Profiles in Leadership #10

Irwin Jacobs: Engineer, Entrepreneur, and Philanthropist

Irwin M. Jacobs, Sc.D., New York Delta '56, co-founder of Qualcomm

by **Alan S. Brown**

What does it mean to be a leader? In this series "Profiles in Leadership," Tau Beta Pi is exploring that essential question through the lives of member engineers who attained leadership positions in their fields.

Don't let Irwin Jacobs' unassuming demeanor fool you. He may look and speak like the MIT professor he once was, but beneath his unassuming exterior beats the heart of a gambler.

Jacobs' company, Qualcomm, was only four years old in 1989 when it challenged the wireless industry's communications standards. His team had done trailblazing work in satellite and military communications but had no wireless experience. His proposal involved difficult technology. The industry was already committed to another standard.

Wireless providers faced problems. Mobile phone sales were booming and analog technology could not handle the traffic. Rather than build new towers, the industry wanted to digitize and compress conversations so it could fit more data into the existing spectrum.

But first they needed to agree upon a communications standard. After several fractious years of debate, they opted for TDMA. Time division multiple access earns its name by slicing each frequency channel into time slots. It allocates those slots among several phones, which send short bursts of compressed data during their slot. This boosts the amount of traffic each channel could handle, but Jacobs thought there was a more efficient way.

Jacobs knew TDMA. His previous company, Linkabit, had developed time-based modems for satellite and military communications, starting in the 1970s, and an early specialized TDMA wireless phone.

Jacobs discovered an alternative after founding Qualcomm in 1985 when Hughes Communications asked his firm to review a technical proposal for a satellite-based mobile phone system. Hughes had proposed a TDMA-like approach to share satellite bandwidth. While returning from a meeting with Hughes, Jacobs and two of his partners, Andrew J. Viterbi, Ph.D., *MA B '57*, and Klein Gilhousen realized there was another option that no one had considered.

Code Division Multiple Access

It was called CDMA for code division multiple access. Developed during World War II, it used a technique called frequency hopping to keep enemies from jamming or listening to Allied radio transmissions. By sharing a code, two radios could shift from one frequency to the next in tandem. Without knowing the code, it would be extremely difficult for someone to follow or jam the conversation. This made it secure, and with trillions of potential codes, it all but eliminated radio interference from nearby cell towers.

Qualcomm ran the numbers and found CDMA might triple satellite capacity over time division. Hughes was skeptical but payed for a prototype. It worked as predicted, but Hughes eventually dropped the project.

Jacobs wanted to move forward, but Qualcomm lacked the resources until it commercialized Omnitracks, a satellite truck monitoring system, in September 1988. With a steady source of revenue, Jacobs turned to CDMA. He was willing to bet his company that he could make the telecoms listen.

Jacobs meets with Yang Xianzu, chairman of China Unicom, the world's fourth largest telecom operator in terms of customer base. The company embraced Qualcomm's CDMA standard for its wireless network.

Jacobs was never afraid of taking the bold step. Born in New Bedford, MA, he learned early about hard work and limited resources. Yet his entrepreneurial streak showed through even as a teen when he recycled war surplus chemicals and paper to rebind books for sale.

He excelled at math and science and constructed small devices from cigar boxes and milk bottle wires. Yet when it came time for college in 1950, his guidance counselor told him there was no future in engineering. Jacobs, whose parents owned a restaurant, opted for Cornell University's school of hotel administration.

He wanted more math and science, and he felt annoyed by his roommate's ribbing about how he would never get such good grades in engineering. In his second year, he changed majors, even though he would have three semesters of engineering to make up. Even so, his hotel training gave him skills, such as accounting and business law, which he would draw upon later.

Information Hotbed

After Cornell, Jacobs entered graduate school at MIT, a hotbed of information and communications theory. "People like Claude Shannon (Claude E. Shannon, Ph.D., *MI Γ '36, dec.*) were just beginning to think about how we might get the maximum amount of information through a noisy channel by converting analog to digital," Jacobs recalled.

Jacobs received his Sc.D. in 1959 and stayed on at MIT as an assistant professor. This was when the first integrated circuits were moving into the mainstream, transforming digital theory into commercial practice.

After seven years at MIT, Jacobs' life changed again. He spent a sabbatical at the Jet Propulsion Laboratory in Pasadena, CA. There he met Viterbi, a UCLA professor with whom he would found Linkabit and Qualcomm.

He and his wife fell in love with Southern California, yet Jacobs turned down an offer to help create the engineering program at the new University of California, San Diego. "For two days, I was unhappy," Jacobs recalled. "Then I came home in a heavy rainstorm, and my wife told me about a great suburban home she had read about. Then she said, 'There's only one problem. It's in San Diego.'"

Jacobs took the plunge.

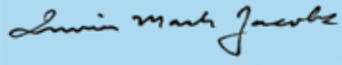
At MIT, his interactive style of communication guided graduate students. At UCSD, he became a leader. He put together a curriculum, hired faculty, attracted students, and landed research grants. "Those skills helped me when I started two companies," he said. Jacobs also began consulting. He and John Wozencraft, a pioneer in coding theory, had just published a book, *Principles of Communication Engineering*. It was the first textbook on digital communications, and it emphasized the practical aspects. This attracted many clients.

By 1968, Jacobs had formed Linkabit with Viterbi and another UCLA professor. "I had been saying that digital communications theory would be useful in real world, and here was a chance to prove it."

He was willing to consult as long as he did not have to

This Leader In Brief

Full professional name: Irwin M. Jacobs.
Most recent positions: chairman and CEO emeritus, Qualcomm Inc., 1985—retired March 2009.
Birthplace: New Bedford, MA, 1933.
Highest degree: Sc.D., Electrical Engineering and Computer Science, Massachusetts Institute of Technology (MIT), 1959.
Major career highlights: MIT, assistant and associate professor, electrical engineering, 1959-66; Co-author, *Principles of Communication Engineering* (still in use today), 1965; University of California, San Diego, professor of computer science and engineering; Linkabit Corp., founder and president, 1968-80 (acquired by M/A-COM); Qualcomm, founder, president, and chairman, 1985-2009.
Board memberships: Salk Institute for Biological Studies, chair, board of trustees; Pacific Council on International Policy; Technion (Israel Institute of Technology), international advisory board.
Honors: National Academy of Engineering, member, 1982 (chairman, 2008); Institute of American Entrepreneurs, High-Tech Entrepreneur of the Year, 1992; American Electronics Association, Inventing America's Future Award, 1993; National Medal of Technology and Innovation, 1994; IEEE Alexander Graham Bell Medal, 1995; American Academy of Arts and Sciences, fellow, 2001; Dorothy I. Height Chair's Award, Leadership Council on Civil Rights, 2004; IEEE/Royal Society of Edinburgh Wolfson James Clerk Maxwell Award, 2007; American Association for the Advancement of Science fellow, 2009; Marconi Prize, 2011; and IEEE Medal of Honor, 2013.
Greatest accomplishment: Worldwide successful deployment of CDMA and next-generation data communications.
Family: Married Joan Klein in 1954; sons Gary, Hal, Paul, and Jeff.
Leader most admired: Claude Shannon, a leader in information theory. Albert Einstein, for his thought experiments.
Hobbies: Reading, traveling, music, art, and theater.
Favorite books: Tends towards biographies and politics.
Personal motto: Lead by example, not by dictation. Integrity is the highest aspect of leadership.
If you could do one thing over: Things worked out successfully for me.



Above: Jacobs as a one-year old in New Bedford, MA, a fishing and textile center near Cape Cod. **Center:** Jacobs as a student at Cornell. **Bottom:** Jacobs married the former Joan Klein in 1954. They have four sons, Gary, Hal, Jeff, and Paul, who succeeded his father as Qualcomm CEO and chairman.

manage. Linkabit's success at landing NASA and defense contracts changed his mind. He took a sabbatical to organize the business and never looked back.

Like many entrepreneurs, Jacobs filled every job, including sales. He learned the intricacies of promoting new technology early on when Linkabit proposed a better satellite decoder to a government agency.

"We did a great job on the technical description, but our contact used some curse words to describe the parts of our proposal that dealt with reliability, manufacture, support, and training," Jacobs said.

"I spent the next two weeks reading military specifications and engaging people who could help us deal with them. When we came back, we could answer all his questions. It just goes to show that if you take each issue seriously and think it through, you can do a good job selling."

The project called for Linkabit to manufacture its first product, a greater risk than Jacobs realized. Linkabit had never manufactured any hardware before. The company built a printed circuit prototyping line, which caught fire. Fortunately, an engineer in the building called the fire department before the flames reached the decoder chips.

Linkabit went on to develop or implement many new technologies. It built modems for satellite-based Internet and jet aircraft. It commercialized VideoCypher, which descrambled satellite TV signals. It was a leader in very small aperture earth terminal (VSAT) business satellites, and it created one of the earliest commercial uses of a reduced instruction set computing (RISC) processor.

As the company grew, Jacobs went after top engineering talent. He knew that if he hired the right people, they would attract even more talent. This must have worked because Linkabit alumni directly or indirectly went on to start 75 other companies.

In some ways, he ran the business like a university, bringing in outside speakers and encouraging open discussions of new technologies and business areas. Wages were fair, but Jacobs told employees the real payoff would come from stock options.

That led to the 1980 merger with communications devices and components maker M/A-COM. It was a good fit at first, but then headed south. After five years, Jacobs, Viterbi, and several Linkabit alumni left to found Qualcomm.

Jacobs' bet on CDMA was a near thing. He brought his CDMA and TDMA projections to a local telecom, Pactel. Pactel got Jacobs on the agenda of the June 1989 meeting of the Cellular Industry Association.

"Companies were already moving ahead on TDMA," Jacobs said. "We did a slide show, and we thought for sure that someone would interrupt and say, 'Here's a point you missed.' No one found anyone wrong, but they didn't believe us either. CDMA is much more complicated than TDMA, and many people thought it would never work. We needed to build a demonstration system."

That September, Linkabit sent out invitations to see a live demo. "It was not working yet, and the engineers didn't think it would be done in time," Jacobs said. Days and nights of hard work prevailed. The system was

warming up at the live event when a receiver failed.

"I was about to tell our visitors to go out to the lab when one of the engineers told me to keep talking while they traced the problem," he said. "I had been a professor, so talking another 50 minutes was no problem."

The demonstration convinced operators that CDMA had great potential, but they needed to see more before they made it a standard. That would require a huge investment to build chips, phones, and base stations.

To raise funds, Jacobs licensed CDMA to users for an up-front fee and a royalty if the system reached commercialization. It was one of the first deals of its type. His first customer was AT&T Labs, which also provided some development funding. The Qualcomm founders also added funds they received from the sale of Linkabit.

By 1991, CDMA was ready to face off with TDMA. The Communications Industry Association, which set standards, convened a meeting to compare the two technologies. It approved CDMA as a second digital standard.

In October 1995, Qualcomm rolled out commercial CDMA systems. In just seven years, Qualcomm had gone from industry outsider to a pace-setting telecommunications company that was making its own chips and phones.

It was also developing advanced systems that make today's data-driven smartphones possible. When Jacobs retired in 2009, Qualcomm had revenues of $10 billion.

Qualcomm had made Jacobs rich. *Forbes* puts his fortune at $1.2 billion. In 2010, he signed The Giving Pledge, a promise by 40 American billionaires to give away more than half their fortune to philanthropic causes.

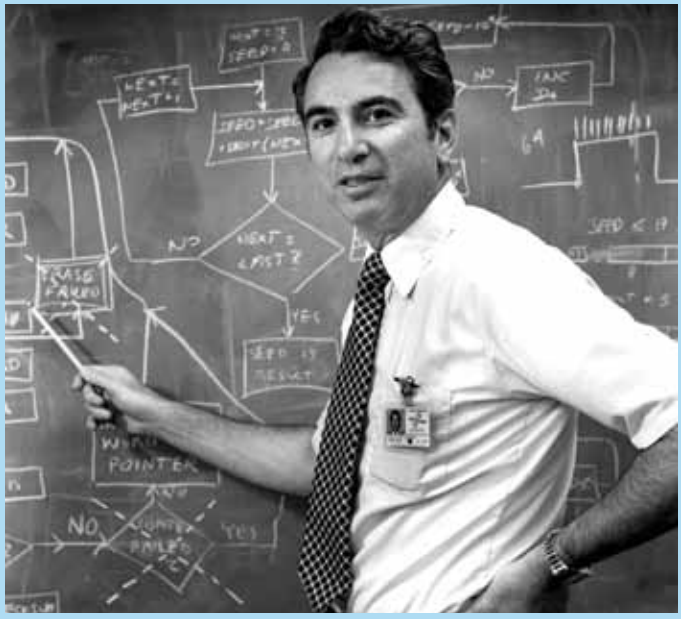
Jacobs is well on his way to doing that. He has pledged $120 million to both UCSD's Jacobs School of Engineering and the San Diego Symphony. He will spend tens of millions of dollars more on schools (UCSD, Cornell, MIT, and Technion) and San Diego's central library, public radio station, and natural history museum.

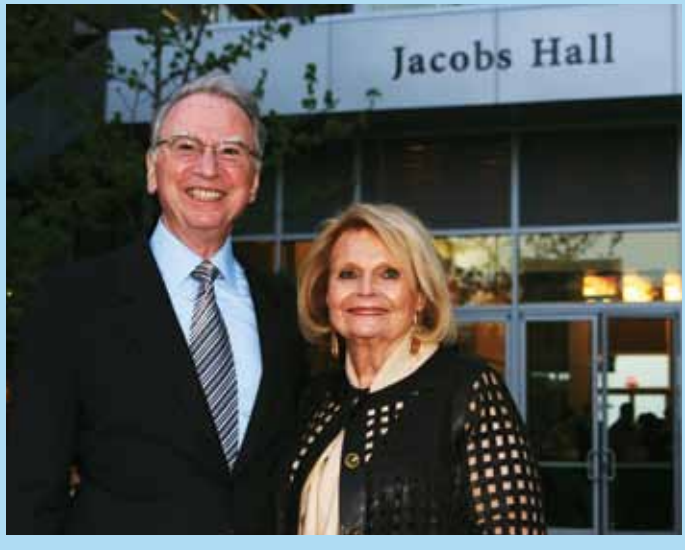
Jacobs also chaired the Salk Institute for Biological Studies' board of trustees through 2016, raising $330 million in new funding.

It was a fitting coda to Jacob's career. Jacobs never shied away from risks, yet they were always calculated risks. He chose California over MIT, but both were great options. He left academia only because Linkabit was growing so rapidly. He bet on CDMA because he fully understood the technology's advantages.

"That's why a high-tech company wants a CEO who is an engineer," Jacobs said. "They need someone who wants to do new things, and who is able to ascertain the risks and costs." Jacobs is proud of where those risks led: "I can go anywhere in the world and see the impact mobile phones have on health, education, and economic progress. It's good to see an idea used so well."

Alan S. Brown has been an editor and freelance writer for more than 30 years and lives in Dayton, NJ *(insight01@verizon.net)*. A member of the National Association of Science Writers and former co-chair of the Science Writers in New York, he graduated magna cum laude from New College at Hofstra University in 1974. He is an associate editor of *Mechanical Engineering* and contributes to a wide range of engineering and scientific publications.





Above: Jacobs working through an early project at Linkabit, his first startup. **Center:** Jacobs at Qualcomm Stadium in 2010. His company bought the naming rights in 1997. **Below:** In 2010, the Jacobs School of Engineering at UCSD rededicated its building to Jacobs and his wife Joan. He has pledged $120 million to the school.