Gerard Kitchen O'Neill FREE

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Physics Today **46** (2), 97–98 (1993);
https://doi.org/10.1063/1.2808821

ASA SILVER MEDALISTS HONORED AT MEETING IN NEW ORLEANS

The Acoustical Society of America, during its November meeting in New Orleans, bestowed Silver Medals on four individuals. The Silver Medal in Underwater Acoustics and Engineering Acoustics went to Victor C. Anderson; the Silver Medal in Noise to George C. Maling Jr; the Silver Medal in Engineering Acoustics to Alan Powell; and the Silver Medal in Musical Acoustics to Thomas D. Rossing.

Anderson was cited for "pioneering underwater sound research in ambient noise and for the invention and engineering development of the delay time compression correlator and digital multibeam steering sonar." The DELTIC correlator, which Anderson worked on in the mid-1950s, is a device used in sonars for generating cross-correlation functions in real time. The other invention for which Anderson was cited, the DIMUS sonar, allows the simultaneous generation of a set of preformed beams from a hydrophone array.

Anderson earned a PhD in physics from the University of California, Los Angeles, in 1953. He has spent much of his career at the Marine Physical Laboratory of the Scripps Institution of Oceanography: In 1947 he became a research assistant there, and in 1968 he became a professor of applied physics at the University of California, San Diego, and associate director of the lab. He retired in 1989.

Maling was cited for "outstanding leadership in noise control and in the development of widely used, internationally and nationally standardized methods for noise evaluations." In the early 1960s Maling designed and built a plenum for acoustical testing of small air-moving devices; this plenum was eventually adopted as an international standard. From 1976 to 1979 he headed the American National Standards Committee S-1 on acoustics and was involved in developing standards for determining the noise emission of sound sources.

Maling earned a PhD in physics from MIT in 1963, after which he continued to work there as a researcher for two years. In 1965 he joined IBM in Poughkeepsie, New York, where he was a senior physicist until retiring in July 1992.

Powell was cited for "leadership in research in the silencing of ship noise and for fundamental contributions to aeroacoustics." As technical director of the David Taylor Naval Ship Research and Development Center from 1966 to 1985 Powell built up a large program in ship acoustics. More recently he has returned to personal research in aeroacoustics, studying phenomena involved in flow resonances, such as those in edge tones and the screech of supersonic jets.

Powell earned a PhD in engineering from the University of Southampton in England in 1953. From 1956 to 1964 he was a member of the engineering faculty at the University of California, Los Angeles. In 1964 he joined the David Taylor Model Basin, which became the David Taylor Naval Ship Research and Development Center in 1966. In 1986 he became a professor of mechanical engineering at the University of Houston.

Rossing was cited for his "major influence on research and teaching in musical acoustics and contributions to the understanding of percussion instruments." He and his students have studied modes of vibration and sound generation in a wide variety of bells, gongs, drums and bar percussion instruments, using techniques such as holographic interferometry and experimental modal testing. Rossing has written several books on acoustics, including *The Physics of Musical Instruments* (Springer-Verlag, New York, 1991), which he coauthored with Neville Fletcher.

Rossing received a PhD in physics from Iowa State University in 1954. After three years as a researcher in the Univac division of Sperry Rand, he joined the physics faculty of St. Olaf College. Since 1971 he has been a professor of physics at Northern Illinois University.

OBITUARIES

Gerard Kitchen O'Neill

Gerard O'Neill died on 27 April 1992, after losing a seven-year battle with leukemia. Like Richard Feynman in similar circumstances, he worked and pursued new adventures until a few days before his death. He accomplished more in the years after he became sick than most of us accomplish in a lifetime.

He had three careers. As an experimental physicist, he invented and developed the technology of storage rings that is now the basis of all high-energy particle accelerators. As a teacher and writer, he explored the possibilities of human settlement and industrial development on the Moon and in orbiting space colonies. As an entrepreneur, he founded several companies to develop new commercial technologies, ranging from a cheap satellite navigation system (Geostar) and a secure short-range office communication system (Lawn) to a high-speed train system.

O'Neill began his scientific education as a radar technician in the US Navy. He then went to Swarthmore College as an undergraduate and to Cornell University as a graduate student in physics. After earning his PhD in 1954, he came to the Princeton University physics department as an instructor. Two years later he published a letter in *Physical Review* entitled "Storage-Ring Synchrotron: Device for High-Energy Physics Research." In two pages it laid down the path that high-energy physics has followed for the subsequent 36 years. If you read the letter now, you can see that almost everything in it is right. But it took a long time before most of us understood how right it was. O'Neill built a storage ring himself at Stanford to convince people that it was feasible. He solved the tough technical problems of injecting a beam from an accelerator into the ring and keeping the betatron oscillations of the particles in the ring small, so that a substantial fraction of the injected particles were stably captured.

By 1965, using the Stanford linear accelerator as the injector, he had storage rings running with large enough circulating currents to do the first colliding-beam physics experiment. The experiment, done in collaboration with Burton Richter and others, was a measurement of electron–electron scattering at a center-of-mass energy of 600 MeV, far higher than any fixed target experiment could achieve. The results showed that electrons behave like structureless point charges down to distances of the order of 10^{-14} centimeters. After this demonstration that storage rings actually worked, high-energy physicists all over the world hastened to build their own.

With the benefit of hindsight we can find one serious mistake in O'Neill's 1956 letter. He grossly underestimated the possible improvement of high-vacuum techniques: He claimed that a storage ring could hold a beam with a lifetime of a few seconds. If he had said hours instead of seconds, nobody would have believed him. It took 20 years before storage rings with lifetimes measured in hours became routine. By that time, having taught the world how to do high-energy physics, O'Neill had moved on to other things. His 1968 proposal to use an electron–positron storage ring accelerator as a K-particle factory, with the energy tuned to sit exactly on the narrow phi resonance at 1020 MeV, has begun only recently to receive serious attention.

In 1965 O'Neill became a full professor at Princeton, where he remained until his retirement in 1985. He enjoyed teaching and devoted much of his time and energy to doing the job well. In 1969 he was responsible for teaching Physics 103–104, the basic introductory physics courses. He decided to reform the courses radically, replacing the traditional problem exercises with "learning guides," which led the students step-by-step to a deeper understanding of what they were doing. The reform was an immediate success, and the learning guide system is still used in Princeton courses today. When O'Neill was concocting problems to put into his first learning guides, the students had recently been watching the Apollo missions on television, and so he emphasized applications of elementary physics to people and things in orbit and on the Moon. These orbital problems were popular with the students. At the end of the term,

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O'Neill asked the class to write a term paper about a human habitat in space, calculating the requirements of mass and energy and propulsion for a viable settlement. The students responded enthusiastically to this too.

After reading the term papers, O'Neill was infected with their enthusiasm and wrote a paper of his own, "The Colonization of Space," which was published in 1974 in PHYSICS TODAY. Thereafter space colonies remained one of his main interests. In 1978 he and his wife, Tasha, founded the Space Studies Institute, a privately funded organization that supports technical research on the science and engineering of space activities. The institute successfully built a working model of a mass driver, a device invented by O'Neill for cheap and efficient movement of materials from the Moon or an asteroid into orbit.

It was characteristic of O'Neill to combine far-reaching visions with practical work in the machine shop. All his inventions, whether in high-energy physics, space technology or high-speed trains, were worked out in real hardware models with meticulous attention to detail. When, as usually happened, experts in the fields that O'Neill invaded raised objections to his ideas, he had always thought of the objections first and found ways to answer them. Some of his commercial ventures failed for financial and political reasons. Not one of his inventions failed for technical reasons.

O'Neill founded the Space Studies Institute with the intention of introducing a new style into the world of space technology. His purpose was to organize small groups of people to develop the tools of space exploration independently of governments and to prove that private groups could get things done enormously cheaper and quicker than government bureaucracies. And to bring his vision of the free expansion of mankind into space to a wider public, O'Neill wrote books. His first book, *The High Frontier* (William Morrow, 1977) has been translated into many languages. It established O'Neill as spokesman for the people in many countries who believe that the settlement of space can bring tremendous benefits to humanity and that this is too important a business to be left in the hands of national governments. In 1985 the US government recognized his status as an advocate of the private sector by inviting him to serve on the National Commission on Space.

O'Neill's third career, as an entrepreneur, began with the Geostar project in 1983 and was in full swing up to the day of his death. His final venture, the high-speed train system, which he called VSE (for velocity, silence, efficiency), was started during his last six months. The basic idea of VSE is to build a train network like a telephone network, with all trips nonstop, the stations widely distributed, and the switching system transparent to the users. Unlike other high-speed train systems, VSE is designed to outperform commercial airlines—in velocity by a factor of 5, in silence by a factor of 100, in efficiency by a factor of 10. Like other O'Neill inventions, it will have to wait a long time before the world discovers how sensible it is.

I was privileged to be a close friend of two great men, Richard Feynman and Gerard O'Neill. I was often struck by the deep similarity of their characters, in spite of many superficial differences. Both were indefatigable workers, taking infinite trouble to get the details right. Both were effective and enthusiastic teachers. Both were accomplished showmen, good at handling a crowd. Both had good rapport with ordinary people and abhorred pedants and snobs. Both were uncompromisingly honest. Both were outsiders in their own profession, unwilling to swim with the stream. Both stood up against the established wisdom and were proved right. Both fought a fatal illness for the last seven years of their lives. Both had spirits that grew stronger as their physical strength decayed.

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Walter M. Elsasser

Walter M. Elsasser, one of the most versatile and gifted scientists of this