April 2007
www.ieee.org/lmc

IEEE life members newsletter

contents

IEEE

Shocking Discoveries Lead to Lifetime with the IEEE

Lyle D. Feisel, Chair, IEEE Life Members Committee

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As I was starting to think about this article for the *IEEE Life Members Newsletter* and the rich history that the newsletter reports, I remembered a bit of my own history and my first two experiences with electricity. Both, it turns out, were painful.

My elementary school education was in a one-room country schoolhouse where science education was, to say the least, somewhat limited. We did, however, have a telephone battery and some insulated copper wire so the students were able to wind an electromagnet, which naturally fascinated everyone. Somehow, I acquired a short piece of small diameter wire and was moved to connect it between the two poles of the battery. I was further moved to use that wire as a convenient handle, sticking my finger in the loop and lifting the battery. While I could not at that time have said that $P = V*I$, I probably said some other things as I found out that something made that wire very hot. I ended up with a painful burn across my finger and an unintended lesson in experimental safety.

The other experience also resulted in pain, albeit not to me. Somewhere, I had acquired an automobile ignition coil that had been rendered unusable in a car because it had a crack in the Bakelite neck. It still worked, however, and I learned by experience that if I connected the ever-present telephone battery to the terminals and then disconnected it, I could feel a little jolt from the high voltage terminal. Pleased with my discovery, I demonstrated it to my father who was able to feel the shock in his callused fingers, but only if he wet them. Again, not knowing a thing about $L\frac{di}{dt}$, I reasoned that if I connected one wire to a file and the other to a nail, I could get lots of connections and disconnections and hence lots of those jolts. It worked like a charm, so back I went to demonstrate to Dad.

He again wet his hands and took hold of the high voltage end while I gave a long, hard scratch of the nail on the file. Well, we both learned something from the demonstration. To his everlasting credit, Dad didn't punish or even scold me. However, he did urge caution in future experiments and removed his name from my list of testers for devices detecting electrical phenomena.

I suspect that many, if not most, of our Life Members first learned about electricity through similar experiences. We have gone on, however, to more efficient and, usually, less painful methods of learning and then to long and successful careers in engineering. Currently, the IEEE has over 24,000 life members registered. Assuming, conservatively, that each of us had a 40-year career, our combined service represents about 1 million years of engineering activity. One million years of IEEE membership, that's a long time. I'm pleased to say that the Life Members are continuing to support our profession through their financial contributions to the Life Members Fund.

The Life Members Committee has provided some recognition of this support by distributing Life Member pins to donors the first time that they give US$50 or more. That recognition was greeted so warmly that we are following up with another memento for donors this year. You can read about that on page 3 of this issue. In the meantime, thanks very much for your support of the Life Members Fund. And for your million years of engineering with the IEEE.

Real Life Work Experiences Needed for Educational Resource Project

Lou Luceri, LSM

Throughout your career, you have no doubt experienced defining moments and faced key challenges that could provide a learning experience for others involved in managing technology intensive environments. We need your help in passing these experiences on to the next generation as the lessons learned and critical thinking required to deal with the demands of business based on technological advance.

To facilitate such an exchange, the IEEE Engineering Management Society has committed to providing a real-life educational resource for managers, engineers, and scientists who are interested in creating new businesses and better business practices and processes through integrating technological and business knowledge in a competitive global economy. Towards this goal, we need real-life cases developed from the perspective of the technological professional. In this spirit, we invite you to submit a short treatment of an incident or a description of an informative encounter that you feel would be worthy of development into a case study that serve as a vehicle for passing your experiences or challenges on to help the next generation make better decisions or engage in more productive behaviors.

Upon acceptance of your proposal, an experienced case writer will be assigned to help develop the case. If so desired, you will have the privilege of having your name listed as the case originator.

The cases will:

- reflect the "real-life" issues that we all encounter in our daily work
- be created by practicing engineers, managers, and innovators
- meet the needs of managers across all disciplines working in technology intensive environments
- deal with expectations and realistic results in complex and uncertain situations.
- lay the foundations for integrating technical and business knowledge
- bring real-world experiences to all managers from entry level to those in positions with responsibility for the organization's future.

Please submit your proposals or questions to Lois Peters (peterl@rpi.edu). If you wish, we can provide you with a case study template for your write-up. We look forward to receiving your proposal.

2006 IEEE Life Members Fund Giving

The IEEE Life Members Committee wishes to acknowledge those IEEE members and other friends who generously contributed to the IEEE Life Members Fund during the calendar year of 2006. We are fortunate to be supported by so many members that we, unfortunately, cannot list them all. Each and every gift provides the resources that the IEEE Life Members Committee needs to support philanthropic activities that encourage students and young electrical engineers to pursue a career in engineering, investigate the history of electrical engineering, and represent the interests of IEEE Life Members or similarly mature members.

Leader - US$10,000 to $24,999

Mrs. Christa Pandey in honor of Dr. R.K. Pandey	Non-Member

Associate - US$2,500 to $4,999

Paul Baran	Life Fellow
Thomas Kailath, Sc.D.	Life Fellow

Sponsor - US$1,000 to $2,499

Robert F. and Jean E. Holtz Trust	Non-Member
Theodore S. Saad	Life Fellow
Edward S. Yang	Life Fellow

Gold Advocate - US$500 to $749

Lloyd Jones, PE	Life Member
Richard W. Landon	Life Member
Kenneth D. Skjervem	Life Member
William H. Surber, Jr.	Life Senior Member
Kiyo Tomiyasu	Life Fellow
Gary Tooker	Life Senior Member
John M. Undrill	Life Fellow

Silver Advocate - US$250 to $499

Oliver C. Boileau, Jr.	Life Senior Member
Ray F. Campbell	Life Member
Graham B. Davis	Life Member
John M. Derrick, Jr.	Life Member
Patrick R. Donnelly	Life Member
Bruce A. Eisenstein, Ph.D.	Life Fellow
Oscar G. Garner	Life Member
John W. Gore, Jr.	Life Senior Member
James V. Hirsch	Life Member
Colin M. Jones	Life Senior Member
Howard F. Kidder	Life Member
Frederick L. Maltby	Life Senior Member
Allan D. Packler	Life Member
Jerald V. Parker	Life Senior Member
Donald R. Potter	Life Member
John D. Richards	Life Member
David E. Sundstrom	Life Senior Member
Wayne L. Weigle	Life Member
Dr. Arthur W. Winston	Life Fellow
Robert A. Wise	Life Member
Lorenzo L. Wong	Life Senior Member

IEEE Life Member Groups

Did you know that a Life Member (LM) Group is a nontechnical subunit of Region, Section(s), or geographic Council that is established to fulfill the mission of the IEEE? Since 2000, the Life Members Committee (LMC) has had an ongoing program to support the funding and promotion of LM Group activities. These Groups are formed to meet the needs and concerns of the local LM Groups that annually conduct at least two meetings will receive Regional Activities Board (RAB) funding through their Section. Additionally, these Groups are also taking active part in the Sections, particularly in respect of history projects such as Milestones.

In 2006, eight new Groups were formed to bring the total of LM Groups to 43. These Groups conducted activities that meet the needs of LMs and conduct activities in concert with the IEEE mission. LM Groups conducted more than 90 meetings which attracted more than 4,400 guests and over 2,000 IEEE members. The topics discussed during the meeting included environment (cleaning up the Hudson River and wind energy generation), health (human aging), historical (the development and deployment of GCA, a WW II radar system for Landin), and social (holiday event).

The LMC has a goal of establishing, by 31 December 2008, an LM Group in each IEEE Section having 100 Life Members or more. Currently, 66 Sections have more than 100 LMs within their geographic boundaries but only 20 of these Sections have LM Groups. You only need to obtain the signatures of six members (preferably LMs) to form an LM Group. More information on the formation process is available on the LMC Web page at www.ieee.org/lmc.

LM Groups that conduct at least two meetings annually will receive RAB funding through their Section. Additionally, the LMC has agreed to provide funding to the LM Groups on an as-requested basis. Current LM Group chairs are encouraged to contact their Regional LM coordinators for more information on the funding provided by the LMC.

LM Groups (1 March 2007)

Region 1, LM coordinator
Julian J. Bussgang
j.bussgang@ieee.org
Boston Section
New York Section
Mid-Hudson Section
Syracuse Section
Schenectady Section

Region 2, LM coordinator
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Philadelphia Section
Northern Virginia Section
Pittsburgh Section
Washington Section

Region 3, LM coordinator
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Florida West Coast Section
Daytona Section
Palm Beach Section
Winston-Salem Section
Atlanta Section
Melbourne Section
Louisville Section

Region 4, LM coordinator
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Chicago Section
Twin Cities Section

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Kansas City Section
Oklahoma City
Wichita Section

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Montana Section

Region 7, LM coordinator
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Kingston Section
London Section
Montreal Section
Southern Alberta Section
Toronto Section
Vancouver Section
Winnipeg Section

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Israel Section
Italy Section
United Kingdom & Republic of Ireland Section

Region 9, LM coordinator
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Chile Section
Puerto Rico & Caribbean Section

Region 10, LM coordinator
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Gb.Gwilliam@ieee.org
Bombay Section
New South Wales Section

IEEE Life Members Committee Announces Expanded Donor Recognition Program

During its March 2007 meeting, the IEEE Life Members Committee (LMC) unanimously approved an expansion of its donor recognition program.

As of 1 October 2007, all donors who give US$100 or more to the IEEE Life Members Fund will receive the first in a series of limited edition pewter coasters.

The first engraved coaster will depict the TELSTAR IEEE Milestone, which represents the first transatlantic television signal that was sent via satellite in 1962. One coaster will be given per donor per year in recognition of that donor's individual gift to the Life Members Fund.

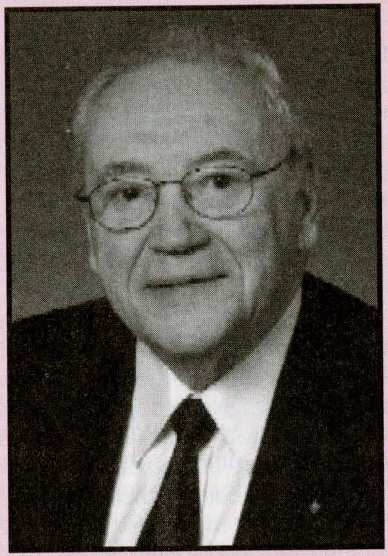
The LMC is planning to continue the coaster program for at least six years. A new coaster depicting a different IEEE milestone will be issued in each of the subsequent years.

The coaster program is in addition to the IEEE Life Member Pin program that began in 2006 and recognizes Life Member (LM) gifts totaling US$50 or more to the IEEE Life Members Fund. One pin is issued per Life Member.

After 1 October, LMs who haven't yet made a donation to the Life Members Fund will receive both a pin and a coaster for donations of at least US$150.

Details about the new incentive plan will also be available at www.ieeefoundation.org. Click on "Donate Online." If you haven't yet made a donation to the Life Member Fund to receive an LM pin, you can do so now by returning the business reply envelope that appears in this issue of the newsletter.

Three IEEE Members to Share Bernard M. Gordon Education Prize



Arthur Winston

Two IEEE Life Fellows and another IEEE Member were recently named as corecipients of one of the engineering profession's highest honors, the Bernard M. Gordon Prize. The prize is given annually by the U.S. National Academy of Engineering. The academy selected Life Members Harold S. Goldberg, and Arthur Winston, the 2004 IEEE president, as well as IEEE Member Jerome E. Levy to share the US$500,000 prize. Tufts Gordon Institute, in Medford, Mass. was also named as a recipient. Neither the institute nor Tufts had a role in choosing this year's Gordon Prize recipients.

The three Members received the award, which recognizes innovation in engineering and technology education, on 20 February at Union Station in Washington, DC.

Goldberg, Winston, and Levy were recognized for their "multidisciplinary graduate program for engineering professionals who have the potential and the desire to be engineering leaders." The three created the master of science program in engineering management offered at the Gordon Institute, which was established in 1984 in Wakefield, Massachusetts. The institute joined Tufts University in 1992 and is now part of its School of Engineering. The master's program teaches project management and communication skills, product innovation and development, and leadership.

Newsletter Donations Surpass US$10K

The IEEE Life Members Committee would like to thank the 70 members who generously contributed to the IEEE Life Members Fund through the December 2006 issue of the *Life Members Newsletter*. Through the middle of March 2007, the following was received:

IEEE Grade	# Gifts	Amount
Life Fellows	10	US$675
Life Senior Members	21	$836
Life Members	34	$1,945
Senior Members	3	$212
Members	2	$110
Total	**70**	**$3,778**

Gifts to the IEEE Life Members Fund of the IEEE Foundation support educational and professional projects that are of interest to IEEE Life Members and that reflect the range of the engineering field.

To make a gift, simply return the envelope found in the middle of this newsletter or visit the IEEE Foundation on the Web at www.ieeefoundation.org and click on the "Donate Online" tab. For more information, contact the IEEE Development Office at +1 732 562 3915 or e-mail supportieee@ieee.org.

tales from the vault

Present for the Birth of the Integrated Circuit

I was a University of Florida college co-op who worked at Texas Instruments (TI) in the summer of 1960. While working there, I met Jack Kilby, who won the Nobel Prize in 2000.

Jack had only been at TI for two years at the time. I was assigned to help test the "solid circuits," as they were called, that Jack was producing on an experimental line. These solid circuits were the forerunner to the integrated circuits.

At that time in 1960, there was no automated testing of the solid circuits. TI did have automated testing for all of the standard three-lead transistors. The circuit was a very simple flip-flop with seven resistors, a couple of caps, and two transistors. The amazing part was that it was all solid state with no discrete components.

Parts of the substrate were doped in a fashion to generate a certain amount of resistance. The components were interconnected with very fine wires.

As a technician, I used a power supply, a Tektronix scope, and a pulse generator to see if the circuits would meet the spec that Jack had given me. All the circuit had to do was divide by two, a relatively simple function.

When I first started, he gave me several thousand of the devices and said: "Start testing."

I could not believe it but every once in a while, I found one that worked. Jack was very happy and wanted an analysis of why the others were not working.

My analysis basically explained what voltage was required to trigger it and, once it was working, how much range the collector supply had as well as at how high a frequency it would operate.

Believe it or not, the first yield rate was 0.5%. That is, I found one out of 200 that would meet spec. After several weeks of testing, improvements were made in the design and an automated test set was designed so I did not have the tedious duty of testing the thousands that were being produced. (The first working units were available to outside companies who wanted to try them at US$250 each.)

Marvin J. Moss, LM
Marietta, GA

The Case of the Airsick Shunts

Constant Warning Time (CWT) train detection for railroad grade crossing systems was introduced in 1962 based on a joint development between Southern Pacific Railroad and Stanford Research Institute. Previous systems detected only train presence on a track circuit designated as the crossing approach. Consequently, faster trains gave shorter warning times and slower trains gave longer times. The CWT detector tracked the location and speed of approaching trains and provided a relatively constant warning time regardless of train speed.

By 1971, when I became chief engineer of Safe Tran Systems' California electronics plant, these CWT systems were just being installed across the country (they have since become universally accepted in North America). The CWT system applies a constant current at a specific frequency in the 80 Hz to 1 kHz range across the rails at the grade crossing with a termination shunt across the rails at the start of the approach track circuit. As the ferrous rails have inherent inductance, the inductive reactance of the track circuit out to the termination shunt is known.

As a train passes this shunt and approaches the crossing, this track circuit inductance is reduced linearly with distance and the voltage across the rails at the grade crossing drops due to the moving train shunt. By detecting the in-phase and quadrature components of this distance voltage, the complex impedance of the track circuit, and thus the location of the train, is determined. Its speed is then determined from a time differential of the distance voltage and prediction made for its arrival at the grade crossing. The integrity of the rails and track circuit connections is also determined from this distance voltage, even with no train present.

The track circuit has a very low characteristic impedance due both to the low inductive reactance of the rails and to leakage through track ballast. Thus, the series tuned termination shunt must have a very low resonant impedance, typically less than 0.5Ω. These shunts are supplied in a rugged, sealed PVC cylinder with flexible #6 AWG leads, 2.0 m in length, and buried in the ballast to thwart vandalism.

By the early 1970s, we were shipping CWT units throughout the country. Changing frequency of the grade-crossing unit required only changing a PC board but shunts had to be changed as well. As a result, shunts were occasionally shipped by air to customers. These typically arrived tuned off frequency and exhibited a higher than acceptable resonant impedance. When replacement shunts were air shipped, they too arrived tuned off frequency.

This resulted in a thorough investigation. Calibration of all plant instruments was rechecked, shunts were air-shipped back and forth to Safetran field offices and checked, air carriers were queried on cargo hold pressures and temperatures, and shunts were cycled in a temperature, humidity, and pressure chamber to isolate the cause of the airsickness. No congenital problem was identified. Despite the undesirable delays, all shunts were shipped by ground and tuning problems disappeared.

Some time later, an engineer issued a rush order for a shunt to be used on a new product field test. Though not air shipped or even shipped, it was tuned off frequency. An investigation revealed that rush-order shunts were tuned in the repair department rather than in production, where shunts were tuned with leads extended, per instructions. Since shunts had not been expected in repair, no such instructions existed and shunt leads were coiled during tuning as bench space was limited. The additional inductance of coiled leads was the problem. It was found that manufacturing had systematically labeled all shunt orders called out for air shipment as rush orders. The airsick shunt mystery was solved.

James Moe, LM,
Circle Pines, MN

A Summer to Remember

Around 1960, it was frequently possible for a college student to get a job for the summer working on a professor's research project. As an E.E. student at Stanford, Dr. Phillip Gallagher hired me to work on a research project. "Project Firefly" involved sending up sounding rockets from the Pensacola Naval Air Station in western Florida. The rockets released various gasses into the ionosphere and studied the behavior of the gasses in the ionized region. The launches were planned for early morning hours when the sun illuminated the ionosphere but not the atmosphere below. This allowed photographic records. Our job was to study radio reflections from the ionized clouds.

My job required flying with a friend to the area of Fort Walton Beach, Florida, which was a resort area. The flight arrived late in New Orleans, and we missed our connection. Unfortunately, we were forced to spend the night with a tour of Bourbon Street. Arriving in Florida, we spent a couple of weeks setting up transmitters and antennas. Two of us were then sent to a receiver field site at Fort Rucker, Alabama. We had to stay at a new motel near the small town of Dothan. For a week or two, we climbed telephone poles setting up antennas, cables, receivers, and tape recorders.

We then got into the routine of the summer. Two to four launches per week were scheduled. A successful day consisted of getting up around 3 a.m., going to the site, setting up the receivers and recorders, and recording data for an hour or two. After labeling everything, we went home about 7 a.m. At the motel, we ate at the restaurant, swam in the pool, and visited Dothan. Our adjoining rooms each had a TV, so we watched a lot of that.

Some weeks, when weather looked bad, the entire group returned to Fort Walton Beach. We had enough time there that we bought a SCUBA tank and regulator (you didn't need certification in those days). I probably didn't earn a huge amount but got more than I needed for Stanford tuition, which was either US$750 or $1,005 per year at that time.

Phil Fialer, LM
Palo Alto, CA

After WWII, Naval Service Continued

I was in the Naval Reserve after World War II and was recalled to active duty in 1951. By the spring of 1952, I was gun boss (gunnery officer) on the USS Douglas H. Fox (DD779) patrolling off the east coast of North Korea, generally in the Hungnam area The main battery consisted of six 5/38-in guns in dual mounts, controlled from the gun director (mounted on a cylindrical base about 10 ft above the bridge) through the electromechanical fire control computer located below the main deck. This battery was designed to be used against other ships, shore targets, and aircraft. We also had 20-mm and 40-mm mounts.

The 5-in director had optical equipment for the trainer (rotational motion), the pointer (vertical motion), and for the gunnery officer as well as an optical range finder. It also had fire control radar mounted on the top of the director. Trainer, pointer, and gun boss had power-assisted equipment. The gun boss had a slew control for rapid acquisition of targets. Once in, automatic operation targets were followed both optically and on radar by signals from the fire control computer, which also provided the signals to point the guns automatically. Corrections generated by rotation of the handwheels of the trainer and pointer to keep on target went to the fire control computer to improve the solution.

When we fist arrived on station, we made a slow trip up the coast with the skipper using very large binoculars to survey the shoreline, looking for possible gun emplacements. Later on, we would needle the North Koreans/Chinese by putting a few rounds from our 5-in guns into locations that seemed to be likely targets. Sometimes, we would be treated to return fire; on other occasions, we would be fired on unexpectedly

In either case, we would slew the 5-in gun director toward the source of the gunfire and return fire. The ship would go into a war dance, turning and changing speed erratically so that the batteries ashore would not be able to predict where we would be by the time they were ready to fire again. (We never took a direct hit; the worst was shrapnel from a round that landed close aboard, wounding a radioman in the calf.) The war dance did not affect our fire because the fuel control computer, the gyrocompass, and the stable element (a gyroscope with vertical axis that established which way was straight up) would feed appropriate signals to the gun director and to the 5-in mounts so that we kept on target.

From time to time, we were also called on to fire at targets identified by the troops on the ground. This would occur during the day and especially at night. For this type of action, control was in the fire control center below the main deck. Target location was given in grid coordinates, we knew where we were in that same grid, and directions and distances were set manually into the computer. This was always a time to be nervous because we certainly didn't want to fire on our own troops, and fortunately that never occurred.

One morning while on patrol, I went to the director to relieve the assistant gun boss, who had stood the 4–8 watch. The director was driven in train by a direct current motor, supplied by an amplidyne that was mounted vertically on the inside of the base. My assistant informed me that he could not slew the director using the slew control, and the trainer could move it only very slowly at best. It took little time to isolate the problem. The output of the amplidyne could not be raised above a few volts no matter what we did. A scope on the output terminals showed a wave shape that looked like that from an unfiltered full wave rectifier.

My conclusion was that there was a shorted coil in the armature of the amplidyne. By adjusting brush position, we were able to get performance from up to what might be called at best a marginal state. We could slew slowly, the director would follow signals from the trainer's handwheel or from the computer in the fire control center provided that the handwheel was rotated only slowly or the computer was tracking a target moving at low speed. No protection against aircraft, and no more war dances until there was a real repair. A replacement for the amplidyne (with integral drive motor) was ordered but it would take weeks to arrive.

The next morning, I went up to relieve the assistant gun boss. He was wandering around inside the base again. "What's the problem?" "I can slew the director, but when I release the slew control, the director oscillates back and forth around the set position." A quick check showed that the amplidyne was generating much higher voltages than it had been. A trip to Won San the day before had apparently cleared the short in the armature. We reset the brushes to their original location and didn't have any further trouble. The replacement amplidyne arrived and was stored in the director base. And I left the ship having been released from active duty.

Richard H. Engelmann, LM
Cincinnati, OH

Anti-Ballistic Missiles

As a newly minted EE in 1967, I was working for the General Electric Company in Owensboro, Kentucky. My first job was to assemble the transmitter that rode on the incoming test missile, launched from the Kwajalein atoll in the Pacific. The transmitter announced, "Here I am," to the killer missile launched from California.

It was a C-band, plate-pulsed cavity power oscillator utilizing a GE ceramic triode. I read in the paper fairly recently where this is still an active program. They are still using the "Here I am" device and still can't hit it. The story I read said that the last two attempts failed because the target rockets couldn't get off the ground on Kwajalein. Gee, that wasn't a problem back in '67.

This has been likened to trying to hit a bullet with a bullet but that is not a good analogy. ICBMs travel faster than bullets. A person more knowledgeable that I am told me that this is impossible to do reliably—something to do with signal-to-noise ratio.

Perhaps after 40 years or so, this money could be better spent elsewhere.

Thomas W. Webb, LSM
Plano, TX

Tracking

In the 1960s, when the space program was everything and the Atlantic Tracking Range was very active, the Grand Bahamas Island (GBI) station was headquarters for a Lorac location system. There were five stations using a four-channel microwave system for communication. When tests were not in progress, the only means of communication was the system order wire. This was not continuous from one station to another so by the time a message got to the head-end, it was usually jumbled.

The idea was hatched to use the main channels of the system (one per station) during nontest periods, which were sometimes hours long and sometimes days. I was given the project of installing normal-through patch panels in the four minor stations (the head-end panel was already in place). At the same time, telephone ring-down equipment and magneto phones (fancy army field phones) were also to be installed to make communications easier. At the head-end (station 1) the four channels fed into the recently installed refurbished 100-line exchange, allowing each station access to any phone at the head-end or at GBI, either individually or simultaneously.

The head-end was a place in the Bahamas called Carter Cay. At high tide, it was two islands that were a stone's throw wide; at low tide, the islands became one. Before the refurbished exchange was installed, non-test communications were by jury-rig telephone/radio link. Standard telephones had been gutted and modified to key, send, and receive over a radio link connected directly into the GBI exchange. There were four such links. When the exchange was installed, these links became operator trunks between GBI and Carter exchanges. When one of the minor stations wanted to talk, they turned the crank, picked up the phone, and Carter switchboard would answer. The caller could then be connected to any phone on the Carter or GBI switchboards, and from there, to any phone on GBI or at Kennedy Space Center.

The Carter phone system was another challenge, as only four new phones were sent with the system. To replace the existing locations, I found where the removed parts has been stashed and proceeded to rebuild the old units to work as standard phones. I was able to re-assemble several units, and, by redirecting unused cable runs and using surplus cable, I was able to install phones around the Carter main building.

There were two exterior runs necessary but no parts or equipment for an aerial run, so I scratched a shallow trench in the soil and crushed coral surface between buildings. Having located some armored army field wire, I had a ball skinning the ends, mounted blocks just inside both buildings, and then ran standard inside wire from block to exchange and from block to phone.

Looking back, this technology seems much more like World War II than the space age!

C.J. Abbott, LM
Hempsted, NY

Slide Rule Gives Flight to Tracking Antenna

In 1949, I was working as a microwave engineer at Hughes Aircraft Company (HAC) in Culver City, California. I was responsible for the design, test, and integration of the RF subsystem for the APG37 airborne fire control radar, which was intended for use in the new generation of jet interceptors and fighter airplanes, beginning with the F86.

The microwave subsystem was comprised of the duplexer, balanced mixer, rotary joints, and antenna. The antenna was to be a parabolic dish with painfully severe specifications on size, weight, gain, side lobe level, and tracking accuracy, which was obtained by conical scanning (monopulse was still in the future). Other groups at HAC were designing and testing the modulator, IF amplifier, display, servo system, and fire control computer.

Then the time came to put it all together and test the system as a whole. The hardware was carted to the roof of the laboratory building and assembled in a small penthouse with a large garage-type door opening to the north, looking over the landing strip of the small HAC airport. When it was all connected, someone pushed the switch. The programmed time delay elapsed, and the set came to life: the antenna started scanning right and left, painting half the way up on the PPI screen a creditable map of the alluvial plain up to the barrier of the Santa Monica mountains. The San Fernando Valley, out in the shadow of the mountains, was dark as expected.

Then someone noticed a blip at the very upper edge of the screen: it was some target that was high, but somewhere far beyond San Fernando, probably coming up from Palmdale. We decided to try and track it. The antenna locked on it right away and stayed locked pointing higher and higher as the target came nearer and larger before finally hitting the limit switch in elevation. Right over our head, at perhaps 3,000 ft high, flew a B36 bomber, the biggest target anywhere in the sky at that time. This was a magical coincidence. Not even Howard Hughes could have borrowed a B36 to celebrate the first activation of our APG37 radar, and the ensuing festivities were to an appropriate scale. Later, an F86 plane was assigned to the development program and was fitted with the prototype radar. While that plane carried out all the test and evaluation flights from the HAC runway, I went on to do other things.

Almost 50 years later, I attended a meeting of the San Fernando IEEE, which featured a slide show that was organized and narrated by D. Pidheny, also an APG37 veteran at HAC who had collected a wonderful set of archival quality photographs that illustrated the history of the evolution of antennas from archaic rhombics to modem dishes and arrays. In the middle of the presentation, there it was on the screen, my APG37 antenna mounted in the nose of the experimental F86 with the radio removed and resting on the ground next to it. And the speaker pointed to me sitting in the audience and said: "And there is the guy who designed this thing." It was gratifying and embarrassing, and all I could find to say was "And I did it using only a slide rule."

G. Fonda-Bonardi, LSM
Los Angeles, CA

A Co-Op Student Before Graduation

While attending Rensselaer Polytechnic Institute in the late 1950s (BSEE '61), I had the good fortune to be hired as a co-op student by General Electric. This was an excellent program and provided many benefits to the would-be engineer as well as being an excellent recruiting tool for GE. Incidentally, GE's "Advanced Courses in Engineering" or A-B-C Course for young graduates was also an outstanding program that provided mutual benefits to both the employee and employer. I was fortunate to have taken part in that program as well.

In reading some of the "Tales from the Vault" stories, I am reminded of some of my experiences while a co-op with GE. My first assignment was with GE's Light Military Electronics department in Utica. This was the era of the B-70 project, and GE was subcontracted to IBM in Owego, New York for some bench-test equipment for a large coherent radar system that was slated for the ill-fated B-70. My principal responsibility while there was to keep track of the interconnections between the myriad instruments and devices that were mounted in rows of bolted-together 19-in racks and their central power supplies. There were several racks of Lambda dc power supplies whose outputs needed to be distributed to the various custom-built instruments. Each box had a different military style (multiple pin connector), and those had to be cataloged and ordered. So much for the romance of designing exotic circuits.

One experience stands out in my mind. The prime equipment apparently had large traveling wave tube (TWT) amplifiers with electromagnetic solenoid focusing coils (I never did see any of the prime equipment). We had to provide a current-regulated source of 28 V dc at up to 35 amps for bench-testing the TWTs. One of the engineers had designed a transistorized regulator using the famous 2N173 power transistor. There was a bank of seven of them mounted to a copper heat sink through which cold water ran. It was my job to set up and test these circuits. I was forced to relocate to the lab's sink so that I could hook up the water hoses. The fact that I was dealing with currents and voltages that would pass for an electric welder was brought home to me one day when I dropped the probe of my trusty Simpson 260 VOM, and it brushed against the heat sink (at collector potential) and the aluminum chassis (at ground potential). There was a momentary Pffft, and I saw a drop of something splatter on the floor. I thought at first it was solder until I noticed the missing chunk of aluminum chassis and realized the drop was molten aluminum.

My remaining two assignments were with the GE broadcast transmitter group in Syracuse. In addition to designing and manufacturing commercial radio and television transmitters, this group had two very interesting and challenging contracts. The first was called "Project Heat" and involved the design and construction of several 250 KW power oscillators that were going to be used to heat the skin of military aircraft that were undergoing tests. The heating would help to simulate supersonic flight. These oscillators were required to tune continuously from about 200 kHz to about 2 MHz. They were pulsed on and off at a low audio rate, and the duty cycle was varied to control the heating power. They would have made great jammers for the AM broadcast band but were to be used in a heavily shielded building at Wright-Patterson AFB. I never heard how the project turned out or how effective the shielding might have been. My job was to build a scale model of the oscillator to test tank coil geometries for the sliding tuner mechanism. I used 1/4-in copper tubing for the tank coil and parallel 6J6 triodes to simulate the scaled-down characteristics of the triode that would be used in the final model. It was a fun project and tested our ingenuity.

When I came back for my next assignment, I worked on another special order project, a group of six 250-KW short wave transmitters for Voice of America. This design was a 250-KW conventional AM transmitter with plate modulation that required a 125-KW audio amplifier. The transmitter was required to operate at any frequency between 3–30 MHz. In addition, a frequency change had to be accomplished within a short time. This meant that the settings of all the tuned circuits, from the exciter up through the final stage, had to be recorded in a table for each operating frequency.

When the transmitter was shut down, the operator changed all the settings according to the table and turned the transmitter back on. It was supposed to come up to within 10% of full output and then live tweaking could take place after the transmitter was operating. This sounds easy except that the final amplifier contained two power triodes about the size of small golf bags sitting in a tub of boiling water with a tank coil made out of 1-in copper tubing and several large tunable Jennings vacuum capacitors, each about the size of a gallon of milk. The capacitors were ganged together with a chain drive to tune them. To be able to reproduce settings, we counted the rotation of the gears with a microswitch riding on the teeth of the gears and connected to an electro-mechanical up-down counter. We spent more time trying to eliminate false and dropped counts in this scheme than we did designing the final amplifier. A flexible shaft coupled to a clock-type set of pointers would have worked better, but as electrical engineers, we were too stubborn to take a mechanical approach.

Of the many interesting aspects of this monster transmitter, the most interesting was the need to measure the power output. There were no commercially available dummy loads for 250-KW transmitters. The GE engineers devised a 4 x 4 ft stainless steel tank into which they put several resistors comprised of zigzag strips of heavy duty cage screening connected on one end to the tank wall and in the center to a cylindrical copper structure with a spiral slot and shorting bars for tuning. The ubiquitous Jennings capacitors completed the matching circuit since the line impedance from the transmitter was 50Ω, and the impedance of the screen resistors was very low. Once we showed that we could obtain an acceptable VSWR with this design, the next job was to be able to calorimetrically measure the power dissipated in the resistors. The resistors operated under flowing water, so we measured the input and output temperature and the flow rate of the water flowing through the box. A little slide rule work produced the power dissipated.

To prevent loss of heat to the air, we covered the box and wrapped the whole thing in fiberglass insulation. The steam would rise from the box when the transmitter was running. We resisted the temptation to steam clams in it but it probably would have worked well. Ultimately, we were able to show that the transmitter final stage was operating at an acceptable efficiency. The input to the final amplifier was 12 KV at 25 amps. The grid drive was 8 amps. What a great Ham transmitter this would have made. Incidentally, the power supply used strings of solid-state diodes, as did GE's standard 50-KW broadcast transmitter at that time. There were many other anecdotes related to the massive size of this transmitter. The six transmitters were slated for installation at the VOA facility in North Carolina.

I have had many varied experiences in my career as an engineer but none were quite as exciting and unique as those that I experienced as a co-op before I had even graduated.

Dean Chapman, LM
Camillus, NY

Before Cell Phones, Trucks Enable Switchboard to Communicate Liberation

During World War II, I was trained at Ft. Monmouth to operate AN/TRC-l radio telephone receivers and transmitters. The radios were installed in the back of a two-ton truck equipped with carrier bay equipment to facilitate radiotelephone and Teletype communications. I was assigned to the 3186th Signal Service Battalion and was shipped to England, France, and Germany. My team consisted of an equipped truck, two carrier technicians, and a driver. I was the radio technician.

My team provided communications to the 4th Armored Division of the Third Army. There were similar teams all over France and Germany attached to divisions, corps, and armies. We were also highly mobile, sometimes traveling 50 miles a day, and could not string telephone wire fast enough. Our trucks were the perfect solution.

We provided wireless communications before cell phones were invented. Division switchboards connected a telephone pair of wires to our truck and could communicate all over Europe.

Our radios operated on VFH frequencies, which are line of sight and required antennas at the highest elevation in the area. Although I was a private, we were important enough to have two tanks assigned for our protection.

In April 1945, the 4th Armored reached Weimer, which was in a valley. To attain a higher elevation and set up our equipment, we traveled east with our two tank escorts. Alongside the road was mile after mile of a barbed wire fence. At the top of the hill was a gate guarded by armed Germans. I ordered the guards to open the gates, and we drove in with the two tanks. This was Buchenwald, one of the most notorious concentration camps. The camp commandant realized Germany had lost the war and was relieved to surrender to Americans instead of to the Russians. He was told to order his men to lay down all their weapons immediately and they complied. When the inmates realized we were Americans, they surrounded our vehicles and started kissing our feet. As soon as the division hooked up telephone wire to our truck, I called the commanding general. He drove up immediately. Along with us, he was shocked at the conditions in the camp and called General Patton from our truck. The next day Generals Patton, Bradley, and Eisenhower arrived at Buchenwald. All the generals came to my truck to make radiotelephone calls. General Eisenhower told me that this was the first major concentration camp liberated by Americans. While in my truck, he called his headquarters in Paris to request transportation for newsreel cameramen and journalists to come to Buchenwald to inform the world of this horrible atrocity.

The following day, the 4th Armored left Weimer to continue advancing east into Germany. My team and truck left Buchenwald and advanced with the tanks.

Stephen S. Heller, LM
Delray Beach, FL

Big Wheels Keep on Turning

The "Air Drops Chafe Chickens" article in the December 2006 issue of the *IEEE Life Members Newsletter* that was written by John V. Weber, LM of Rome, New York, sure brought back memories.

I was employed by RCA Service Company in the Government Service Division from 1955 to 1974. In 1960, I was sent to the Rome Air Development Center's (RADC) flight test group for six months to work with the electronic spectrum signature group. After 12 years, hundreds of hours of flying time, and thousands of miles, the job was completed.

The flight test group had specially equipped C131 and KC135 aircraft for electronic countermeasures and spectrum signature work. The C131 was equipped with an automatic range control system, which enabled the aircraft to fly in a circle around the object that was being tested. I had so many hours flying in a circle that my wife gave me a special plaque, which states, "Blessed are they who go around in circles, for they shall be called the big wheels."

While performing the spectrum signature work, the aircraft would fly in a circle around the test object, from 50–100 ft to several thousand feet above the ground. Sometimes the trip was very rough and, for that reason, a big garbage can was kept in the back of the aircraft.

The flight test group did signature work around the world, on all types of radar and communications networks, and I was proud to be a part of that group.

J. D. Batteas, LM
Carrollton, TX

Contribution of Electrical Engineers During WWII

During WWII, I served with a carrier air service unit (CASU 67), and many of our personnel were electrical engineers. Upon the Japanese surrender, we learned that one of our weapons concerned the Japanese prisoners almost as much as the atomic bomb. They thought we had a high-powered laser that would destroy their aircraft on night bombing missions over our fleet area land bases. If our search lights landed on one of their bombers, they believed it would disintegrate.

Actually our antiaircraft guns fired shells with proximity cases, armed, tracked, and fired in tandem with the searchlights coordinated by servo-mechanisms. To insure that friendly aircraft were not fired on, the guns were further controlled by IFF (Identification Friend or Foe), which was an FM-modulated pulse transmission that was also developed during WWII by electrical engineers.

W. Lewis Wood Jr., LSM
Memphis, TN

Ham Operators Find a Way

During the late 1930s, I was a student at Rhode Island State College and lived with a group in an off-campus dorm sponsored by a faculty organization. Among us were a few ham radio operators who were not, by house rules, allowed to have their transmitters but were permitted to have their H-F receivers. The faculty member who was supposed to be our monitor lived in another wing of the building. This was an unmarried young mathematics instructor who lived with his elderly mother. She was a lovely person who frequently baked cookies and the like for us, and he was always willing to assist us with our homework problems. It was an ideal situation especially for our ham operators whom he frequently brought over to his ham station and shared operations with them.

While the instructor was a fully qualified, Class A, licensed amateur operator, he was dedicated to devoting his efforts entirely to the recently opened 5-m band. Like so many of us during those years of the Great Depression, he was doing whatever he did on a shoestring budget. His homegrown transmitter was a single tube modulated oscillator (they were still legal in those days), using a Type 45 vacuum tube with its Bakelite base removed. (You can find a more elaborate two-tube version on page 129 of the 1934 *ARRL Handbook*. The cost of the Type 10 tubes that were called for was beyond the means of many of us at that time, and somewhat used Type 45 tubes were more plentiful.) His receiver was a one-tube super-regenerative, probably copied from the one on page 133 of that same *ARRL Handbook*, but as I recall was modified to use an ac powered rather than a battery type tube (probably a Type 27). With that miniscule "flea powered" emission and that not so super receiver, his DX'ing was generally limited to five –ten miles.

One evening, we heard a whoop and a holler from the other wing of the dorm. He came rushing over to gather us as witnesses. He had a solid contact with Los Angeles! Transcontinental! Three thousand miles! On his "sub-flea" power! Impossible, but there it was with a dozen or so of us as witnesses. This continued for several more evenings and finally Los Angeles faded into history.

This experience excited our young professor to the point that he decided that, budget or no, he was going to build a modern, up-to-date transmitter and receiver. It would have a crystal controlled oscillator and maybe as much 50 watts into the final. He worked on the design down to the finest detail and consulted frequently with any of us who were radio savvy. The crystals for ham use at that time maxed out in frequency at about the 40-m band and were quite expensive. So, he used a 160-m band crystal and doubled it until the frequency was within the 55–60 MHz limits of the 5-m band. I do not recall his output tubes, but they were a matched pair, running in Class B with plate modulation. His receiver was quite conventional and theoretically far more sensitive than the super-regenerative that he was using formerly. The design of the entire setup including a new antenna seemed perfect. Nothing was left to chance, and every detail was checked and rechecked by at least a dozen of us including the head of the Electrical Engineering Department, who was also quite radio savvy.

One day, our young math instruction announced to us that he would be finished wiring that evening and would turn the transmitter on for what today we would call a "smoke test." Evening came and we were all listening to our favorite radio programs and pretending to be studying our home work. Suddenly the professor's "CQ-TEST" call came in on our AM broadcast receivers—not just in one place, but all over the dial from 550–1500 KHz. Our embedded hams reported that their H-F receivers were getting him from 550 KHz to 30 Mhz.

He must have known that something was wrong, for he came over looking for help. With that many of us looking, we were sure to find something. We did, a wiring error in the transmitter. Normally, in a plate modulated transmitter, the secondary of the modulation transformer is connect in series with the B+ feed to the final stage in the R-F section of the transmitter. But it wasn't there. He had inadvertently connected the secondary of the modulation transformer in series with the common negative ground return from the power supply.

Instead of plate modulation, he was modulating every element of every tube in his system. Simultaneously, he had cathode modulation, grid modulation, screen modulation, suppressor modulation, plate modulation, a modulated oscillator, modulated buffer, modulated doublers, modulated drivers, and a modulated final.

This experience soured him on ham radio such that he never touched his ham rig again, at least not while I was there.

Paul Painchaud, LSM
Brea, CA

A Coil with a Different Twist

I spent my entire 45-year engineering career trying to make sure that electronic components worked as they were intended and analyzing why when they did not. Early on, I found that I could not completely trust prints and specifications. In about 1957, my employer was designing an electronic stabilizing package for U.S. Air Force aircraft. At the heart of the circuit was an LC tuned oscillator. Critical to this circuit were precision pairs of RF chokes and capacitors, packaged tightly cordwood style.

To meet the frequency and stability specs, the choke coils had to be known to be better than 0.1% tolerance. No manufacturer produced to better than ±1 (1.0)% at the time. However, once wound, the selected coils were extremely stable. The circuit designers had found that they could pair selected chokes with capacitors to meet their specs. They gave me chokes that would work as reference units. My job was to set up a precision measuring system that would match coils selected from lots of 1% units to the reference standard to better than 0.1%. I cobbled together an extremely sensitive comparison system for the chokes (and the capacitors) using decade capacitors, a Gertch box, appropriate shielding, and an extremely sensitive differential voltmeter. It was very stable.

For several months, I was churning out pairs matched to better than 0.1%, and the assembled tuned circuits worked perfectly. But then, disaster struck. The modules were skewed way off frequency. By substituting parts, it was clear that I was no longer selecting coils that worked. What could be wrong?

I checked and rechecked those circuits. All was well. The measured inductance of the offending coils precisely matched the reference standard. Almost by accident, I checked the magnetic polarity of the coils. An energized unit brought close to the sensitive voltmeter caused the needle to swing the opposite way. More definitive measurements indicated that the north pole of a dc-biased "nonworking" coil was at the opposite end of the color-coded end when compared to the reference units.

I'm not sure that the circuit designers were fully aware of the importance of consistent installation of the coils. In these tightly packed circuits, the effective inductance of one coil was affected by all the magnetic fields of the units around it. The dc bias currents flowing through all the units in the cordwood stack caused this interaction, but it made no difference as long as the assemblies were physically the same as the originally designed units. The actual inductance measured in the lab was quite different from the effective inductance of the packed units. However, the measuring circuits were well shielded, so there was no effect from external fields.

Part of one mystery was solved. Different polarity. Now, the question became why. The procurement drawings had not specified polarity, nor did the manufacturer offer this option. Calls to the manufacturer provided no help. He had made no changes, and pole reversal seemed impossible.

The only possible explanation seemed to be in the winding. These were very small, vacuum impregnated epoxy-encased coils wound with AWG #56 wire, a real challenge to disassemble. Nevertheless, in a week, we were able to get far enough into the winding to see that the recently received units were wound oppositely from the original units relative to the color-marked ends.

"Impossible!" said the manufacturer's design department. But I had the evidence and flew to the plant where I insisted on a tour of the assembly floor. At the site of the coil-winding machines, I talked to the foreman, a tech who had been there when Edison was a young kid. Confronted with the problem, he checked his machines. Unknown to his design department, these were quite old winders. While very serviceable machines, they operated on dc current. Also unknown to the designers was a plant shutdown a month earlier during which the machines were disconnected for service. When reconnected, the driving voltage leads were reversed, and the machines wound coils quite well but backwards. Polarity had never before been an issue for RF chokes.

Our drawings were quickly revised to include polarity. Production was successfully resumed. I developed a life-long suspicion that problems might be caused by parameters or tolerances not in the component specifications.

R.J. (Dick) Backe, LM
Gettysburg, PA

Radio-Frequency Interference

In 1964 while pursuing my BSEE at the University of Kentucky, I was working full time as chief engineer and morning DJ at a small AM radio station.

I received a letter at the station from the engineer-in-charge of the Detroit FCC office. He had received a complaint from someone in our town about a ham radio operator interfering with his radio to the point that he couldn't even receive our local station. The FCC had no one in the area, and he asked me if I would look into it. I was the only ham operator in the county at the time, and I operated only from my car, so I was pretty sure that ham radio had nothing to do with this problem.

I visited the gentleman, who was about 85 years old. He had a Kentucky professional engineer's license (civil) hanging on his wall. He told me it was the first one issued in the state. He was hopping mad about the interference.

He turned on his radio and the room filled with the noise, which is associated with severe electrical arcing. Sure enough, he couldn't receive any stations. I walked around the neighborhood and quickly noticed a large pole pig transformer that was arcing internally. I could hear the zapping 50 ft away. Also, it was leaking oil (or something). I could read the date code on the transformer, May 1916.

The power company replaced the transformer and all was well.

Thomas W. Webb, LSM
Plano, TX

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The *IEEE Life Members Newsletter* is distributed to Life Members and those who are not Life Members but are 1) IEEE members 65 years and older, 2) retired IEEE members aged 62–64, and 3) members of special boards and committees.

Submitting Articles

We welcome articles for this newsletter. In particular, we seek articles about projects that are initiated at the Section and Region level by Life Members as well as "Tales from the Vault," which should focus on novel or interesting technical issues. The suggested length for "Tales from the Vault" submissions is 500 words.

Acronyms should be completely identified once. Reference dates (years) also should be included. Editing, including for length, may occur. If you wish to discuss a story idea before hand, you may contact Emily M. Smith, managing editor, by e-mail at lm-newsletter@ieee.org. The deadline to submit an article for possible inclusion in the next issue is 5 November 2007. Please include your Life grade, town, state, country, phone number, member number, and/or an e-mail address with your piece.

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