



## AMOS E. JOEL, JR.

1918–2008

Elected in 1981

*“For inventions and contributions to switching system developments for the nationwide public telecommunications network.”*

BY W. O. FLECKENSTEIN

SUBMITTED BY THE NAE HOME SECRETARY

AMOS E. JOEL, JR., a world authority in the field of switching, died October 25, 2008. He was 90 years old. Amos was born in Philadelphia on March 12, 1918. He was fascinated with electronics in his childhood and graduated from DeWitt Clinton High School in the Bronx. He earned his bachelor’s (1940) and master’s (1942) degrees in electrical engineering from the Massachusetts Institute of Technology (MIT). After graduation he was hired by Bell Laboratories, where he worked for 43 years. During World War II, he designed circuits for general-purpose digital computers and was instrumental in the development of coding and decoding machines for military and diplomatic uses.

Amos Joel was totally engaged in switching technology for his entire adult life. In his career at Bell Laboratories he was involved in many projects, was a prolific inventor, wrote a great deal about switching technology, and participated in many education and training programs. One could make a very long list of his contributions. For this tribute I have decided to focus on three contributions that I believe are major:

First, the Automatic Message Accounting (AMA) system, which was a necessary ingredient in the move from operator-handled toll calls to Direct Distance Dialing (DDD) by the customer.

Second, the system design of the first Electronic Switching System (ESS).

Third, the design of the Traffic Service Position System (TSPS) to provide much more efficiency for operator handling of special calls.

### **Automatic Message Accounting**

The evolution of the telecommunications network in the United States is a rich technical story. It has been a continuous process from the very beginning. One of the biggest steps in that evolution was the move from operator handling of toll calls to direct distance dialing by the customer. The planning for that move, carried out by Bell Laboratories, was one of the finest pieces of systems engineering I have ever seen. The main ingredients of the plan were as follows: a standard 10-digit numbering plan for North America that gave a unique destination code for every telephone line on the network, a network hierarchy and routing plan so the common control switching systems of that time could route calls through the network efficiently, and an automatic system for billing the customer.

The billing system involved a system in the local central office to record the details of all long-distance calls for that office. The storage medium at the time was embossed paper tape. The tapes were shipped to a central AMA center, where the call records were automatically assembled and calculations were made for billing the customer. I was a relatively new employee at Bell Labs when this work was done and was not directly aware of individual contributions. However, I have been told that Amos Joel was a major contributor to the design of the AMA system.

### **Electronic Switching**

With the invention of the transistor in 1948 and the rapid advances in semiconductor electronics, it quickly became clear that the speed of these technologies would be a major advantage in common control switching systems. At that time Amos worked in a small systems engineering group and did

the first system design of a local electronic switching system. In 1976, I nominated A. E. Joel, R. W. Ketchledge, and W. Keister for the IEEE Bell Medal, which they won—Joel for the early system design, Ketchledge for the hardware implementation, and Keister for stored program control.

### **Traffic Service Position System**

Even though customer dialing of long-distance calls reduced substantially the need for operators in the Bell System, many operators were still needed to handle special types of calls, such as collect calls, person-to-person calls, and charge-to-third-number calls. Amos Joel was a major contributor in the development of the Traffic Service Position System, which was a console for the operator with as much automation as possible to provide as much efficiency as possible in handling these special calls.

In the 1970s when I was made vice president of switching systems in Bell Labs, one of the major goals that I set for my organization was to reduce the operator force in the Bell System by 50 percent. The TSPS system was one of the major tools that allowed us to meet that goal.

The three major contributions discussed above and a myriad of other contributions mark the stellar technical career of Amos Joel. In 1981 he received the Franklin Institute's Stuart Ballentine Medal and was elected a member of the National Academy of Engineering. He received the Kyoto Prize in Advanced Technology in 1989.

He is survived by his daughters, Stephanie Joel of New York City and Andrea Joel of Burbank, California. His wife, Rhoda Fenton, died in 2000, and his son, Jeffrey, died in 2003.

### **Additional contributions from Andrea and Stephanie Joel:**

"Yes, my career has been one-of-a-kind, and interaction with many friends at Bell Laboratories, in the Bell System, and from around the world, who made it possible."—Amos E. Joel, Jr., April 18, 1983 (upon his retirement)

From a very young age, we knew that we had an extraordinary father.

For “Show & Tell” in grade school, we brought a copy of our father’s patent for the “Automatic Message Accounting System,” which, at the time, as profiled on the front page of the “Business Section” of *The New York Times*, was the largest patent granted by the United States Patent Office (USPO). So we knew that our father was some sort of a creative/scientific genius—if not a bona fide, local celebrity.

However, in our home, he was a dad who worked hard, had a fabulous and mischievous sense of humor, loved Italian food and chocolate, was fascinated by trains—especially the GG1, and appreciated all kinds of music, which he played nightly on his Yamaha or Hammond organ. Family time was spent mostly at dinners, holidays, and summer family vacations, many of which took place on Cape Cod. Although his work was very intense, he was always a very gentle, quiet man with a twinkle in his eye. His great joy was in making us laugh.

His love of inventing and patents became stuff of legends in our house. We always loved to hear the story of how he met our mother on a blind date. He invited her up to his room at MIT to see his patents—which, in fact, he really did! Although Mom thought he was crazy, they were married for a fantastic 58 years!

Dad’s “love affair” with inventing did come at an early age. At 14 he developed a personal telephone system for himself and his friends. To us these were his “juvenile delinquency years,” whereby he connected all of his friends on West 86th Street in New York City, using phone lines in abandoned apartments that were vacated because of the Depression. We were always amused at this story and how a telephone repairman discovered the rigging and threatened to send him to “juvey hall” if he didn’t disconnect it pronto. How easily his brilliance could have been channeled for “evil” rather than for the greater good of humanity!

NOTE: This system was the forerunner of his future “Joel All-Relay Dial System,” which was the basis of his graduation thesis from MIT.

Throughout his formative years, Dad’s fascination with inventing and technology grew increasingly stronger.

There was no question that he wanted to work for only one company—Bell Telephone Laboratories (Bell Labs), the scientific/research/development arm of AT&T. Although that almost didn't happen, Bell Labs hired him in 1941, after he graduated from MIT.

When the United States entered World War II, Bell Labs was instrumental in the development of electronics and communications technologies. Our father's contributions to these efforts were immeasurable. He was part of the team that developed and created designs for early digital computers and cryptanalysis machines, code named "Project X." British computer pioneer Alan Turing used some of Dad's ideas in the development of the "Colossus" machine, which helped crack the German "Enigma" code.

Dad's group also designed a scrambler code named "Sigsaly." This allowed for private encrypted communication between Winston Churchill and Franklin D. Roosevelt. For this extraordinary accomplishment, along with his colleagues, Dad's name appears on the wall of Buckinghamshire, the wartime code-breaking center at the Bletchley Park Museum. Dad was always proud of his wartime achievements and the impact that they had on the outcome of the war. Fast forward to 1994. His daughter, Andrea, already an Emmy Award-winning set decorator for CBS, was able to put the art director of the television miniseries, "World War II: When Lions Roared," in touch with Dad. CBS needed help in re-creating the room from which Churchill conversed with FDR—a room, of course, with which Dad was very familiar—and had actual pictures of the room that he could now share.

It was interesting attending the theater with Dad in 1987 to see "Breaking the Code," a play about Alan Turing and the breaking of the "Enigma" code. It was the first time we met any of Dad's colleagues who worked with him during the war. Clearly, the audience was filled with as many wartime "celebrities" as there were on stage!

In 1946, after World War II, Bell Labs realized the importance for engineers to learn about electronic switching. Dad was instrumental in providing an electronic switching curriculum

to the newly formed “school,” which enabled him to go from one facility to another to train Bell’s engineering staff. So Dad became a “traveling professor,” a responsibility that he embraced until he retired in 1983.

Our brother Jeffrey, who was a mathematician, had a greater understanding regarding what our father did for a living, but nowhere was his celebrity more apparent than during the 1964 World’s Fair. Dad was instrumental in the development of the AT&T Pavilion, which at the time was showcasing the “Picture Phone.” Although our father would have been content to wait in a lengthy line for all of us to view the exhibit, on which he had labored day and night, our mother soon showed him the error of his thinking.

Throughout the development of this pavilion, family dinners were constantly interrupted by calls from Robert Moses, requiring Dad to drop what he was doing and travel to the site in Flushing Meadows, Queens. From Mom’s perspective, at the very least, we should be given preferential treatment rather than wait in line. Sheepishly, Dad went to the head of the line and spoke with the manager, gaining our immediate entrance. We were treated to a private tour of the exhibit with Dad’s running commentary. Within no time he had amassed a large audience, which crowded around him to hear what he had to say.

Over the years Dad received many awards and acknowledgments for his significant contributions:

1976: He was awarded IEEE’s Alexander Graham Bell Award. He accepted this award with William Keister and Ray Ketchledge, “for conception and development of Electronic Switching Systems and their effective introduction into a nation-wide telephone system.”

1981: He was awarded the Franklin Institute’s Stuart Ballantine Medal for “his achievement in bringing into being the electronic switching system (ESS) and for his contributions towards the many functions it makes possible for modern telecommunications.”

1987: He was instrumental in the development of the IEEE (Institute for Electrical and Electronics Engineers)

Communications Society, which honored him in 1987 as the “Father of the ISS International Switching Conference.” From that time on, he was known to his colleagues as “Mr. Switching.”

NOTE: The forerunner of the IEEE was the AIEE (American Institute of Electrical Engineers). Encouraged by Bell Labs, Dad helped promote the need for and oversaw the development of a “Switching Committee.” This committee eventually became the International Switching Symposia (ISS).

1989: He was awarded the Kyoto Prize in “recognition of eminent achievements in the field of telecommunications.”

1992: He was awarded IEEE’s highest honor, its Medal of Honor. This marked the first time that our entire family attended an awards ceremony—including his father. How proud was he!

1993: He was honored by the United States with the National Medal of Technology for “his vision, inventiveness and perseverance in introducing technological advances in telecommunications, particularly switching, that have had a major impact on the evolution of the telecommunications industry in the U.S. and worldwide.”

2008: Perhaps the most treasured recognition was bestowed upon him within his last year. At the age of 90 he was inducted into the National Inventors Hall of Fame for “his U.S. Patent #3,663,762 on the Mobile Communication System.” “This basic patent on cellular switching pioneered the most rapidly growing segment of the telecommunications industry. His invention allows for the convenient use of cell phones.” His patent also became a focal point in a lawsuit between AT&T and Motorola as to which company was entitled to bragging rights to the development of the cell phone. Because of Dad’s initial patent, awarded in 1972, that right was granted to AT&T.

In 2008 we (Andrea and Stephanie) were able to bring Dad to Akron, Ohio, to accept this honor in person, accompanied by Dad’s godson, David Quinto. This memorable trip was made all the more remarkable by David’s story that Dad had related to David’s father, Dad’s oldest and dearest friend. In 1972, Bell

Labs was apparently quite shortsighted on the marketability of Dad's invention. Bell Labs viewed it as important, but a patent of little or no consequence—seeing an application for maybe about 100,000 users worldwide—slightly less than the 4.6 billion current users worldwide!

On regarding this invention of cell phone technology, Dad was most gratified that his invention enabled 9-11 victims to speak with their loved ones until they ultimately perished. Ironically, Dad did not have a “modern cell phone” for his own personal use. Although he kept up with and was continually fascinated by the current design/technological trends, he was content to carry his original cell phone prototype, which was something analogous to a brick. He kept the phone in his car so that he could order pizza on the way home from the office.

Before he passed away in 2008, and in conjunction with his induction into the National Inventors Hall of Fame, a front-page article ran in *The Newark Star Ledger* about his achievements. Dad always loved kids and for many years served as a judge for the New Jersey Science Fair Competition. He also used to go to schools and discuss technology with kids in the local grade schools, but after the article appeared, Dad actually achieved “rock star” status.

Having heard about the article on our father, and being offered the opportunity to be addressed by anyone of importance, local campers resoundingly wanted to meet the inventor of the cell phone. With eager anticipation, they waited for his arrival, and as he was walking down the hallway to the classroom, the whispers grew louder as they announced that he had arrived.

2009: His final recognition, to date, was awarded to him posthumously. He was given the Marconi Society's Lifetime Achievement Award.

Dad was passionate about documenting and sharing his love of and the importance of electronic switching from which other engineers could learn. He published numerous articles on the subject, and in conjunction with the 100th anniversary of the invention of the telephone, AT&T commissioned a series of books on the history of Bell Labs. Dad edited the volume on switching.

Other publications of note are:

*Electronic Switching: Central Office Systems of the World* (IEEE Press, 1976)

*Electronic Switching: Digital Central Office Systems of the World* (IEEE Press, 1982)

*100 Years of Telephone Switching (1878–1978): Part 1: Manual and Electromechanical Switching* (Elsevier, 1982);  
*Part 2: Electronics, Computers and Telephone Switching* (Elsevier, 1990) (Both edited with Robert J. Chapuis)

*A History of Engineering and Science in the Bell System: The Early Years, 1878–1925* (Bell Labs, 1982)

*A History of Engineering and Science in the Bell System: Switching Technology, 1925–1975* (Bell Labs, 1982)

*Asynchronous Transfer Mode* (IEEE Press, 1993)

“He was the ultimate Switchman,  
living to four-score and ten.  
His patents all were legendary;  
He improved the lives of men.”

—Stephanie Joel (October 24, 2008)