

AL HIBBS
1924 – 2003

Albert R. Hibbs, BS '45, PhD '55, known worldwide as "the voice of JPL," died on February 24 at age 78 of complications following heart surgery. Born October 19, 1924 in Akron, Ohio, Hibbs decided as a five-year-old that he wanted to go to the moon. He *did* qualify as an astronaut, in 1967, even though he was seven years over the age limit. He was slated to fulfill his dream on Apollo 25, but the program ended at 17. At Caltech, he studied physics under the Navy's V-12 program. "I wanted to conquer space, and my roommate, Roy Walford, decided that he would conquer death. Together we would then conquer time," he later wrote. (Walford, now professor emeritus of pathology at UCLA's medical school, is an internationally known gerontologist.) In the late 1940s, he and Walford took time off from graduate school at the University of Chicago to "break the bank" in Reno and Las Vegas by exploiting the mechanical quirks of certain roulette wheels, earning them a story in *Life* magazine; their winnings financed a 40-foot sailboat and a year and a half roaming the Caribbean.

Hibbs joined the Jet Propulsion Laboratory, then run by Caltech for the Army, in February 1950. (The Lab was developing guided-missile technology but

the word "rocket" smacked too much of Buck Rogers, so Caltech had coined the euphemism to avoid scaring off potential donors.) As head of the Research and Analysis Section, he was the systems designer for America's first successful satellite, Explorer 1.

When JPL became part of the patrimony of the newborn NASA later that year, he helped draw up JPL's master plan to explore the solar system with unmanned spacecraft. His gift for explaining difficult science in lay terms led to him becoming the radio and television chronicler of the Ranger and Surveyor missions to the moon in the 1960s; the Mariners to Venus, Mars, and Mercury in the '60s and '70s; the Vikings to Mars in the '70s; and the Voyagers to the outer solar system in the '70s and '80s. He also hosted or narrated various programs for NBC and PBS, winning a Peabody in 1963 for the four-year NBC children's series, *Exploring*.

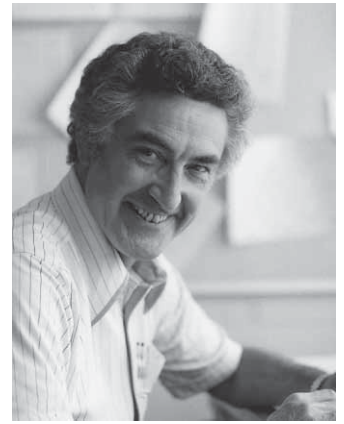
After helping to set up JPL's Space Science Division from 1960 to 1962 and serving as its first chief, Hibbs went on loan as a staff scientist for the U.S. Arms Control and Disarmament Agency, studying how arms-control treaties could be monitored from space. Five years later, he returned to JPL, where he spent the rest of his career working in a

variety of technology programs, earning NASA's Exceptional Service Award and the NASA Achievement Award in the process. He retired in 1986, three years before Voyager 2 reached Neptune.

Hibbs maintained close ties with Caltech, where over the years he taught courses in government, national security, transportation issues, and physics. He took time off from JPL to earn his PhD, supported by his wife, the late Florence Pavin. His advisor was Richard Feynman, another noted raconteur, lockpicker, and thespian, and the two became close friends. They cowrote *Quantum Mechanics and Path Integrals*, a standard text on the subject, and Hibbs wrote the foreword for *Surely You're Joking, Mr. Feynman*.

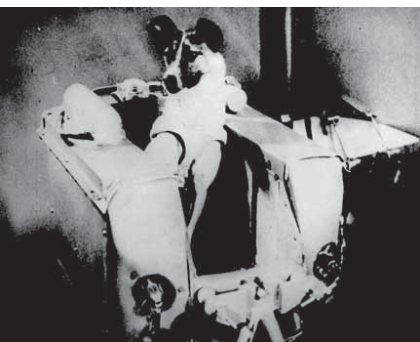
Hibbs's own unpublished reminiscences, taped by Nicolas Booth, are the source for the account of Explorer 1's launch that follows.

Hibbs is survived by his second wife, Marka; children Victoria and Bart (BS '77); stepchildren Larry Wilson and Alicia Cortrite; sister Agnes Jones; and three grandchildren. Donations may be made to the Caltech Y, Mail Code 158-86, Pasadena, CA 91125. □—DS



A backstage photo of Hibbs as a fishmonger and fellow JPLer Bruce McLaughlin (BS '77) as Motel the tailor in Caltech's February 1980 production of *Fiddler on the Roof*.

ON THE EDGE OF SPACE BY AL HIBBS



Sputnik I, launched by the Soviet Union on October 4, 1957, inaugurated the Space Age and scared the bejeezus out of America.

The basketball-sized, 183-pound object passing over our heads once every 96 minutes was a reminder that nuclear bombs could ride on rockets as well. This fear turned to outright terror on November 3, when the half-ton Sputnik II was launched, carrying a dog named Laika, above. Unfortunately, the first Earthling in space had a one-way ticket and died when her oxygen supply ran out a week later.

It was the last Friday of January 1958, and I stood in the gathering gloom of a Florida night outside a small Quonset hut on a windswept sandspit that nobody had ever heard of called Cape Canaveral. America was trailing badly in the Space Race—then just a few months old, during which time the Soviet Union had launched two Sputniks, and our first attempt, Vanguard, had blown up on the launchpad live on television. That had been a Navy project. At the Jet Propulsion Laboratory, we were a contractor to the Army and we didn't want to suffer an equally ignominious episode. I was just 33 years of age.

After Vanguard's failure, a number of politicians complained that we had got the wrong Germans. (After World War II, we had scooped up quite a number of engineers who had worked at Peenemünde on the V-2, the world's first ballistic missile.) In fact, we had got the cream of the crop, led by the redoubtable Wernher von Braun. They were now at the Army's Redstone Arsenal in Huntsville, Alabama. There were so many Germans there that some of the Army people used to refer to it as Hunsville.

Although the Navy had been given the plum job of launching America's first satellite with Project Vanguard's approval back in 1955, the Army had never given up. We called our project the "Reentry Test Vehicle" or RTV, which we claimed was going to test the nose cone for the Army's Jupiter intermediate-range ballistic missile. We'd go well above the atmosphere—

we had enough power to do that—then point straight down and aim at the earth. This would mimic the Jupiter's reentry conditions. We tested it three times, and I recall someone suggesting that we deliberately have a failure—that is, the object we were firing into space would fail to reenter and just stay up there. It was a nice idea!

The Navy knew perfectly well what we were up to, even though the general public didn't. When a local newspaper in Huntsville picked up those innocuous initials and suggested that they stood for "Rocket To Venus," there was an almighty row. It started off a congressional investigation and ended up with us having to hide what would become the first experiment in space in a cupboard at JPL. Eventually, President Eisenhower came to our rescue, appearing on television to announce that he was asking the Army to attempt the launch of a satellite as part of U.S. participation in the International Geophysical Year.

While all this was going on, the head of the Naval Research Laboratory, Admiral Bennett, got up in the midst of a meeting of the Joint Chiefs of Staff and complained that the Army should not be given the job. He felt the Army's launching system was unreliable. The Joint Chiefs were very annoyed, as this was not on the agenda, so they directed him to get together with the Army's chief scientist—a guy named Jones—to discuss the matter.

So a JPL group showed up in Mr. Jones's fancy Pentagon office—walnut table and leather-upholstered furniture. I was there because I had done all the calculations on the probabilities of success and failure. There was also Bill Pickering [BS '32, MS '33, PhD '36], the Lab's director; and Jack Froehlich

[BS '47, MS '48, PhD '50], the project manager. Our opposite numbers also showed up. There was Dr. Hagen from the Naval Research Laboratory, head of the Vanguard project; Bennett; and sitting off to one side another admiral named Clark, who was Bennett's superior in the Office of the Chief of Naval Operations.

Jones opened the meeting, Bennett made his pitch, and then Pickering asked me to give the numbers I had. Statistics is a funny business. It has its own jargon, and I'm afraid I used a bit of it, which Bennett complained about. Froehlich interrupted, giving a very patronizing little high-school lecture about mathematics to Bennett, who got more and more pissed off as it went on. Pickering sank down into his big leather chair, wishing, I guess, that he could separate himself from Froehlich.

At this point, Eberhardt Reichtin [BS '46, PhD '50] entered the room. He was in charge of the radio and tracking system and was never one to hide his light under a bushel. (He later became head of the Defense Advanced Research Projects Agency and then head of the Aerospace Corporation.) Eb listened to about 15 or 20 seconds of the conversation and broke in, saying, "Admiral Bennett, it's perfectly clear you're just trying to throw sand in the air, you're trying to delay and postpone a project which is of vital interest to the country. It seems to me, Admiral, that you are doing something that's quite un-American." Quite a thing to say in an era of McCarthyism! Pickering put his hands over his eyes and sank even deeper into his chair. Admiral Clark rose, straightened his double-breasted Navy uniform and said, "Gentlemen, I don't

think anything further can be accomplished with this conversation.” He then walked to the door and held it open for everybody else to depart, and I heard him say, sort of sotto voce as Eb walked out, “You’ll go far, young man.”

So we were given the go-ahead to launch. There was quite a discussion as to what to name the first satellite. Our feeling came from cards, which was (and probably is) one of JPL’s enduring hobbies. John Small [BS ’41, MS ’46, Eng ’47], head of our upper-stage development group, would often wisecrack, “The winners laugh and joke, while the losers yell ‘Deal!’” So we thought, having lost to the USSR the opportunity to launch first, we should call it Deal. General Madeiras, who was in charge of the program, liked Highball, and the Secretary of the Army was keen on Topkick. In the event, Eisenhower chose Explorer.

But at JPL, the preoccupation with cards stuck. Today, for example, the main tracking controller in the operations building is called “Ace” and his deputy is known as “Deuce.” And a few months before that Pentagon meeting, in the blockhouse at the Cape counting down an RTV launch, there came a period of dead silence as we waited for the telemetry group to give us the go-ahead. Then out of the back room came this raucous voice, “Down for three, you bastards!”

By late January 1958, we were ready to launch Explorer 1. The Army had a Quonset hut several miles from the launchpad, and I occupied one corner of it with my crew. Our job was to do a fast analysis of all the tracking data and predict as early as possible whether the launch had been a success. We had a tracking station at the Cape, but we also needed measurements downrange. The next

station was on the island of Antigua in the eastern Caribbean. Then British bases in Nigeria and Singapore, then Earthquake Valley outside of San Diego. There was nothing more between the West Coast and the Cape.

The Antigua tracking station was Navy-operated. We were allowed to put our receiver on it, although we had to use their antennas, and they never gave us a chance to test the setup. A short while before launch, they threw a switch to send the antenna output to our receiver. The switch was so badly corroded that it didn’t give a signal, but we didn’t know this at the time—the Jupiter had lifted off and the satellite should be visible, so why wasn’t a signal being picked up? It was one hell of a problem and a little too late to start wondering what had gone wrong.

Not only were we losing valuable data, the pressure was on. Froehlich and Madeiras were having kittens across the hall from my crew, and up at the National Academy of Sciences, a press conference was due where Pickering, von Braun, and James Van Allen (who had built the instrument aboard the satellite) were waiting to announce that Explorer 1 had reached orbit.

We could, at least, get two important numbers from the Cape. First was the rocket’s speed in the direction radially away from our receiving station, given by the Doppler shift of the radio signal. Second was the exact time at which the signal cut off as the satellite went over the horizon. We had hoped to get a similar pair of numbers from Antigua, as there was no way of getting real-time data from either Nigeria or Singapore. (Strange as it may seem to posterity, they didn’t have phone or telegraph links with us.) With either of Antigua’s

numbers, we could have done a pretty good job at calculating the orbit. With both, we would have been quite exact. Without them I had to fall back on calculating probabilities.

Given the limited data, I estimated that we had a 95 percent chance of being in orbit. A satellite in a close, circular orbit, say a couple of hundred miles up, will take about an hour and a half to go around the earth. So it would take at least that long before we could get confirmation from Earthquake Valley, where we did have phone contact. I knew perfectly well that the general wanted information before then.

Of course, there were big computers at the Cape, and they were also using radar and radio data to track us. I learned later from the range safety officer that his computers—never very reliable—had indicated that the rocket was going to come down in Tampa. Since we had all watched it lift off as a brilliant point of light in the night sky moving steadily east, he knew that wasn’t the case. He had graciously refused to blow it up, as he would have done if it really was headed toward a Florida city.

After about half an hour, I went in to see Madeiras, and I started giving him the probabilities. He said—and I quote—“Don’t give me any of this probability crap, Hibbs. Is the thing up there or not?” (Madeiras later became an Episcopalian minister. Maybe he liked their probabilities of reaching the heavens better.) Well, the most likely solution was that it was up, with a very high apogee and a satisfactory perigee, so it would probably stay up. My best guess from the little data we had on the upper atmosphere was that it would stay up for about 15 years. So I told Madeiras that we were



Explorer 1 lifted off at 10:48 p.m. on January 31, 1958, on a Jupiter-C rocket, von Braun’s modification of the Redstone ballistic missile that was itself a direct descendant of the German V-2. The Army Ballistic Missile Agency and JPL finished modifying the rocket and built and launched Explorer in just 84 days.

PICTURE CREDITS:
38, 39 – NASA



From left: Pickering, Van Allen, and von Braun hold a model of Explorer 1 and the final stage of its rocket aloft at the press conference. Explorer's payload included a cosmic-ray counter, which discovered the lower Van Allen belt—a zone of charged particles trapped by the earth's magnetic field.

**ANNE MARIE BUCK
1939 – 2003**



in orbit. Explorer 1 stayed up for a little more than 12 years, so it wasn't too bad a calculation under the circumstances.

After my report, Madeiras and Froehlich took off in an Air Force car for an auditorium at Patrick Air Force Base, where a press conference had already been called. The reporters were sitting around anxiously waiting for somebody to show up and tell them what had happened. I was in one of the last cars to go. While I was waiting, I was overcome by a strange mixture of emotions. I was staring up into the sky, quietly crying, for it was a complete letdown: several years of intense work were over, and, apparently, successfully. My feelings were simply, "We did it!"

At the auditorium, I asked a guy in my group, Chuck Lundquist, on loan from Huntsville, to get in touch with Earthquake Valley and keep the line open. (I was up on stage behind Madeiras, who was going to speak to the press.) Chuck was to come out of the phone booth and signal me as soon as he heard anything. Until then, he was to come out every five minutes and signal "not yet."

We knew it would be a while, because the high

apogee meant the orbit would be longer than 90 minutes. In fact, it was more than two hours. Everybody was getting pretty nervous, even me, although I should have known better—I was the one who had predicted when it should arrive. Madeiras, bless him, trusted me implicitly, and fended questions from the press by saying repeatedly, "Don't worry, we'll hear from it."

Meanwhile, up in Washington, Pickering, von Braun, and Van Allen were on stage and fully aware that 90 minutes had gone by with no sign of the satellite. After 90 minutes, someone walked over to Pickering and said, "Well, better luck next time, Bill, I guess you didn't quite make it, chuckle, chuckle, chuckle." But Pickering sat quietly and said, "I'll wait till my boys tell me that." Of course, I had already told him by phone that it was up, but I think he wanted to be a little more certain.

It was almost two hours after launch that Chuck gave me the sign—thumb and forefinger together in a circle—that all was well. I walked up to whisper the same in Madeiras's ear, and he announced the result to the press and the waiting world. □

Anne Marie Buck, university librarian since 1995, died of cancer April 2 at the age of 63. She presided over the Caltech library system during a revolution in information technology and scholarly communication and led it into the new age, which she embraced with enthusiasm.

A memorial service was held at the Athenaeum April 11 for colleagues, family, and friends to "share our grief, to mourn our loss, and, most of all, to celebrate Anne's life," as President David Baltimore said in his opening remarks.

Buck was born in 1939 in Birmingham, Alabama, and graduated with a BA in geology from Wellesley College in 1961. She began her library career in 1974 as director of the Dunbar Public Library in West Virginia after her two children were in school, and returned to graduate school to earn her master of library science degree from the University of Kentucky in 1977, when she was 38. For a number of years thereafter, she held several key positions at Bell Laboratories. After the breakup of AT&T, she established and directed the Bellcore Library Network and served for two years as director of Bellcore's human resource planning. She taught library management at

Anne Buck loved to travel, and photos of “Bucky’s” journeys to far-flung places were shown at the memorial service. Here she is at Olduvai Gorge in Tanzania (right) and Angkor Wat, Cambodia (left).



Rutgers University and the University of Wisconsin, and, from 1991 until coming to Caltech, she was university librarian at the New Jersey Institute of Technology. Buck served as vice president of the Engineering Information Foundation and initiated that group’s Women in Engineering Program, dedicated to increasing the number of women in that field.

At the memorial service, Baltimore praised her “organizational skills, her love for words and books,” but he also noted her feistiness, her “quirky humor,” and her “characteristic good cheer,” indelible aspects of her personality that were subsequently echoed by other speakers.

“Anne was gutsy,” said Kimberly Douglas, director of Caltech’s Sherman Fairchild Library of Engineering and Applied Science. “She spoke her mind even when perhaps it wasn’t always in her best interest. And she lived and worked with a gusto, a vitality and enthusiasm that manifested itself in all aspects of her life.”

Douglas first met Buck when the latter was interviewing for the Caltech position. The design of the new Fairchild Library was close to completion. “In the library

we sensed we were entering upon a new era, though we were not exactly sure what that would entail. We knew we needed someone different, a strong person with a fresh view, a champion for the library to follow a new path.”

For someone of a generation introduced to computers “at a mature age, Anne stood out in her insight into the utility and potential of the information revolution we were undergoing,” said Douglas, who described Buck’s instrumental role in organizing a 1997 conference on scholarly communication, which explored a greater role for electronic publishing. But “the greatest gift that Anne gave the library was, without a doubt, her enthusiastic support of the library staff and the role and service that libraries provide within a research institution,” Douglas continued. “Her unwavering and vigorous support over the last years now leaves the library staff fully confident and equipped to successfully meet the coming challenges Caltech faces. We have much to thank her for.”

Richard Flagan, the McCollum Professor of Chemical Engineering, was chair of the faculty library committee when Buck arrived at Caltech at a time

of skyrocketing journal prices. The two of them faced the task of cutting 30 to 40 percent of the journal subscriptions without alienating the faculty. Buck managed to keep the faculty involved in the process, said Flagan, and made sure that essential needs were still met.

“Anne did not limit her efforts to dealing with the immediate problems, however,” said Flagan, “but rather embraced a vision in which the developing Internet becomes a medium through which academic researchers could reclaim control of scholarly communication.” Buck, Flagan, and Provost Steve Koonin organized the 1997 conference to bring together librarians, professors, journal publishers from academic societies, and provosts (“the people who pay the bills”) to discuss how the Internet could be used “to serve the needs of the research community in communicating the results of their research.” Flagan credited Buck with designing the program and attracting participants who could offer some radical proposals for the future of the scholarly journal.

Buck and Flagan subsequently published their own proposal for publishing, indexing, and archiving

electronic journals—“Scholars Forum: A New Model for Scholarly Communication.” They posted it on the Internet. Flagan claims it’s his most cited paper.

In the future world of electronic publishing, Buck saw libraries continuing in their traditional role of archiving. But she saw more than that. Anne’s vision, said Flagan, was that libraries “can continue their role of preservation, not through simply storing the material, which has been possible with paper, but by taking a much more active role in translating it from medium to medium as technology changes require.”

“She transformed the libraries at Caltech from mere repositories for the works published elsewhere to a leader in the move toward active preservation and dissemination of the knowledge discovered and created on this campus.”

Joan Wilson, president of the Friends of the Caltech Libraries (FOCAL), described Buck as a “superdedicated professional with ideas and imagination. We are going to miss her spunky personality and thoughtful take on where the world of libraries should be in the 21st century.”

Buck’s son, Stephen, shared

a “top-10 list” of what made his mother one of a kind, including her rigorous planning, her love of traveling “by methods we normally only want to read about,” her passion for collecting obscure items and rocks, and (number one) her fastidiously indexed filing cabinet, from which she could pull information on almost any topic. “For all those who needed information before the Internet and Google, there was Anne Buck.” Besides her son, Buck is survived by a daughter, Susan Buck Rentko, and two grandchildren, Elizabeth and Christopher Rentko.

Other friends, family members, and colleagues—from her grad school days, from her job at Bell Labs, from organizations she belonged to, from her travels—offered brief remarks on their friendships with Buck and her meaning to their lives. Several commented on the grace and courage with which she faced her final illness.

“Anne was a tough cookie,” said Eric Van de Velde, director of library information technology at Caltech. “I had my share of confrontations with her and she relished it. But she never faulted me for disagreeing with her and for fighting for my point of view. Her toughness continued to her last days. There was not a hint of self-pity, and pity was the last thing she wanted from us. So therefore I don’t offer words of pity now. I only offer a heartfelt congratulations to Anne on wrapping up an impressive life.” □ —JD

GILBERT D. McCANN 1912 – 2003



Gilbert Donald McCann, professor of applied science, emeritus, died in Solvang on April 9, aged 91. He was the driving force behind computing at Caltech for 25 years (and a professor for 34), starting in 1946 with an analog computer that he invented, continuing through the time when new materials, miniaturization, and software transformed digital computing and made the analog obsolete, to the time when every department was using computers small enough for desktops.

Born in Glendale in 1912, McCann studied electrical engineering at Caltech, gaining a BS in 1934, an MS in 1935, and a PhD in 1939, before joining Westinghouse in Pittsburgh to study natural lightning phenomena. A photograph of the young McCann sitting calmly in a car being struck by a three-million-volt bolt of electricity went around the world, but he had not always been so lucky when experimenting with electricity: as a graduate student, a two-million-volt stroke from a surge generator he had built paralyzed all his outer nerves and muscles for 24 hours and left a large cataract in one eye. An unknown person had switched off the spark-gap ground, and the

lightning bolt jumped straight to his metal-rimmed glasses.

Research at Westinghouse was diverted to supporting the military during World War II, and McCann set to work to devise a way of doing complex engineering calculations using electrical circuits to simulate mechanical forces—the basis of his analog computer. The machine he invented could do calculations that would previously have taken years. It enabled him to design a rapid feedback-control system for improving the tracking accuracy of antiaircraft guns. Rushed to the gun batteries defending England’s east coast just a month before the Germans launched their massive V-1 bomber attack, the system enabled most of the V-1s to be shot down as they crossed the coastline.

Persuaded to return to Caltech after the war (not least by his wife, Betty, who missed Southern California), he started as an associate professor of electrical engineering in 1946, rising to professor a year later. He immediately set up an analysis lab to make a larger, improved version of his analog computer. Westinghouse was already at work on one when he left, and he negotiated a deal whereby they would make two of everything and ship the second set to Caltech for a very good price. Assembled in the Norman Bridge Laboratory of Physics with the aid of Charles Wilts (BS ’40) and Bart Locanthi (BS ’47), the huge calculator weighed in at 33,000 pounds. Though without a catchy name like its Westinghouse twin, the Anacom, Caltech’s direct analogy electrical analog computer was soon providing an invaluable service for JPL, the military, and the entire Southern California aerospace industry, all of whom lined up to have their



McCann sits at the console of his direct analogy electrical analog computer, a behemoth that took up all sides of this large room in 1958. The results of engineering calculations were read from the oscilloscope above the console.

engineering problems solved, particularly those related to missile guidance systems and jet airplane design. At one stage, McCann recalled, every aircraft company in America and Europe was a customer, and in 1950, *Engineering & Science* reported that the lab was “too busy to take on all the problems which have been submitted.” “It was a world-class computing instrument at the time,” said Carver Mead. “It could do things nobody else could do anywhere.” But by the early 1950s, the fact that the analysis laboratory was becoming a computer bureau to service the needs of industry got to be too much for Caltech, particularly Clark Millikan, director of the Guggenheim Aeronautical Laboratory. He suggested spinning off a commercial company, and Computer Engineering Associates was formed. McCann was the largest shareholder, but could not run the company because he would have had to resign his faculty position.

An engineer at heart, he initially saw digital computers as a sideline “for the physical chemists.” The analog computer was faster, but its accuracy was limited to 1 or 2 percent, more than enough for engineers but not good enough for mathemati-

cians, so in 1949 he recruited Stanley Frankel to head a small but highly innovative digital-computing unit, an excellent choice because, by the early 1950s, Caltech was one of the leading centers in both analog and digital computing. McCann’s graduate students were now focusing more and more on miniaturization and innovative materials for digital computers, and there was also the Computer Center on the first floor of the Spalding Laboratory of Engineering to run. When IBM donated a massive 7090 in 1961, McCann led a successful fund-raising campaign for a new building to house it and, when the Willis H. Booth Center for Computing (now Powell-Booth) was dedicated in 1963, he became director for the first seven years. In 1966, he was made professor of applied science, the position he held until his retirement in 1980, after which he was made emeritus.

In the late ’40s, a collaboration with Werner Reichardt, his German equivalent during the war and later director of the Max Planck Institute for Biological Cybernetics in Tübingen, sparked his interest in applying computers to analyzing how brains work, especially how they perceive and process vision, and he pursued this research throughout his time at Caltech. Fred Thompson (professor of applied philosophy and computer science, emeritus) remembers McCann using beeswax to mount houseflies on a stand in the center of a large, six-foot sphere with flashing images (dubbed the planetarium). Gold fibers inserted into their brains captured data from individual neurons as they responded to visual signals, which were fed into the computer. A notice outside the lab door said “Do not commit insecticide.” Over the years McCann worked

closely with Caltech biologists to study other animal brains, including those of honeybees, fruit flies, earthworms, fish, and humans.

As to what happened to the analog computer, McCann recounts in his memoirs that in the 1960s a small company in Santa Paula contacted him asking for one, long after Computer Engineering Associates had been sold off and the Caltech computer dismantled and stored in a warehouse. “I bought enough parts for their computer from Caltech for a song, and Bart Locanthi, my son Norman and I built it in Bart’s garage,” he recalled, adding that the deal made him enough money to travel to Germany to buy a much-desired 1954 Mercedes 300 convertible to add to his classic-car collection.

He received the Eta Kappa Nu Award for Outstanding Engineer in 1942 and the Glen A. Fry Lecture Award of the American Optometric Foundation in 1979, and he was a fellow of the Institute of Electrical and Electronics Engineers, as well as a Caltech Associate. A keen gardener and breeder of Arabian horses, he and Betty moved in the mid ’80s to their horse ranch near Solvang. Betty predeceased him in April 2002, but he is survived by his son, Norman; his daughter, Janice; and a brother, Louis. The family requests that donations in his memory be sent to Caltech at the California Institute of Technology, Development Office 105-40, Pasadena, CA 91125.

□ —BE