BBN's Earliest Days: Founding a Culture of Engineering Creativity

Leo L. Beranek

In establishing BBN, the founders deliberately created an environment in which engineering creativity could flourish. The author describes steps taken to assure such an environment and a number of events that moved the company into the fledgling field of computing.

During World War II, I served as director of Harvard University's Electro-Acoustic Laboratory, which collaborated with the nearby Psycho-Acoustic Laboratory (PAL).[1] The daily close cooperation between a group of physicists and a group of psychologists was, arguably, unique in history. One outstanding young scientist at PAL made a particular impression on me: J.C.R. Licklider, who demonstrated an unusual proficiency in both physics and psychology. Another individual, a psychologist, who distinguished himself at PAL was Karl D. Kryter. I made a point of keeping their talents close by in the ensuing decades, as they would ultimately prove vital to the growth of Bolt Beranek and Newman Inc. (BBN) in the upcoming man–machine symbiosis age.

In 1945, at the close of World War II, Richard Henry Bolt became an associate professor of acoustics in the Physics Department at the Massachusetts Institute of Technology (MIT). With Bolt as its director, a new acoustics laboratory was immediately formed, which had faculty supervisors from the fields of physics, electrical engineering, architecture, and mechanical and aeronautical engineering.

Two professors at MIT were then world leaders in acoustics, Philip Morse and Richard D. Fay. They, along with Bolt and MIT President Karl Compton, enticed me away from Harvard in 1947 with the title of associate professor in communication engineering (tenured) and technical director of the Acoustics Laboratory. The laboratory was financed primarily by funds from the US Navy's Bureau of Ships, although there soon was additional financing from the Office of Naval Research. I began teaching a course in September 1947 called, appropriately, Acoustics. My office was across the corridor from Bolt's, and our contracts with MIT allowed each of us one workday a week, plus weekends and summer, to do personal consulting.

BBN's beginnings

Requests regularly came into the office of MIT's president asking for acoustical help. Those requests were routinely routed to Bolt. One arrived in 1946 from the New York architectural firm, Harrison and Abramowitz, requesting a quotation for services as potential consultant to the United Nations permanent headquarters to be built in New York City. Dick bid and won the commission. In October 1948, a set of drawings for the project arrived, which, when unrolled on his office floor, was 8 inches thick and 10 feet long. Dick realized that the project was more than a one-man job, and he called me in to share his awe. Dick immediately proposed that we form a partnership—we had papers drawn up some days later—and Bolt and Beranek came into existence (see Figure 1).

Bolt had received his PhD in acoustics from the University of California at Berkeley in June 1939. He was a dynamic man with a ready smile and brilliant mind. He had the ability to quickly absorb new fields and become adept at understanding and working in them. At MIT he was a popular lecturer and attracted many promising students into the field of acoustics. He was a judicious, thoughtful administrator and was liked by all who came into contact with him. His relation to me was always excellent, with hardly ever any misunderstanding.

The firm, Bolt and Beranek, had the blessing of MIT's new president, James Killian. He offered to help us get started and rented us two rooms in the MIT Acoustics Laboratory for our use, but warned us that we would have to seek space outside of MIT if our needs expanded. Our first employees, each part time, were three brilliant MIT students working for their graduate degrees: Robert Newman, Jordan Baruch, and Samuel Labate. Other consulting requests came to MIT, and we soon had to buy acousti-

 Published by the IEEE Computer Society

cal measuring equipment, which took up all the space in the two rooms.

A little over a year later, Bob Newman completed his architectural degree. In relatively short order, we employed him and in 1950 changed the partnership's name to Bolt Beranek and Newman (BBN). Newman had received his master's degree in physics at the University of Texas and, during World War II, had worked for two years at Harvard's Electro-Acoustic Laboratory and for the remaining part of the war at a naval research laboratory in Pennsylvania. At the end of the war, he enrolled in a graduate school program in architecture at MIT. Bob had a good eye for architectural design. He quickly learned the basics of architectural acoustics from Bolt and soon was in charge of BBN's architectural acoustics division. As a lecturer to architects on acoustics, he was a master. Every architect who attended his lectures at MIT—as well as at Harvard and a dozen other top universities—vividly remember both him and what he taught.

The United Nations project was demanding. The architect, Wallace Harrison, produced a design for the General Assembly building that was a large truncated cone. The UN delegates sat at tables on the floor of the cone facing the cone's north wall. A large two-level seating space for an audience was attached to the cone, projecting externally, on the south side. Bolt and Newman took responsibility for the acoustical treatment and encountered no unusual problems. The sound system design was left to me, and it proved to be almost unsolvable. The architect insisted that the loudspeakers be embedded in the cone's north wall, about 15 feet behind the main podium, a sure situation for howling feedback. By carefully choosing loudspeakers and microphones with good phase characteristics, limiting the frequency range to 300 to 6,000 Hz, and eliminating any acoustical resonances in the space around the embedded loudspeakers, I completed a system that worked without any feedback, and the speakers' voices were perfectly intelligible. The prestigious success of the UN headquarters building made our name known to architects everywhere, and our business boomed.

In 1949, I convinced MIT's Department of Electrical Engineering to appoint Licklider as a tenured associate professor and to work with me in the Acoustics Laboratory on voice communication problems. A new office was built for him on the floor above mine. Shortly after his arrival, he being the only psychologist on the MIT faculty, the department chair asked Licklider to serve on a committee that established the Lincoln Laboratory, an MIT research powerhouse supported by the Department of Defense. The opportunity introduced Licklider to the nascent world of digital computing, although he had no occasion to work with, or to learn programming on, their two new experimental machines, the TX-0 and the TX-2. Licklider devoted a fair amount of his time to Lincoln Lab projects, one example being his help in the lab's discovering that airplane identification by radar signals could be improved through measuring the reflected signal's modulation by the (audio) frequency of the rotating propellers. In addition, in the Department of Economics and Social Sciences of the School of Humanities, Licklider hired a number of promising young psychologists, the first of which was George Miller in 1951, in an effort to form a psychology department at MIT.

Figure 1. Partners Dick Bolt and Leo Beranek, summer 1949. (Photo from author's personal collection.)

Steady growth and expansion

BBN's business grew steadily and more staff was rapidly added. In October 1949, we vacated the MIT space and moved to the second floor of a (now nonexistent) building at 57 Brattle Street. In 1951, we moved into two apartments and the basement of a six-apartment building at 16 Eliot Street in Cambridge (see Figure 2, next page). We also opened an office in Los Angeles. In the next few years, we took over additional apartments and by 1955 we occupied the entire building. In 1956, we boasted 50 full-time employees plus several part-time employees or consultants.

We moved into an existing building at 50 Moulton Street in Cambridge in 1957 and added a two-story building adjacent to it in

Figure 2. The home of BBN in 1953: 16 Eliot Street, Cambridge, Massachusetts. (Photo from author's personal collection.)

Figure 3. Sam Labate and Bob Newman breaking ground in 1959 for an addition to BBN's 50 Moulton Street building in Cambridge, Massachusetts. (Photo courtesy of BBN Technologies.)

Figure 4. Entrance to BBN's 50 Moulton Street building, Cambridge, Massachusetts, in 2005. (Photo courtesy of Jennie Connolly.)

1959. Figure 3 shows Labate and Newman at the 1959 groundbreaking for our Moulton Street addition; Figure 4 is a recent photo of that facility's entrance.

In December 1953, BBN incorporated, the primary reason being to isolate the partners from liabilities that came from an important area of business: the control of jet aircraft noise. Just as we had begun operations, we had been contacted by the National Advisory Committee on Aeronautics and by companies engaged in the manufacture of jet engines. These organizations had asked us to design structures for testing engines that would minimize noise. With BBN's incorporation, Bolt was named chairman of the board, I was president and CEO, Labate was executive vice president, Newman was vice president, and Baruch, treasurer.

Samuel Labate had come to MIT after World War II to study in the mathematics department. He took my acoustics course and became acquainted with Dick, me, and the staff at the Acoustics Laboratory. Sam's master's thesis was on measurement of acoustic materials using an impedance tube. He proved to be a clear thinker and was well liked by his fellow students and supervisors. Because of Sam's "can do" attitude, he was a valuable and adaptable acoustical consultant who could be depended on to carry a job through to completion.

Jordan Baruch was the most brilliant of my students. He had come to MIT to be an electrical engineer and was a straight-A student. He had taken my acoustics course in 1948, the second year that I taught it. Jordan was one of 160 in the class. He was quick to understand what I was teaching and asked so many questions that, after a week or so, I suggested that he yield more time to others.

Jordan's doctoral committee included representatives from the departments of electrical engineering, physics, and mechanical engineering. Jordan has what I would call a photographic memory. For example, at BBN he read a five-volume set of military procurement books in just a few days, yet ably referred to almost any part of the text when discussing the contents with government contracting personnel. In addition, he was and is well informed about a wide variety of subjects, such as health, gardens, automobiles, and computers.

Finances

The five partners owned all the stock in equal amounts and constituted the entire board. This created a concern on our part that the high-level people we were employing would become restless if all the financial profits from their work accrued to only five people. Thus we devised several somewhat novel means to alleviate this worry and reward employees.

First, we instituted the *K*-factor plan to inflate the salaries of key personnel. The K-factor was formulated by determining the ratio R of the company's total gross income to its total salaries and inserting it in a formula for $K = 0.66 + 0.33R$. The basic salary of each participant was multiplied by the K factor. The value of K was limited to the range 0.75 to 1.5. For many years the K factor varied only from 1.1 to 1.2.

The second means of reward was to establish a stock purchase plan. The purchase price was set at the beginning of a year by the book value of the company, and the participant had to pay for the stock within 12 months. This led to a handsome gain when the company went public in 1961 (see Figure 5).

The third means was to establish a promotion structure for technical personnel that paralleled the conventional corporate ladder—for example, a typical corporate progression was unit head, division head, vice president, president, and CEO. In our parallel technical ladder, the first step was the title consultant, engineer, or scientist (C, E, or S). The next step was senior C, E, or S. Third was principal C, E, or S. In 1969, we established the title of chief C, E, or S. Salaries at the various levels were commensurate with the salaries of the administrative heads. Above all, I insisted that the motto of the company be, "Each new person hired should raise the average level of competence of the firm." This became an operating creed that kept us from hiring anyone whom we believed was not as smart as ourselves.

The company grew without the help of outside financing, except for maintaining a line of credit at the First National Bank of Boston. By 1961, with borrowings of $325,000, it was apparent that the company needed cash for expansion, and it went public, raising nearly $1 million. Baruch as treasurer and I as CEO planned the offering, working with our auditors and lawyers. An interesting point was our selection of the underwriter for the offering. We interviewed several investment firms: Paine Webber thought our offering price should be $4.50 per share; Smith Barney thought $8.50; but we chose Hemphill Noyes & Co., which took us public at $12 per share. The price on opening day rose to $18. It remained above the level of $12 well beyond the next year.

Figure 5. BBN IPO day: Leo Beranek, Jordan Baruch, Dick Bolt, Samuel Labate, and Robert Newman, summer 1961. (Photo from author's personal collection.)

New directions: Licklider and computers

As president, more and more of my time was taken up by BBN activities. Consequently, I reduced my teaching load at MIT to 75 percent in 1951 and to 50 percent in 1953. I resigned from my tenured professorship in 1958, thereafter teaching two-week summer courses on noise control for several years. Bolt remained a full-time professor, devoting only his one day a week to BBN.

The company's extensive work in developing acoustical criteria for acceptable noise levels outdoors, and in building spaces, resulted in a decision to develop a stronger and broader activity in psychoacoustics—the science of sound as it affects humans. From our initial interest in how people respond to aircraft noise, we were led to other aspects of psychoacoustics, notably human speech and hearing. Our company obtained government contracts to support research on speech compression, criteria for predicting speech intelligibility in noise, and last, but certainly not least, the reaction of communities around airports to propeller-aircraft noise.

Around 1955, I began seriously to consider the long-range directions of the company. My

Figure 6. Louise and J.C.R. Licklider, December 1954. (Photo from author's personal collection.)

thoughts were guided by my experience in World War II with the psychoacoustic personnel at the Electro-Acoustic and Psycho-Acoustic Laboratories at Harvard and, later in the war, by my experience as head of the Systems Research Laboratory in Jamestown, Rhode Island. The mission of that facility was to speed up the handling of information on US warships so that they could more effectively combat the mounting danger of Japanese kamikaze aircraft.

I visualized a potential growth region for BBN in man–machine systems, machines that efficiently amplify human labor. Two examples were in my mind: optimization of aircraft blind-landing and the performance of racing boats (for example, in the America's Cup race). I reviewed my knowledge of people working in areas at BBN that were related to this, and Licklider loomed as the outstanding candidate. He not only was a first-rate psychologist with physics training, but at MIT he had acquired considerable knowledge about the uses of computers, through his exposure to the Semi-Automatic Ground Environment (SAGE) air defense system and from Lincoln's computer gurus Wesley Clark, Jay Forrester, Kenneth Olsen, and Ben Gurley.

A look at my appointment book from those days shows that I courted Licklider with numerous lunches in spring 1956 and one critical meeting in Los Angeles that summer. Because joining BBN meant that Licklider would have to give up a tenured faculty position at a major institution, we persuaded him by offering a rather large stock option at about $1.50 a share and the title of vice president in charge of man–machine and information systems. Licklider came aboard in the spring of 1957.[2-4] Lick, as he insisted that we call him, was outgoing and always on the verge of a smile (see Figure 6); he ended almost every second sentence with a slight chuckle, as though he had just made a humorous statement. He walked with a gentle step, often with a Coca-Cola in hand, and he always found the time to listen to new ideas. Relaxed and self-deprecating, Lick merged easily with the talent already at BBN. He and I worked together especially well: I cannot remember a time when we disagreed.

Licklider had been on staff only few months when he told me, in fall 1957, that he wanted BBN to buy a digital computer for his group. When I pointed out that we already had a punched-card computer in the financial department and several analog computers in the experimental psychology group, he replied that they did not interest him. He wanted a then state-of-the-art digital machine produced by the Royal-McBee Co., a subsidiary of Royal Typewriter.

"What will it cost?" I asked.

"Around $30,000," he replied, rather blandly, and noted that this price tag was a discount he had already negotiated.

I exclaimed, "BBN has never spent anything approaching that amount on a single research apparatus. What are you going to do with it?"

"I don't know," Lick responded, "but if BBN is going to be an important company in the future, it must be in computers."

Although I hesitated at first—$30,000 for a computer with no apparent use seemed just too reckless—but I had a great deal of faith in Lick's convictions and finally agreed that BBN should risk the funds. I presented his request to Labate and Baruch, and with their approval, Lick brought BBN into the digital era. Lick sat at that computer many hours each day, literally hoarding the machine, learning how to do digital programming.

Licklider hired Karl Kryter (see Figure 7) in October 1957, and he became actively involved in speech bandwidth compression and effects of noise on sleep. Soon after, Thomas Marill—interested in auditory signal detection and artificial intelligence—and Jerome Elkind, interested in the man–machine area, joined BBN in 1958.

Men and machines

Our 1958 client brochure stated that BBN's Engineering Psychology Department had two divisions: one for communication studies that served to identify man's capabilities in the establishment and control of information flow, whether between humans or between men and machines, and another for man–machine studies that served to establish the engineering criteria for the optimum design of a man–machine system, whether a factory, vehicle, or computer.

Within a year of the computer's arrival, in fall 1958, Ken Olsen, president of the fledgling Digital Equipment Corporation, stopped by BBN, ostensibly just to see our new computer. After chatting with us and satisfying himself that Lick really understood digital computation, he asked if we would consider a project. He explained that DEC had just completed construction of a prototype of its first computer, the PDP-1, and that they needed a test site for a month. We agreed to be a test site, at our regular hourly rates.

The prototype PDP-1 was a monster compared to the Royal-McBee; it would fit no place in our offices except the visitors' lobby, where we surrounded it with Japanese screens. Lick and Ed Fredkin—a youthful and eccentric genius who came to BBN because of the Royal-McBee in 1958—and several others put it through its paces for most of the month, after which Lick provided Olsen with a list of suggested improvements, especially how to make it more user friendly.

The computer won us all over, so BBN arranged for DEC to provide us, in 1960, with its first production PDP-1 on a standard lease basis. Then Lick and I took off for Washington, D.C., to seek research contracts that would make use of this machine, which carried a price tag of $150,000. Our visits to the Department of Education, National Institutes of Health, National Science Foundation, NASA, and the Department of Defense proved Lick's convictions correct, and we soon secured several important contracts.

In 1961, Lick hired William Neff as head of a biomedical unit, assisted by Philip Nieder and Norman Strominger. Their first government contract was for research on basic brain function and behavior, in particular, neuromechanisms of hearing. At the same time, he hired Vincent Sharkey to work on human factors. Sharkey's contract support was mostly highly classified.

By winter 1961, our client brochure divided BBN's systems activities into five parts:

- man–computer symbiosis (time sharing, light-pen control by touching the monitor, and real-time control of research studies);
- artificial intelligence;
- man–machine systems (information displays, audible signals to supplement visual radar information, and pattern recognition);
- psychoacoustics and psychophysics (intelligibility and naturalness of speech in communication systems, speech compression, deafening effects of impulse noise, brain wave responses of man to sound, and noise during wakefulness and various stages of sleep); and
- biomedical research (colorimeter of digital type, and instrumentation for recording and displaying the physiological variables and visual signals needed by surgeons during open-heart and brain surgery).

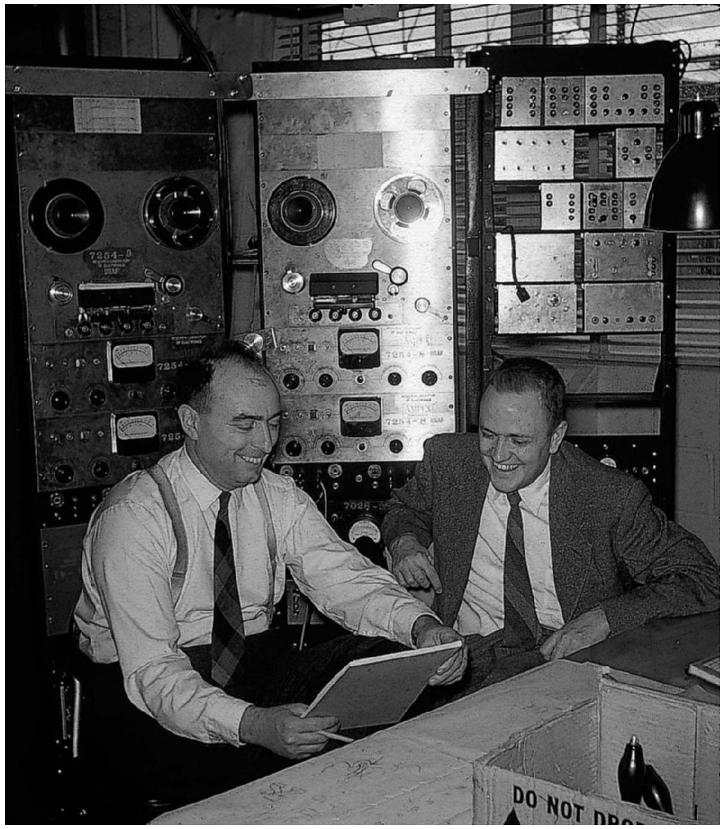

Figure 7. Karl Kryter and guest in laboratory at BBN's 50 Moulton Street, Cambridge, Massachusetts, building, 1958. (Photo from author's personal collection.)

Also, we listed engineering psychology under the direction of John Senders, who joined BBN in 1962. He became involved in experiments on the effects of distractions on performance suffered by airplane pilots and automobile drivers.

Once we had the PDP-1, in 1960 Lick brought two MIT consultants on computers into BBN's life, John McCarthy and Marvin Minsky. McCarthy had conceived of time-sharing computers and had pled with MIT computer people to implement the concept, which they were slow to do. At BBN, he found a response in Lick and, in particular, in Ed Fredkin. Fredkin insisted that "time sharing could be done on a small computer, namely, a PDP-1."

"I kept arguing with him," McCarthy recalled in 1989. "I said that an interrupt system was needed." And Fredkin said, "'We can do that.'" McCarthy continued, "Also needed is some kind of swapper." The answer: "'We can do that.'"[5] An interrupt enables an external event to interrupt computations that are in progress, and a swapper has to do with swapping among computational streams.

The team, largely led by Shelden Boilen, created a modified PDP-1 computer divided into four parts, each assigned to a separate user. In fall 1962, BBN conducted a public demonstration of time-sharing, with one operator in Washington, D.C., and two in Cambridge. To augment the PDP-1's small memory, BBN acquired the first FastRand rotating drum, made by Univac, with a 45-Mbyte storage capacity and an access time of about 0.1 second. BBN installed a time-shared information system in winter 1962 in the Massachusetts General Hospital that allowed several nurses and doctors to create and access patient records at a number of nurses' stations, all connected to our central computer.

New directions in psychology

In 1961 and 1962, Licklider was heavily involved in the "libraries of the future" project. (Full details of this project are presented by John Swets elsewhere in this issue.[6]) In summer 1962, Lick was lured by Jack Ruina, director of the Advanced Research Projects Agency (ARPA), to go to Washington in October to head up its Information Processing Techniques Office. Swets joined BBN in 1962 to take over the library project, and Senders also joined the effort. Licklider wrote the final report from Washington, in the form of a book, *Libraries of the Future*,[7] with chapter assistance by Daniel (Danny) Bobrow, M.C. Grignetti, John Swets, Tom Marill, and John Senders. This report was distributed to libraries widely and has been influential in pioneering the use of computers in libraries.

In the early 1960s, new activities in engineering psychology were pursued. For example, BBN was awarded a NASA/US Air Force contract to determine the capacity of pilots to perform and adapt under flight conditions that change quickly and in complicated ways; to recommend display requirements for information essential in the Apollo Manned Space Vehicle System; and to teaching via computers. In the artificial intelligence area, BBN's ongoing work involved recognition of patterns, memory organization, and machine language. Additionally, Swets carried out studies on the Socratic teaching method, and Baruch continued work on the Massachusetts General Hospital time-shared system.

In 1966, BBN had two software projects that vitally needed outside help: the hospital project and a computer system planned for the company-wide use of a large firm in the Boston area. Bolt and Bobrow convinced Frank Heart that he should come aboard to head up the information sciences and computer systems division of BBN. Ray Nickerson also joined that year, working with Jerry Elkind.

Arpanet

Then came ARPA's request for proposals to build the Arpanet in August 1968. Heart was selected to manage the response and he put together the Interface Message Processor (IMP) group. The proposal was submitted in September 1968. ARPA responded with a $1 million contract, and the first IMP was completed and shipped to the University of California, Los Angeles, in September 1969. Others followed monthly. The second IMP was shipped to the Stanford Research Institute, and on 3 October, the first message on the two Arpanet stations was sent: LO—phonetically, "ello."

The work on the Arpanet coincided with the return of Dick Bolt to the company. For over a decade, BBN had been deprived of his services. He had left the company and MIT in 1957, following the nonrenewal of a government research contract at the MIT Acoustics Laboratory. After his departure, he was appointed by the National Institutes of Health to be the principal consultant in biophysics to work with a new study section in that field. Three years later, he was named associate director of the National Science Foundation, also for a three-year stint. The following year he was a Fellow of the Center for Advanced Study in Behavioral Sciences at Stanford University. On his return to MIT, he served for several years as a lecturer in the Department of Political Science. He served BBN until he retired in 1976, and resigned from the board of directors in 1981.

Thoughts on managing BBN

A novel management feature, applicable to a research organization, but not a manufacturing company, was inaugurated by me in about 1957. It had been my observation that a lot of time can be spent by a researcher or a consultant on problems related to money. Also, it was becoming essential to have tighter controls on chargeable time, billing of clients, and better communication with the financial office. To satisfy these growing demands, I set up a financial arm parallel to the research organization.

Under this scheme, each technical department had assigned to it a financial person from this new arm. This person, whom I called a facilitator, had two bosses, the head of the department and the chief financial officer. If a person in a department wanted to buy a piece of new equipment or set up a new research facility, he would sit down with the facilitator and outline his needs. The facilitator would work out with him the specifications on the apparatus and the space needs. Then, after obtaining approvals from the management, the facilitator would attend to the purchasing of the equipment and the location and modification of the desired space. If appropriate, the facilitator would solicit competitive bids. In addition, he made sure that each employee in his department submitted a weekly time sheet, and he kept track of sick and vacation times. He also followed the progress of each work in comparison with its contract and checked against deadlines and penalties. He drafted bills to clients based on the time sheets and the terms of the contract.

The facilitator was required to consult with the chief financial officer and would make sure that the department was following the financial rules of the company and the government. Obviously, he was working both for the department head and the financial officer, which meant that his salary was reviewed by both. In my opinion, this arrangement allowed the technical person more freedom to tend to his activities and not be bothered by red tape. From the financial side, contract provisions and deadlines were being met and billings went out correct and on time. Also, savings arose from competitive bidding. This financial arm remained in place until BBN moved into manufacturing.

My own management style needs analysis. At the start, I was senior in age and experience to all employees, except for Bolt. Through my research and the research of graduate students at MIT, I was a source of new knowledge. This meant that I took leadership in a number of key projects and acted as a close partner with the consulting staff. During this period, Bolt and Newman tended to the architectural acoustics projects that kept pouring in. Labate was responsible for the day-to-day management, and I talked with him every day.

Overall, my management style was to work with the staff whenever possible, to treat the staff as equals, and to make them aware that BBN was a highly professional organization. Licklider exemplified this same style. I held weekly meetings with senior members of the staff to learn what needed to be done to improve our operations. In writing, I encouraged our staff to become members in appropriate technical societies and to write papers for publication—BBN authorized attendance at technical meetings. This attitude then carried over into the computer work that followed, although I never took part in the technical side of the man–machine and psychoacoustics endeavors.

By 1962, BBN had grown to such a size that all my attention was consumed by management activities. After BBN went public in 1961, John Stratton, the new treasurer, began exerting a new influence that almost had grave consequences for BBN. First, he had the idea that BBN should grow by acquisition, rather than at the 26 percent compound annual growth that had occurred up to then (and continued through my presidency, which ended in 1969). Several small companies were acquired by BBN, mostly by an exchange of stock, but all failed.

Then Stratton had his big idea in 1968. He became acquainted with the Graphic Controls Corporation in Buffalo, New York, which made Codex charts and business forms and offered computer services. Its gross income and profits before taxes were about equal in magnitude to those of BBN. He worked out a merger agreement in which BBN would be the surviving company but with a new name, with headquarters in Cambridge or Boston. The chairman and CEO would be the then-president of Graphic, and the president of the new corporation would be Sam Labate. Stratton would be the executive vice president and chief financial officer. I would become the chief scientist. I particularly remember Jerry Elkind coming to me and expressing his concern about the danger of losing many of our superior personnel if the merger took place. For a variety of reasons, including my objections to the idea, the merger was terminated officially on 26 February 1970.

I was happy to become aware of Frank Heart's capabilities, and I learned more about his interests and activities than almost anyone else in the computer group. From the time of his arrival in December 1966 until the request for proposal on the ARPA network in 1968, he built up the group of researchers that won the ARPA contract, developed the ARPA network, and initiated the age of the Internet. Frank was the only software expert I ever met who could estimate the length of time it would take to complete a proposed project and fall within the expenditures that he had "guesstimated" at the start.

My tenure as president ended in the fall of 1969 and I remained for two years as chief scientist. Labate became president and CEO, Swets was named general manager of BBN, and Nickerson assumed his position as director of the Information Sciences Division. My leaving the office of president was the result of an unexpected development. In December 1962, I had joined a group of 30 men and women who were interested in obtaining a license for the operation of Channel 5, in Boston, a large network-affiliated television station. In 1963, on the application to the Federal Communications Commission, I had agreed to be the president of Boston Broadcasters Inc. with the expectation that the executive vice president, Nathan David, would take over the title if BBI were to get the license. Later, David was involved in a questionable case of stock dealing and he had to resign. So, I was stuck with a new career, and, following extensive newspaper publicity about the station, which identified me as BBI's president, I was pressured by BBN's board to resign BBN's presidency immediately. It was two years before the favorable, final US Supreme Court ruling was received. In the interim, until 1971, I served as BBN's chief scientist.

After a year of hiring and construction, BBI went on the air in March 1972 as WCVB-TV (Channel 5) Boston, with ABC as its affiliated network. Actually, this was a good development for BBN. I could not have managed the digital network business as well as presidents Stephen Levy and George Conrades, and the stockholders did much better under them. In conclusion, WCVB-TV was also a great success, and the *New York Times* in a lengthy 15 February 1981 article carried the headline, "Some Say This Is America's Best TV Station." It achieved that status through the application of my long-stated premise that "Each new person hired should raise the average level of competence of the organization."

References and notes

1. See also "Leo Beranek, Electrical Engineer," an oral history conducted in 1996 by Janet Abbate, IEEE History Center, Rutgers Univ., New Brunswick, New Jersey.
2. See also Leo Beranek, "Roots of the Internet: A Personal History," *Massachusetts Historical Rev.*, vol. 2, Massachusetts Historical Soc., 2000, pp. 55-75.
3. For an extensive history of Licklider including his relationship with BBN, see M. Mitchell Waldrop, *The Dream Machine: J.C.R. Licklider and the Revolution That Made Computing Personal*, Viking Press, 2001.
4. The focus of this special issue on BBN's role in the world of computers, and this article, describes my role in moving the company into computers from acoustics. Nonetheless, my own engineering and science work has primarily remained in various areas of acoustics, a field in which I continue to do work today, in my ninth decade: *Acoustics,* Acoustical Soc. of America, 1986; *Noise and Vibration Control*, Inst. of Noise Control Eng., Iowa State Univ., 1988; *Concert Halls and Opera Houses: Music, Acoustics, and Architecture,* Springer-Verlag, 2004.
5. "An Interview with John McCarthy," 2 March 1989, oral history conducted by William Aspray, transcript OH 156, Charles Babbage Inst., Univ. of Minnesota, pp. 3-4.
6. J.A. Swets, "The ABC's of BBN: From Acoustics to Behavioral Sciences to Computers," *IEEE Annals of the History of Computing,* vol. 27, no. 2, pp. 15-29.
7. J.C.R. Licklider, *Libraries of the Future*, MIT Press, 1965.

Leo Beranek, who cofounded BBN in 1948, was BBN's president and CEO (1953–1969) and chief scientist from 1969 till mid-1971. Previously, he was an associate professor of electrical engineering at Massachusetts Institute of Technology (1947–1958) and a faculty instructor of physics and communication engineering at Harvard University (1943–1947). Beranek, a Fellow of the IEEE, served on the IRE Committee on Professional Groups (1947–1948) and was Charter Chairman of the first group, Professional Group on Audio, now the IEEE Signal Processing Society. He earned a D.Sc. from Harvard in acoustics and is the recipient of numerous awards, including the 2003 USA Presidential National Medal of Science.

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