MEMORIAL RESOLUTION
H. TAYLOR HOWARD

(1932-2002)

H. Taylor Howard, Emeritus Professor (Research) in the Electrical Engineering Department of the School of Engineering, died on 13 November 2002 in the crash of his Beechcraft Bonanza minutes after taking off from the Calavaras County airport near his ranch in San Andreas, California. He was 70. His stepson Bryan Files, 37, perished with him. Howard is survived by his wife, Ann, four children, and a brother.

Though officially retired, Howard was continuing a distinguished Stanford career in radio engineering and space sciences that spanned 50 years, and a separate pursuit involving communications, invention, entrepreneurship, and advocacy that resulted in his wide recognition as the "father" of the satellite-to-home television industry.

Howard is remembered fondly as "Tay," or Taylor, by the many friends and colleagues with whom he interacted during these several careers. Highlights of his professional recognitions include election to the National Academy of Engineering, selection as a Fellow of the Institute of Electrical and Electronic Engineers, leadership of the Radio Science Experiment on NASA's Galileo Spacecraft that orbited the planet Jupiter, recipient of a NASA Medal for Exceptional Scientific Achievement, co-founder of Chaparral Communications, and Founding Chairman, Chairman Emeritus, and recipient of the Arthur C. Clarke Award of the Satellite Broadcasting and Communications Association. This last association honored Tay by the creation of the T. Howard Foundation, whose mission is to increase the number of women and people of color in the satellite telecommunications field. He was also a key contributor to the establishment of a fellowship at Stanford for students interested in radio science. Tay was an author on more than 40 scientific journal publications and held ten patents for inventions related to his research and business endeavors.

Notwithstanding his many accomplishments, Tay was an anomaly amongst the Stanford engineering faculty in that he held no graduate degrees and was not involved in regular classroom teaching. As Professor for Research, course lecturing was not a requirement. His ways of contributing to graduate school programs and education in Electrical Engineering were in one-on-one interaction with graduate students and research assistants, teaching by example and in research seminars, leading research projects, and obtaining government research funding.

The 50-year association of Professor Howard with Stanford started when he found a natural niche in the university's rapidly expanding presence in all aspects of the electronic revolution. While still an undergraduate in the Department of Electrical Engineering, he joined a small group of faculty and student researchers in the department's Radio Propagation Laboratory, now called the STAR (Space, Telecommunications, and Radio Science) Laboratory. This was one of several research groups set up when F. E. Terman returned to Stanford as Dean of Engineering, after leading the national WW II wartime effort in radar countermeasures at Harvard's Radio Research Laboratory. Terman and several other Stanford returnees had been introduced to radio at a young age by having been licensed amateur radio operators. Tay shared this background in so-called "ham"

radio. While many hams pursued amateur radio as an end in itself, Tay was among those who used it as an opening to the future commercial and research world of electronics.

One example of Tay's earliest research contributions was his role in the 1954 experiment that first demonstrated the level of privacy inherent in "meteor-burst" communications. This technique involves radio wave reflections from the transient trails of ionization formed by meteors in the upper atmosphere. Tay and two other students were tasked with building equipment and planning and conducting a weeklong campaign of radio transmissions to Stanford from seven sites in Utah. Each night of tests involved simultaneous transmissions from two locations at a time and at three sequential radio frequencies, with a total of 42 independent radio links involved during the week. The measured signal correlations revealed the key features of the susceptibility of this method of communications to eavesdropping and jamming, and how to minimize this vulnerability.

Tay was a regular user of the Big Dish (46 meters in diameter) on the hills behind Stanford, which was completed in early 1963. It was built for both separate and joint research programs of SRI International of Menlo Park and Stanford University. Tay installed a very powerful transmitter in a nearby structure and arranged to use it simultaneously with an SRI transmitter at the base of the dish. This dual-frequency radio facility was then employed for radar studies of the moon and for transmission experiments to Pioneer and Mariner spacecraft, aimed at determining the ionized wind flowing from the sun. Radio receiving instruments on several interplanetary Pioneer spacecraft and on the Mariner spacecraft sent to the planet Venus were also a joint Stanford-SRI responsibility, where Howard was one of the principal participants. The 1967 results of the Venus investigation were part of the radio evidence that indicated that the Soviet Venera spacecraft, which reached Venus at nearly the same time, did not measure the pressure and temperature of the Venus atmosphere at the surface as first claimed, but rather failed at an altitude of about 25 kilometers.

The moon was an object of special interest to Tay. One of his research investigations at Stanford used radar reflections from the moon to measure the density of the interplanetary medium or solar "wind" at a time when its value was uncertain by at least a factor of a hundred. He built his own radio facility at his home laboratory in San Andreas and communicated worldwide with other radio amateurs having similar equipment, by means of reflections from the moon. Moon reflections obtained with several facilities were investigated by Tay and Stanford colleagues to characterize certain properties of the lunar surface, as an input to the planning of the manned landings on the moon with the Apollo spacecraft. Before precursor unmanned spacecraft had been sent to the moon, there was concern voiced by some that the craft with the astronauts might sink out of sight into the lunar dust; the experiments at the Big Dish resolved these concerns well ahead of the first manned lunar landing.

A property of radio waves called polarization is a common thread of connection between several scientific and entrepreneurial aspects of Tay's career. He used the way that nature changes the polarization of radio waves as they propagate between Earth and moon to separate the effects of plasma in the Earth's ionosphere from the plasma of the solar wind, in order to gain a better understanding of both. Additional polarization effects occur during reflection from a surface. Deciphering the polarization properties of radar reflections from the surfaces of the moon and planets was needed to maximize what could be learned from his studies in radar astronomy.

A simple manifestation of polarization can be visualized from the early TV antennas for home reception where, for example, the aluminum "sticks" were horizontal on American rooftops and vertical in England. This lack of conformity occurred by the chance selection of differently polarized transmitting antennas in the two countries and not by any significant advantage of one over the other. It means, however, that a receiving system designed for one country would not work in the other. A related mismatch occurred with American and Russian satellite systems for space transmissions of TV programming to central distribution stations on the ground. Tay took it as a challenge to demonstrate that the American satellite transmissions could be received directly at his home without need for a ground distribution station, and he did just that in his long-term quest to revolutionize the industry for tens of millions of households. But Tay was also interested in the Russian programming. He could of course build a second system or, more simply, mechanically change the small antenna "feed" at the focus of his dish when he wanted to switch between the two satellites. He had a better idea. He invented a feed system where the same mechanical structure could be used for either the American or Russian standard of polarization, with the switch between the two being accomplished electronically. He subsequently co-founded Chaparral Communications for improving and manufacturing this invention. Chaparral became a 50 million dollar enterprise within six years.

Tay impressed us all by his talents and ability to take charge and make things work. While impatient with incompetence, he was unstinting as a mentor of graduate students and in assisting researchers conducting experiments other than his own. He clearly enjoyed a challenging task and spent many hours at the radio antennas and associated laboratories located in the Stanford hills, and in a laboratory and workshop he created at his San Andreas home. He was master of the tools of his trade ranging from giant antennas and powerful transmitters to delicate electronics for complex scientific instruments destined to travel to distant parts of the solar system on planetary spacecraft. And he was sometimes seen on his bulldozer, building and repairing roads on his ranch. It was a privilege to have been his colleague.

Committee:
Von R. Eshleman
G. Leonard Tyler