Jack S. Kilby
Nobel Prize Winner

by Martha S. Polston, *Tennessee Alpha '79*

IT HAS BEEN SAID that much of our success in life can be attributed to the three types of friends that we have along the way. First are the friends that we see everyday who support us in the daily ups and downs of life. Then, there are the friends that we have had in the past, like an elementary-school teacher or a high-school coach, who made a difference in our lives for a period of time but whom we no longer see. Finally, there are those friends whom we have never seen, but, because of their contributions, we are able today to stand taller and reach farther than we could have done on our own. We often refer to this as "standing on the shoulders of giants." It is a rare opportunity when one is able to come unexpectedly face-to-face with such a giant—especially one who can be called our "friend" through association as a fellow engineer. Such is the unique opportunity that was afforded to Tau Beta Pi recently when Jack S. Kilby, *Illinois Alpha '47*, was named as co-recipient of the 2000 Nobel prize for physics.

JACK SEES THE ROLE OF GENERALIST AS FADING TODAY IN ENGINEERING FIELDS AS COMPARED TO THE '50S.

Jack Kilby is an electrical engineer who received his bachelor's degree from the University of Illinois in 1947. Working first at CentraLab in Milwaukee, WI, and then at Texas Instruments in Dallas, he is known to us as the inventor of the integrated circuit. The integrated circuit is the basis of almost every electronic product used today, has literally transformed the world in which we live, and has enabled the entire electronics industry to grow far beyond what anyone could have imagined 50 years ago. After the presentation last December of the Nobel prize to Mr. Kilby in Stockholm, Sweden, Tau Beta Pi called to congratulate him and to ask a few questions regarding his perspective and advice for young engineers today. His insight regarding the invention of the integrated circuit and the role of engineers today provides an inside glimpse of the man "upon whose shoulders we stand."

His interest in engineering was sparked by amateur radio communications. When he was in high school, his dad was running a small power company whose service area was scattered across the western part of Kansas. A major ice storm took out most of the telephone lines and many of the power lines. His dad began working with amateur radio operators to provide some form of communication, and that intrigued a young Jack. This was the beginning of his electronic interest. He entered college to major in engineering at the end of World War II. The year that he graduated was the year that electrical engineering was just beginning to transition from power courses to solid-state physics and electronics as fields of study. Former radar officers, who had served in the military in WWII, were primarily teaching the electronics courses. Since the radar officers were new to the field of teaching, Jack observed that they did not always have the needed teaching skills. Although not necessarily familiar with the newly emerging electronics field, the older EE professors proved to be more valuable instructors to Jack. They taught him the fundamentals of electrical engineering, which became the building blocks for his own exploration of the new fields of technology evolving after the war.

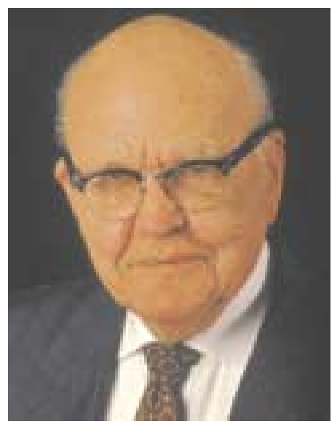
PHOTO COURTESY OF TEXAS INSTRUMENTS

After he graduated, Jack went to work for CentraLab. The firm had purchased one of the first transistor licenses from Bell Labs and was working to develop semiconductors using this technology. Jack points out that Bell Labs was a "very enlightened company" for its time. Contrary to our modern climate, where technology is zealously protected as "proprietary," Bell Labs recognized that this new transistor technology could spread faster and become a bigger commercial market if its use was not restricted just to Bell's natural telecommunications market. As a result, it risked a portion of its "market share" by providing low-cost licenses early in the developmental phase in order to spur market growth. Obviously, this strategy worked in a big way. Today's competitive marketplace and the increasing specialization of companies to meet market niches do not provide as many opportunities for a broad spectrum of research and development as existed at Bell Labs in those days. We asked Jack where this critical role that was played by Bell Labs in the 1950s is being fulfilled today. He emphasized that industry consortia and, particularly, the R&D being performed at universities are greatly needed to fill this void for pure, boundary-pushing R&D.

PHOTO COURTESY OF TEXAS INSTRUMENTS

FIRST INTEGRATED CIRCUIT
Jack Kilby invented the integrated circuit at Texas Instruments in 1958. Comprised of only a transistor and other components on a slice of germanium, Kilby's invention, 7/16-by-1/16-inches in size, revolutionized the electronics industry.

Another major difference between the engineering field today and when Jack was working in the 1950s is the role of the generalists. In the '50s, there were no trained semiconductor engineers. People with a wide variety of backgrounds, including physics, chemistry, and engineering, were drawn into the field. As he points out, there was great diversity in the team working with him in the '50s and early '60s. He believes that there is less opportunity for a generalist today than there was then. Although this appears to be necessary as markets are forced to focus and information grows at such a rapid pace, it probably does inhibit some types of innovations and invention in his opinion.

While employed at CentraLab, Jack attended the University of Wisconsin at night and earned a master's degree in electrical engineering. He never pursued a doctoral degree, although he has since been awarded five honorary doctorates based on his lifetime accomplishments! When asked about why he did not pursue a Ph.D., he indicated that he found working and going to evening school for a master's is a "very hard thing to do." Although he values education, his own career and work experiences began to move forward rapidly, and he never felt the need for the additional degrees. In 1958, he changed companies and began what would be a life-long association with Texas Instruments in Dallas.

At CentraLab, he had been working on packaged circuits and realized that there was a market for that sort of product. When he saw the capabilities of TI, his eyes opened to the possibility of doing more on a single semiconductor wafer. In the early '50s, people were beginning to visualize applications for electronic equipment, but they were much more complex than anything that had heretofore been realized. If those creations had been built using then-existing technology, the equipment would have been too heavy, too big, too expensive, and consume too much power to be useful. Jack refers to this as the "tyranny of numbers." The number of parts that were required was just prohibitive. The first integrated circuits were designed to address this need. The first circuits were "very crude," according to Jack. They would have perhaps a few gates or might be connected into a flip-flop and maybe use a half-dozen transistors. The developmental work on the IC was taking place under the threat of the cold war and the atmosphere surrounding the Cuban Missile Crisis. A major driving factor was the military, which had a broad interest in application, urgency in its needs, and a willingness to pay a premium for an answer to those pressing needs. This early emphasis provided much of the necessary focus for the IC development and led to the first major military application on the Minuteman missile system.

Building on their creations, both TI and Jack saw the emerging fields of radio, television, and computers as logical markets to pursue. We asked Jack about the role of an engineer in marketing an invention, and he clearly believes that good ideas have to be sold and that this responsibility often lies with the inventor. During his career, the economies of the invention were extremely important, and throughout his career Jack has remained focused on the needs of customers, including his own job positions as manager of customer-technology centers and customer-requirements departments. Surprisingly, Jack attributes much of the success of the IC to the story of its cost reduction, which has been much greater than anyone could have anticipated. In 1958, a single silicon transistor that was not very good sold for about $10. Today, $10 will buy more than 20 million transistors, an equal number of passive components, and all of the interconnections to make them into a useful memory chip. The cost decrease has been by a factor of millions to one! He clearly indicated that no one could have ever anticipated that level of cost reduction. Consequently, the IC is more than 40 years old—longer than the vacuum tube lasted and an incredibly long time in the history of electronics. Since the invention of the chip, microelectronics has become the basis of all modern technology. Processors are now used to control everything from vehicles to sophisticated machinery and diagnostic equipment. The end is not yet in sight as our world continues to use more devices with increasing complexity, improved reliability, and more cost-effective electronics.

We asked Jack about his opinion of today's engineering students based upon his own experience as a distinguished professor of electrical engineering at Texas A&M University and his extensive exposure to companies and universities around the country. He remains "amazed at the qualifications" of engineering students today, indicating that they leave school with "infinitely more knowledge" than he had when he began his career. He believes that our students today can do "anything they want to do." Something every student should take note of is his answer to the question of what was most satisfying to him in a career that has spanned 50 years, included more that 50 patents, a National Medal of Science, and induction into the National Inventors Hall of Fame. His answer: "seeing basic ideas grow and develop." He is grateful and rewarded by the fact that he found in Texas Instruments a company that was interested in ideas and gave a young engineer the responsibility to pursue those ideas. That match of employee and employer spawned entire generations of electronic devices and control systems.

Jack Kilby is clearly a "giant of a man." He said that he sees science as the field that increases man's knowledge and engineering as the field that applies that knowledge. It is because of his personal application of knowledge that many generations are able to stand upon his shoulders and reach higher than they ever before thought possible. There are few people who can say that they have uniquely touched almost everyone alive today but, through his invention of the integrated circuit, Jack Kilby can say so with a humble truthfulness.

Jack is also a Tau Bate and thus is part of a family that has long enjoyed association with the best and brightest of our engineering profession. Our members include 70 Rhodes scholars, 12 current and past members of Congress, one past national president, numerous all-American athletes and college presidents, 70 National Medal of Science winners, seven United States postage stamp honorees, hundreds of corporate CEOs like Willard Dow of Dow Chemical, David Packard of Hewlett Packard, and Stephen D. Bechtel Jr. of Bechtel Corporation, 45 astronauts, and 15—no, make that 16—Nobel prize winners. Congratulations, Jack Kilby, from your friends—both seen and unseen—at Tau Beta Pi!

Martha S. Polston, P.E., Tennessee Alpha '79 is an engineering specialist with BWXT Y-12 in Oak Ridge, TN. A registered professional engineer, she earned a bachelor's degree in electrical engineering at the University of Tennessee in 1979, received a chancellor's citation for her contributions to the university, and was presented the distinguished new engineer award from SWE in 1985.

During 1986-90, she served as President of Tau Beta Pi, and she also was an Executive Councillor during 1990-94. In 1987, she was chair of the WATTec technical conference. She has served as the Convention delegate of the Great Smoky Mountains Alumnus Chapter and was an Engineering Futures Facilitator.