves, physics and Judaism, defined his existence. His devotion to these two areas left him little time for anything else and led to a rather Spartan existence. He was a compassionate, caring human being who put his religious beliefs into daily practice and left this world a better place for having visited it.

Paul Zweifel
Radford, Virginia

Donald Tuomi

After a lifetime of contributions to different branches of science, Donald Tuomi died of heart failure on 12 March 2002 in Arlington Heights, Illinois.

Don was born on 12 September 1920 in Willoughby, Ohio, and received his BS in chemistry from Ohio State University in 1943. Instead of immediately continuing his studies, he joined the Manhattan Project at the Special Alloy Materials (SAM) Laboratories at Columbia University. There, he was deeply involved in the successful development of the "barrier" for the Oak Ridge Gaseous Diffusion Plant. The barrier was a key to separating out uranium-235 from uranium-238. After World War II, Don returned to Ohio State and received his PhD in physical chemistry in 1953. His dissertation project, under the guidance of Preston Harris, involved determining the crystal structure of lithium trichloroacetate.

Don contributed to diverse fields. For instance, as a graduate student,

Donald Tuomi

he worked on silver cesium oxide photocathodes for infrared night vision. After graduate school, he joined MIT Lincoln Laboratories, where he worked with Homer Priest on oxygen contamination of silicon and germanium. Then, until 1961, he worked at the Thomas A. Edison Laboratories to determine the limiting mechanisms for electrochemical capacity of the nickel–iron alkaline storage battery. His paper, "The Forming Process in Nickel Positive Electrodes," published in the *Journal of the Electrochemical Society* in 1965, is a prime example of an approach to science that, like Nature itself, recognizes no artificial boundaries. That paper illustrated the use of a variety of investigative disciplines toward solving the problem. In recognition of his contribution, the Electrochemical Society awarded Don its Battery Division Research Award in 1968.

For most of the period 1961–83, Don pursued his major research interest, thermoelectric alloys, at the Borg–Warner Research Center in Des Plaines, Illinois. Known as somewhat of a maverick, he made persuasive arguments for alternative approaches for optimizing thermoelectric properties. For example, he defined certain quality indices and asserted that optimization of alloys involved optimizing his indices. He challenged the commonly held assumption that attainment of a figure of merit greater than 2.7 was practically impossible, and proved his point by making alloys having figures of merit greater than 3.0. He and an associate, Allen Reich, developed greatly improved methods for measuring electrical transport properties and thermal conductivity. Perhaps most important, he described in great detail the challenge of understanding and dealing with multicomponent systems like bismuth-antimony-selenium-tellurium plus dopants.

From 1972 to 1980, Don's work on thermoelectric alloys was interrupted after he was asked by Borg–Warner management to carry out fundamental studies on deformation mechanisms in ABS (acrylonitrile-butadiene-styrene) plastic. At the time, Borg–Warner Chemicals, headquartered in Parkersburg, West Virginia, was the world's leading producer of ABS. Don and I worked together in his group; he challenged the "experts" about the mechanism by which dispersed polybutadiene rubber particles conferred high toughness on an otherwise brittle matrix of styrene-acrylonitrile copolymer. Years later, Don told me, "Bob, I found out in the recent literature that our view of voids in rubber particles not being an artifact of sample preparation is now generally accepted."

Don retired from the Borg–Warner Research Center in 1983. Immediately afterward, he set up a consulting business in Arlington Heights. That business emphasized, but was not limited to, thermoelectric alloy development.

In the years after I left Don's group, our relationship transformed from close colleagues in research to close friends. I have many happy memories of my wife and me meeting Don and his wife, Ruth (often with other alumni of the research center), for dinner and a pleasant evening of conversation. Of course, when Don and I got into technical subjects, the others would just roll their eyes and sigh.

Robert W. Johnson
DSM Desotech Inc
Elgin, Illinois

Albert Edward Whitford

Albert Edward Whitford, a research astrophysicist and a director, successively, of the Washburn and Lick Observatories, died in Madison, Wisconsin, on 28 March 2002 following a short illness. He was especially well known for his pioneering work on photoelectric photometry of stars and galaxies—which led to knowledge of their physical properties and distances—and of the interstellar dust in our galaxy.

Albert was born in Milton, Wisconsin, on 22 October 1906 and received his BA in physics in 1926 at Milton College. That fall, he moved on to graduate work