

A TRIBUTE TO BOB AARON

On June 16, 2007, Bob Aaron, an outstanding Communications Society mentor and one of the great figures of the digital communications revolution, died quietly after an epic struggle with cancer. Bob had been ill for a long time, but this did not dull his mind or inhibit his contributions to society. His passing was still a shock to many people and was a particularly painful blow to the communications community, to which he contributed so much over the past 50 years. His spirit and accomplishments are reflected in the people, organizations, and public communications infrastructure that exist today.

This article is a community effort, supported by many personal reflections, to explain and to pay tribute to his many accomplishments and encouragement in our lives. It even includes excerpts from his own life history written earlier by Bob, the most meticulous and thoughtful of men.

M[arvin] Robert (Bob) Aaron was born in Philadelphia, Pennsylvania, USA in 1922. In 1944 he married his beautiful and musically talented wife Wilma, who has graciously assisted us in avoiding factual errors in this article. Bob served as an officer in the U.S. Coast Guard in World War II, and earned both his BS (1949) and MS (1951) degrees in Electrical Engineering from the University of Pennsylvania before joining Bell Laboratories in Murray Hill, New Jersey in 1951.

David Favin reflected on his long friendship with Bob that began while they were both attending university:

“For 60 years, Bob was my friend starting with my being his waiter in the Poconos. He was an upperclassman. We continually lived near each other. At 2:00 AM, while feeding his son, he explained to me displacement current. With continuous closeness this friendship lasted until our very last words together.” — *David Favin*

Bob demonstrated his aptitude for learning at Bell Labs and in other ventures. Irwin Welber was a close associate of Bob during that period and was impressed by his aptitude and appreciation.

“When Bob joined Bell Labs in the early fifties, he and Wilma were neighbors of ours in a garden apartment. Up to that point they did not have need for a car so Bob did not have a driver’s license. He prevailed on me to teach him how to drive. He was an apt pupil and my task was an easy one. He never forgot that experience and through the years reminded me of it.” — *Irwin Welber*

Early in his career Bob worked on a variety of analog systems, designing filters, networks, and repeaters. This included equipment for the first color transmission of an Orange Bowl game, regulating equalizers for the L3 coaxial cable system, and systems concepts and repeaters for the first repeatered transatlantic cable system placed in service in 1956. In the latter system he introduced the concept of Ocean Block equalizers to compensate for the difference between predicted and in-place cable loss. This concept was used in all coaxial systems that followed and he developed the first comprehensive computer aided design technique. This was published as an invited paper in 1956 and later included in a set of benchmark



papers in EE and Computer Science in 1973.

In 1956 Bob turned his attention to the development of digital systems. He was one of the pioneers in the realization of the first commercial digital communication system, T1, introduced into service in 1962.

Fred Andrews remembered Bob’s thoroughness: “When we worked together on T Carrier, Bob and I complemented each other perfectly. I was the experimenter and he was the ana-

lyst. I soon learned that when experiment and theory disagreed, it was most likely that the experiment was at fault.”

— *Fred Andrews*

In a similar anecdote Irwin Dorros reflected on Bob’s tenacity:

“Bob was tenacious in attacking any issue or project that interested him. The T1 transmission system has Bob’s stamp all over it. His design and analysis helped shape this system into a workhorse for today’s Internet that we all take for granted.” — *Irwin Dorros*

Bob’s mark on T1 will be remembered for a long time. This system proved to be a model for like systems that were developed around the world. His role and that of his group was to develop analytical methods for both circuit and system design that would enable the quantitative understanding required for successful system deployment. This included methodology for the design of filters containing the sampling gates in PCM systems, understanding the performance of non-ideal A/D converters, analysis and invention of codes to combat crosstalk in the repeatered lines, design of non-linear regenerators, and the effects of timing jitter in digital repeatered lines. Publications on the above technical subjects followed in the early ’60s in the Bell System Technical Journal and elsewhere.

A special issue of the BSTJ in Jan’62 contained his paper on the problems and solutions for digital transmission in the Exchange Plant. His work on the design of filters containing a periodic switch was published in a chapter of a book on Modern Filter Theory and Design edited by Mitra and Temes in 1973. Bob also was instrumental in assisting digital carrier’s migration into the subscriber plant. This work led Bob’s attention to digital subscriber systems where he formed a close association and participation in specialist meetings including IEEE’s ISDN and ISSLS conferences. As he was working on these topics, Bob also honed a trait that would remain his mark in life. He became the super-mentor to colleagues both within and outside of Bell Laboratories.

Ralph Wyndrum remembers Bob the mentor: “Bob was in a digital PCM development when I was in loop transmission, which was rapidly moving into digital subscriber carrier. Over the years we worked on ISDN and the International Subscriber Loop Systems Conference (ISSLS) giving papers and organizing sessions. Bob was an outstanding mentor, who would make his time freely available to all who needed it.”

— *Ralph Wyndrum*

To Dave Leeper he became a pole star that guided him throughout his own career:

“Bob became a role model for me at Bell Labs back in 1970. My memory of his energy, writing style, sense of humor, and “have fun” approach to work has been a kind of north star for me ever since. I hope I’m passing on some of Bob’s spirit to the young people I work with today.” — *David Leeper*

Following the T1 work, he supervised a group responsible for the development of new techniques of framing, synchronization, coding and related functions for new high-speed digital systems and hierarchies. In 1969 he became head of a new department responsible for exploring new digital technology.

Rick Baugh remembers Bob’s personal encouragement and support: “I first met Bob Aaron at Bell Laboratories in 1971 when he was teaching a course on Z-Transforms. In the intervening 35 years, I went to him with several career and Com-Soc issues. He always had time to give me great advice. He always remembered our conversations. The next time he would see me, he would ask how things went - a great encouragement to me.” — *Rick Baugh*

Bob’s department then provided support for the first toll digital switch, #4ESS. In addition the first digital echo canceller chip was developed in his department in the late ‘70s, together with new voice coding algorithms that became the basis for the 32kb/s international standard in the early ‘80s.

Eric Nussbaum worked closely with Bob starting in the late 70’s when he was the key transmission catalyst in helping move switching from circuits to digital packets.

“Bob’s *modus operandi* in tackling any problem, whether technical, or later relating to his health, was always to fully research the relevant work in the field, work closely with, and give generous credit to, his numerous collaborators, provide unique insights, and always add a dash of humor for every occasion, usually with a ditty. We can all learn from his continual positive approach to all things in life, but few, if any, of us will be able to emulate his superb ditties! Thanks Bob.”

— *Eric Nussbaum*

Bob was also instrumental in the move to digital signal processing methods for Time Assignment Speech Interpolation (TASI) systems and was responsible for a demonstration of these concepts on an exploratory system introduced between Boston and New York in 1975. This became the model for TASI systems used on both analog and digital submarine cable systems worldwide.

He quickly recognized the importance of the work on fast packet switching in the late 70’s and its relationship to the work of his department in transmission. He formed an alliance with the switching group to further this effort, which led to a field experiment in California in the mid ‘80s of a 3-node system containing Integrated Access Terminals (IAT) and a fast packet cross connect for handling voice, data, and very low bit rate TV.

As Maurizio Decina remembers in verse:

Bob, you showed the way, for the digital revolution
By use of packet switching, and speech interpolation
From PCM buses and codecs, to fast voice packets
For meeting social needs, at very reasonable costs
To widen knowledge, you used a smile for everybody
Sparkling Bob, beloved Maestro of digital technology

Maurizio Decina

This work demonstrated the feasibility and led to the development of Integrated Access Systems that have been used in about 35 countries as gateways to worldwide fiber optic submarine cable systems.

In addition, the concept of utilizing the packetized approach for all services in a distributed, flat network was explored in his department in the ‘80s and is in “vogue” today.

Throughout all of the above work his credo was “to design systems that meet (societal) needs at a justified cost”. This was stated in the introduction to his 1962 PCM paper and he lived by it.

Ira Jacobs recalls this intellectual honesty and management style: “I was always overwhelmed by Bob’s technical depth, intellectual honesty, and the development of people. I’m not sure whether I learned the following maxim from Bob, but he certainly reinforced it in our interactions. The secret of being a good manager is to be more concerned with pleasing the people in your organization than your boss.” — *Ira Jacobs*

Bob was characterized by a technical depth and intellectual honesty that drew talented people to him. Everyone learned and benefited and he continued his role of mentor to many in facilitating their growth and contributions to useful systems.

He thus became the legendary boss and mentor of many of the most distinguished younger contributors (now older, like us) in the digital communication field.

Don Duttweiler recalled working closely with Bob, his colleague boss: “I was lucky enough to land with Bob right after graduation and work with him for almost twenty years at BTL. He was a wonderful boss, colleague, friend, and even golf partner. Bob was a pre-Internet Google for those of us working with him. Almost any technical discussion would soon elicit a stack of pertinent reference papers from his huge personal collection.” — *Don Duttweiler*

Similarly, Dave Messerschmitt remembered Bob, his supportive boss:

“He was supportive in every way imaginable. His bottom line was always benefiting the company and its business, but at the same time, he was extraordinarily loyal to his colleagues. He fully supported my personal goals [to move to academia], while at the same time he manipulated the system to make it more attractive for me to stay.” — *Dave Messerschmitt*

During his career he published a few dozen papers and authored a dozen patents in the fields of circuit theory, computer aided design, information theory, and communications circuits and systems. Several of his papers have been reprinted in benchmark and tutorial collections.

Jack Sipress found Bob both intellectually stimulating and also very caring: “I was blessed to be able to closely interact with him over many years, to learn and benefit from those interactions and to consider him as a good friend. He was the person to go to not only for outstanding advice on both technical and non-technical matters, but also when I needed someone to commiserate with. He was both brilliant and caring. He was one of the people that made Bell Labs the great organization that it was.” — *Jack Sipress*

Through professional contacts and work within IEEE, he maintained this same outlook and spread his influence around the world. Bob was very active in the IEEE starting from his undergraduate days when he was President of the Student Chapter of the IRE and AIEE at the University of Pennsylvania. He helped start what is now the Automatic Control Society and was its first Papers Review Chairman and Secretary.

He was active in the Circuits and Systems Society in many roles culminating with its Presidency in 1973.

His activities in the Communications Society were broadly based for about four decades. He was Chair of the ComSoc Awards Board in the late 1970s and early 1980s, Founder and Chair of the Digital Systems Technical Committee (1976-77), and Member of our Board of Governors in 1986-88. He served as the Chair of the ComSoc Fellow Evaluation Committee in 1994.

His many activities within the IEEE and its societies, which may be viewed in his biography in the IEEE Membership Directory, included chairing the A.G. Bell Award Committee in 1995-96.

He participated in many conferences, as a speaker, session chairman, conference chairman, and banquet speaker. He was guest editor of three issues of the *IEEE Transactions on Communications*, and co-guest editor of the April 1988 *Communications Magazine* and guest editor of the August '95 issue. Bob was also ComSoc's favorite poet and several of his poems have "crept into" technical journals. One example appears below.

In professional activities as elsewhere, Bob was always searching out those deserving recognition as George Hawley remembers:

"I came to know Bob better beginning 20 years ago after he called and told me that he was applying for IEEE Fellow in my name. The more I worked with Bob, the more impressed I was with his intelligence, drive, and passion for every cause he took on. I feel blessed to have known him and eternally grateful for all he did on my behalf." — *George Hawley*

Doug Zuckerman remembers the mark that Bob made on his life and how he has tried to give back to the Society the same nurturing guidance:

"I remember attending technical sessions chaired by Bob. His skill at connecting with the audience and generating excitement is something I will never forget (and have tried to emulate, but don't even come close). Indeed, he was a role model who, through his nurturing behavior, was a guiding light for my future professional growth." — *Doug Zuckerman*

In the parent IEEE he served on the IEEE Finance Committee, TAB, Publications Committee, and various awards boards. He was elected a Fellow of the IEEE in 1968. In 1978 he was a co-recipient, with John Mayo and Eric Sumner, of the Alexander Graham Bell Medal for their pioneering contributions to digital communications. He was elected to the National Academy of Engineering in 1979. In 1984 he received an IEEE Centennial Medal and in 1985 he was awarded the Communications Society Donald W. McLellan Award. In 1988 the C&C Foundation in Japan awarded him a C&C Prize. In 1987 his colleagues in the IEEE Communications Society presented him with a Lifetime Service Award with the inscription "From his friends and admirers in the Communications Society to BOB AARON, our Mentor".

In both work and professional activities, Bob never hesitated to express strong opinions and press for decisive action. Don Schilling recalls one example from 1968:

"Bob Aaron reviewed the *Transactions on Communications Technology* for the IEEE and criticized the quality of its papers. He recommended me for Editor in Chief and the Board told me they would allow a high class *Transactions* only if we also published a Magazine that they could read and understand. Our reformed and highly rated *Transactions* and

Magazines are a direct result of the original no-nonsense review by Bob Aaron!" — *Don Schilling*

Bob mixed acerbic humor and playfulness into the most serious technical and professional discussions and articles. His humor always made a point sharper and briefer than straight comments would have.

Bob Lucky recalled a related anecdote: "At one of our [ComSoc] board meetings there was discussion on the quality of conference talks. There was much talk about creating a major new 'best paper' award. In the midst of the rising enthusiasm for this new award Bob Aaron effectively stopped all further conversation by suggesting, 'Why not create a new award for the worst paper? We could give it a lot of publicity, and everyone would work hard to avoid getting the award.' That kind of off-the-wall comment, tinged with humor, was one of Bob's hallmarks." — *Bob Lucky*

Bob retired from Bell Labs in 1989 and since that time had been an independent consultant. In addition, he enjoyed life with his wonderful wife Wilma who was an incredible caregiver for Bob especially during his battle with cancer.

Bob also continued close association with IEEE co-authoring, among other things, a lead article for a special issue on E-Commerce in the IEEE Communications Magazine in September 1999, for which he was also a co-guest editor.

With the onset of Multiple Myeloma, Bob became very active in understanding and helping others with applying new technologies to combat Multiple Myeloma and other diseases, and became a strong supporter of stem cell research. He was always there for other sufferers and encouraged looking at the opportunities beyond the immediate problems. He joined the Student Society for Stem Cell Research (SSSCR) and was proud to be its oldest member. Joe Riggs, the leader of this group, commented that Bob was so well thought of by their Society that they named their library in progress after him (see <http://www.ssscr.org/library>).

Bob became famous for his poetic contributions about technologies and those who work with them. In addition to the lyrics, he often sang these poems when making a point in a technical session. Charles Terreault recalled Bob's love of expression through poetry and music:

"Bob's poetry went directly to the heart of the matter or to the heart of his listeners. The little tunes [accompanying his poems], which I suspect had Wilma as an accomplice, helped us to remember Bob's message. In the last telephone conversation I had with him, he gathered the strength to hum one in his own inimitable style. That tune will always be with me." — *Charles Terreault*

Steve Gorshe also remembered Bob for his poetic offerings as well as his mentorship and practical insights on life:

"Bob was a gifted mentor. I appreciated his friendship, encouragement and support, and benefited from his practical insights and perspectives. I'll miss his humorous poems and quips. When asked about the interface to the home in the next decade he said, "it's up in the air" and composed a poem to explain." — *Steve Gorshe*

Steve was able to supply us with the following poem that Bob wrote to him in 2005, speculating on the access network from the home over the next decade — fiber, copper pairs, coax, and wireless.

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Up in the Air (by Bob Aaron)

Fiber to the mile's post
 Gives to us a speedy host
 Copper is still at the end
 So, no digging now my friend.

Not by wires do we slave
 When we send by microwave.
 Even in the media wrath
 MIMO tames the signal path.

Thus expect for years to come
 We will use more than just one,
 Fiber, coax, copper pairs
 Signals going through the airs.

It is in the latter case
 Where we match the mobile race,
 Everyone is on the go
 Latest info they must know.

It's WiMAX and Wi-Fi too
 (Where the teeth are colored blue)
 Not just for our business needs
 But finding kids lost in weeds.
 Further on, by shafts of light
 Broadband signals, line of sight
 Depending on budget tight
 Sending out a terabyte!!
 Who will need this wide bit stream?
 Why, is this a wild dream?
 When, will we expand our sight?
 How to "use up" beams of light?

On several occasions Bob wrote poetic introductions to topics and authors in Special Issues of Communications Magazine and the Transactions on Communications. Several of us took Bob's doggerel as a model and wrote our own. To convey Bob's striving for clarity, simplicity, and the light touch, including poetry, in his technical articles, one of us (Steve) appended to his 1979 ComSoc Spotlight column on Bob:

"Bob Aaron sees that we're perplexed
 By pompous prose and turgid text.
 He'd rather keep things light and terse
 So don't give up, it could be verse!"

Steve Weinstein

His expressed view on life was that there are so many opportunities and all we have to do is outlearn the problems to succeed. As Warren Danielson remembers:

"I called Bob as he was about to leave hospice care for home to spend his last hours peacefully there. We talked for a full half-hour and not once was there any hint of sorrow. He recalled joyfully and in detail his first assignments at Bell Labs, the pleasure of working with so many talented people through the years, and his appreciation for the opportunities it provided. What a special man was Bob — up to the very end!!" — *Warren Danielson*

Today, we remember Bob as an exceptional human being who influenced our lives and continues to be an inspiration to us. We will miss you Bob - loving husband and father of James and the late Richard, revered colleague, mentor, and above all our friend.