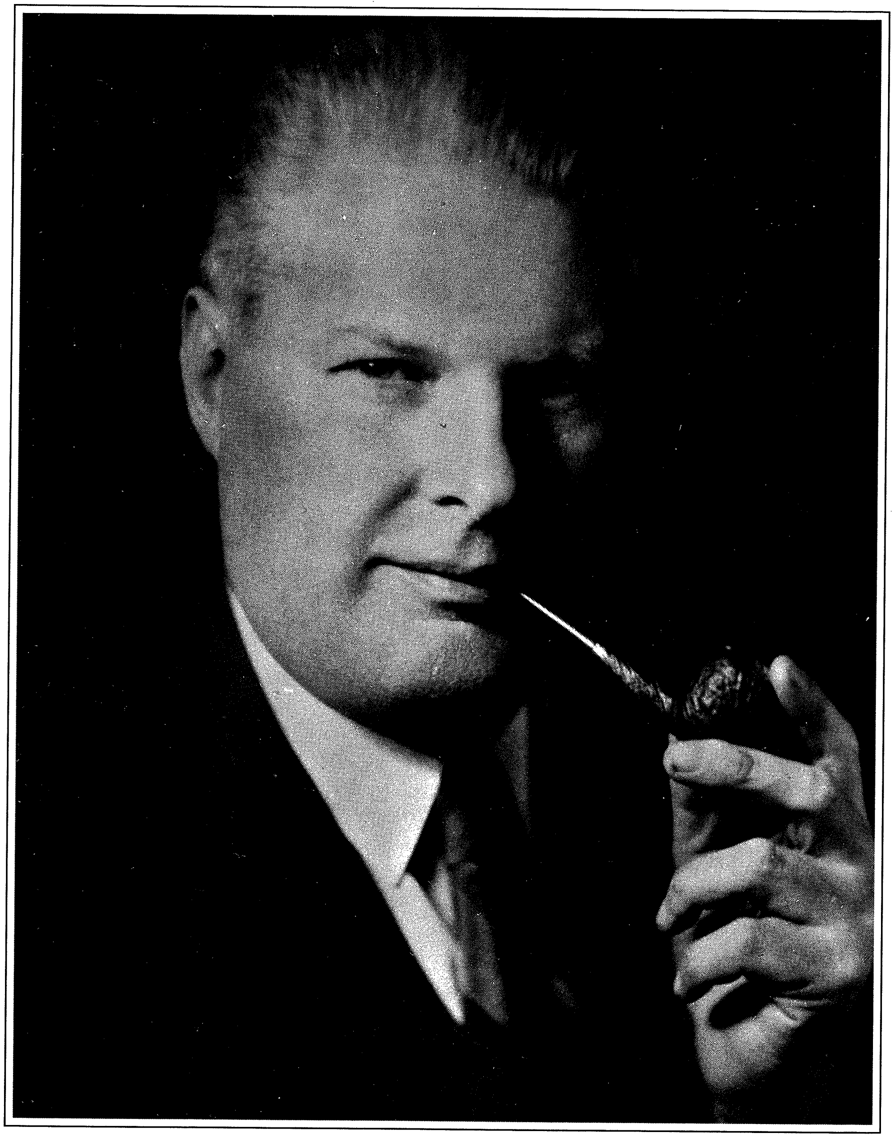
PROCEEDINGS OF

THE RADIO CLUB OF AMERICA, INC.

Founded 1909, New York, U.S.A.

May 1993



DR. HAROLD H. BEVERAGE
1893-1993

THE RADIO CLUB OF AMERICA, INC.

Founded 1909, New York, U.S.A.

Executive Secretary: 11 Diamond Court, Glen Rock, NJ 07452

Proceedings of The Radio Club of America Volume 67, Number 1 May 1993

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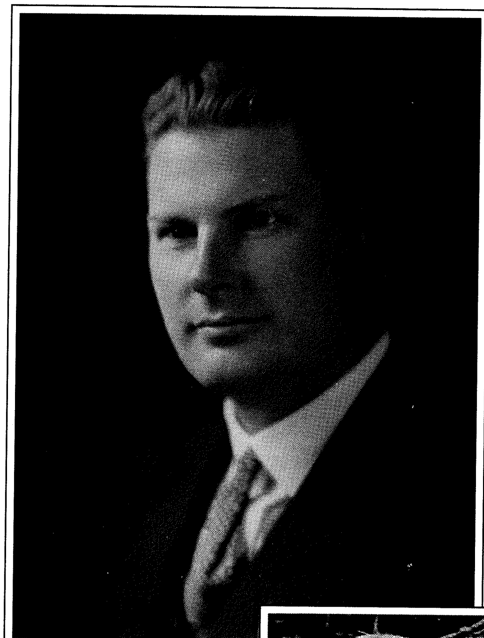
A tribute by
John Marshall Etter

HAROLD H. BEVERAGE

1893-1993

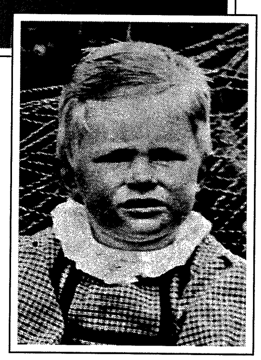
On Jan. 27, 1993, the Radio Club of America lost one of its oldest members, in both age and years of service, with the passing of Dr. Harold H. "Bev" Beverage of Stony Brook, Long Island, New York. It so happens that in April 1989, representatives of the RCA visited Bev at Stony Brook, and that visit resulted in an article in the November 1989 *Proceedings* related many of the things covered by the biography *Genius at Riverhead* by Alberta Wallen. Therefore, I am going to try to relay to you, in words and pictures, some of the happenings in Beverage's work from 1918 through a part of 1923. Keep in mind that, in looking back 70 to 75 years, there can readily be questions concerning exact dates. Any suggested corrections would be welcome.



Harold Beverage, about 1920

Bev's first major assignment was the application of a Barrage receiver at New Brunswick, New Jersey. This work is described in *Genius*. Photo 1 (next page) shows a receiver as pictured in the GE *Review* for October 1920. The actual receiver was probably not as nice looking as this one but no doubt was similar in operation. Photo 2 (next page) shows a rear view of a truck with New Jersey 1918 plates that appears to have been used for wire stringing and measurement purposes at that time. This photo was in Bev's files.

Bev continued this type of work at NBD at Otter Cliffs, Maine, in 1918 and 1919. He had a photo of a Barrage receiver in operation at NBD in 1918, the original of which was sent to the Naval Archives in Winter Harbor, Maine in 1968. A poor copy of this remains in Bev's files but it is not suitable for copying. A print of still another receiver in service at NBD in 1919 will be found in Photo 3 (next page). How this tied into the Barrage receiver operation is not known to the writer. In the summer of 1919, Bev again returned to Otter Cliffs to install a second Barrage receiver and to repair some of the ground wires. Incidentally, before leaving the matter of NBD-Otter Cliffs, I should point out that Bev and his wife, Patricia, were guests at the 50th anniversary celebration of the August 1917 opening of Otter Cliffs Station held at Winter Harbor in August 1967. At that time, Bev met with several of the 1918 NBD staff with whom he had corresponded during the intervening years. It would be nice to have tapes or other records from those meetings. For the further information of our readers,



...and in 1895.

Bev and I had a lot in common ... but I had one big 'winner' – I knew Bev for fifty-six years.

in the early 1930s, John D. Rockefeller acquired the Otter Cliffs area for transfer to Acadia National Park in exchange for a large area on Schoodic Point on the eastern side of Frenchman's Bay after lengthy propagation tests convinced the Navy that radio conditions over there compared favorably with Otter Cliffs. The new installation became known as the Winter Harbor Naval Security Group. A large area at Schoodic was also added to Acadia National Park.

You have probably seen the picture of the 1920 laboratory at Riverhead by now. Here, for the record, is a better picture (Photo 4) of that "touring car" in the background of that group. This car was used for transportation along the Wave antenna that summer. It appears that it was also used for just "relaxing." At some time during that first summer at Riverhead, a "temporary" receiving building was constructed. This came to be known as the "White Shack." The first active longwave receivers at Riverhead were installed in this building (Photo 5). The next photo of interest, taken in front of the White Shack, shows that the girls of 1920 were interested in wireless,

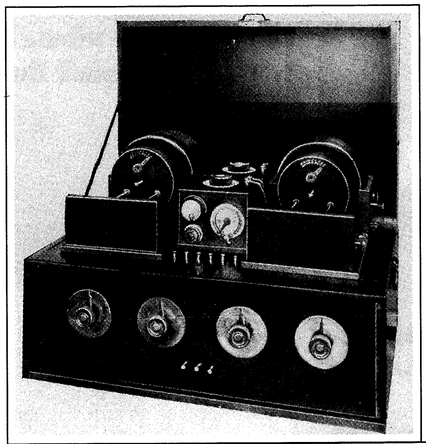


Photo 1. *Barrage Receiving Set assembled in carrying case.*

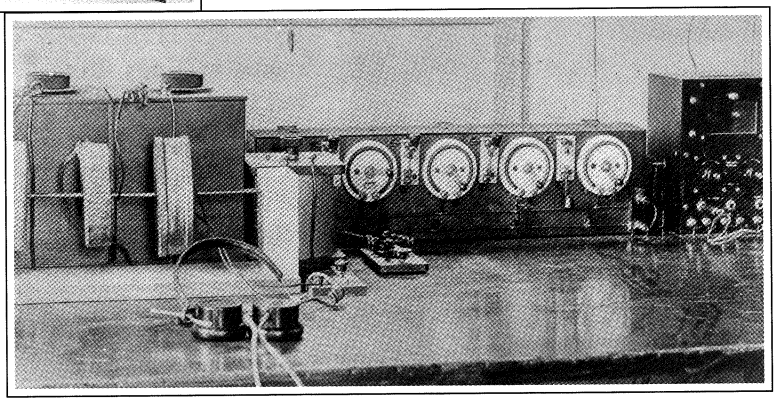


Photo 3. *Composite long wave receiver in field shack, Naval Radio, Otter Cliffs, Maine in 1919.*

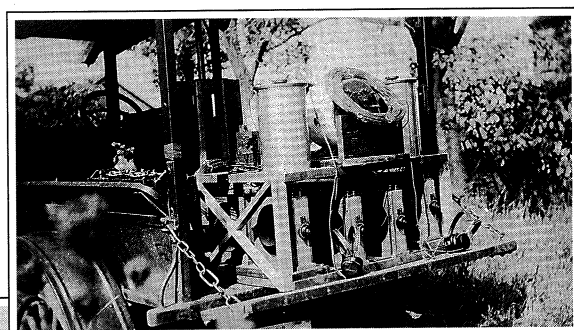


Photo 2. *Rear view of the truck used for measuring purposes.*

Photo 6. *Girls were interested in "wireless", too.*

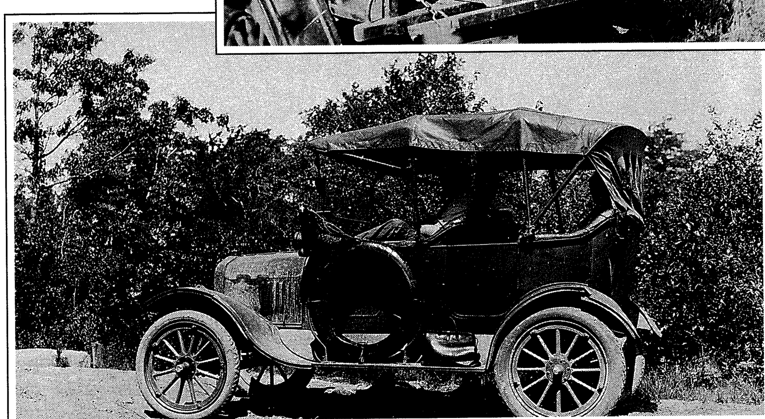


Photo 4. *The "Touring Car".*

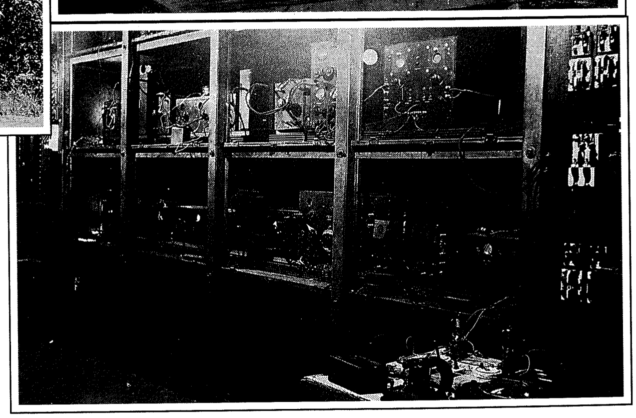


Photo 5. *First multiple receivers at White Shack, about 1920.*

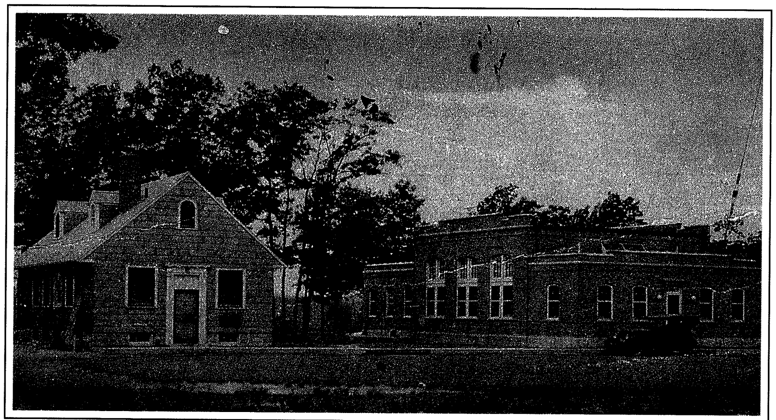


Photo 7. *Radio receiving station of the Radio Corporation of America, Riverhead, Long Island, New York. Building #1 on the left was the first permanent receiving building constructed in 1921. Building #2 on the right was constructed in 1922.*

too (Photo 6).

In May 1921, the first "permanent" receiving building was placed in service. This was Building #1. This was followed by Building #2 in 1922, as long waves were expanding beyond the capacity of #1 (Photo 7). Six longwave receivers were placed in service in #1 (Photo 8). In early 1921, two Wave antennas had been built – E-1, 9 miles long, and E-2, 7 miles long. Somewhat later, SA-1 was built for South America reception, and a third European antenna, E-3, 7 miles long, was built at some distance from E-1 and E-2.

By this time, the local people were beginning to wonder what was going on over there to the south of Riverhead. One day, a man named Frank Woodhull visited the crew working on the ground system out in the field. It is not known if there was any conversation between the Radio Corporation of America employees and him, but when he returned home he was asked what was going on. He replied, "It will never amount to anything. They spent the whole day trying to electrocute a snake."

Then, on July 2, a local boy named John Benedict visited the Radio Corporation station, and while there he learned from the Radio Corporation men's reception by radio of the broadcast of the Dempsey-Carpentier fight that Dempsey had won. John returned to town and told several people that Dempsey had won, but nobody would believe him. Bev and the others should have headed for town and placed a few bets! Not too many people on Long Island had radio receivers in 1921. John later went to work for the Radio Corporation at Riverhead and was our office supervisor when he reached retirement age.

Things were beginning to really expand during this year, and in September 1921, the Radio Corporation took over coastal stations of the International Radio Telegraph Company in Belfast, Maine; Siasconset, Massachusetts; New London, Conneticut; and Cape May, New Jersey. Immediate development started at Belfast. And, of course, Rocky Point was nearing comple-

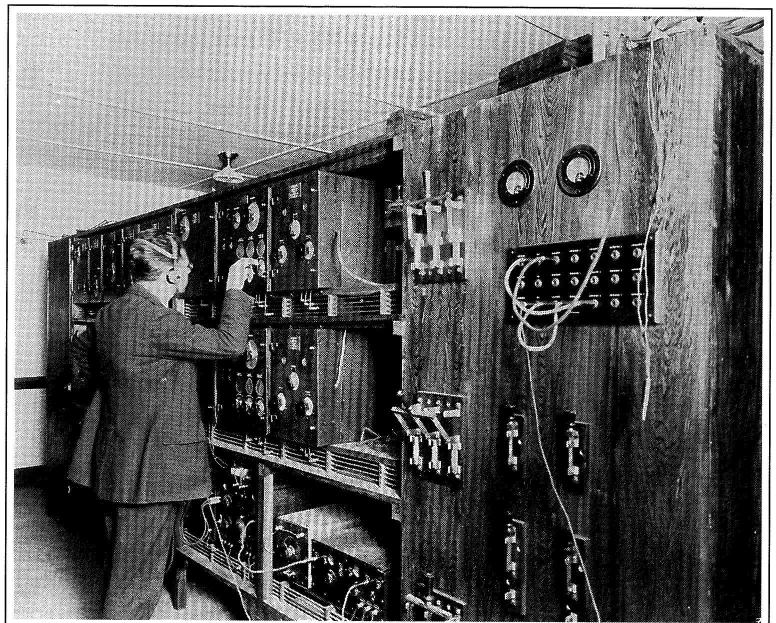


Photo 8. *Long wave receivers at Riverhead, 1921 in Building #1.*

Photo 9. *Long wave receivers at Belfast, Maine similar to L/W receivers used at Riverhead Building #2.*

tion in November 1921. Twelve 410-foot towers with 150-foot bridgearms at their tops were built to form two separate antennas to be fed by two 200kW Alexanderson alternators. Bev, of course, was on the go continually. He was present at the Nov. 5 opening ceremonies at "Radio Central," but left right after that on the *Aquatania* for England to meet with Marconi and then continue on to Brazil where a group of companies planned to install two Alexandersons in a large station down there. Details concerning the eventual facilites down there will not be discussed herein, since the station design was changed by the approach of short waves.

With the rapid increase in traffic-handling demands through Riverhead, it soon became evident that during conditions that were deteriorated by heavy static, there was need for at least a partial solution. The station at Belfast was one choice, since it had only half as many thunderstorms per year as experienced at Riverhead. By mid-1923, Belfast was in service with a Wave antenna 10 miles long with the same type of receivers as used at Riverhead (Photo 9), but in the case of Belfast, signals were to be automatically relayed via radio to Riverhead and thence on to New York via the usual wire lines. Of course the approaching short wave onslaught would shorten the useful life of Belfast and also that of the long wave facilities at Riverhead. Perhaps in a future article some of the behind-the-scenes activities of our short wave days can be brought to your attention.

As usual, Dr. Beverage and his men were leading the way.

Editor's note: Mr. Etter included the following reminiscence with his story.

3/12/93

Dear Don,

I sat here for more than half an hour trying to wind up with some sort of a personal ending but it only produced tears.

Bev and I had a lot in common: I was born 32 miles from him in Trenton, Maine; I was born 22 years after him; I graduated from the University of Maine 21 years after him; I retired from RCA 21 years after he did; I started with RCA 21 years after he did. But I had one big "winner" — I knew Bev for 56 years, '37 to '93.

Regards,
JME

Biography of Harold Beverage

Born:

Oct. 14, 1893, at North Haven, Maine

Education:

B.S. in Electrical Engineering, University of Maine 1915

Employment:

General Electric Company 1915-1920, laboratory assistant to Dr. Alexanderson; Radio Corporation of America 1920-1958, radio receiver research until 1930/chief research engineer 1930-1939/vice president research and development 1940-until retirement in 1958/consultant to Radio Corporation after 1958

Personal Interests:

Amateur radio: first licensed 1911, (W)2BML 1919; photography; sound re-recording

Professional Organization Membership:

Radio Club of America: Member 1920/Fellow 1926/ Honorary 1983/Director 1933-1934; Institute of Radio Engineers: President 1937; American Institute of Electrical Engineers; American Association for the Advancement of Science; International Geophysical Union; American Radio Relay League

Important Accomplishments:

Development of the Wave ("Beverage") antenna; co-inventor (with H.O. Peterson) of the "Diversity Reception System"; eight published papers; 41 U.S. patents

Honors and Awards:

Presidential Certificate of Merit 1948; Armstrong Medal, Radio Club of America 1938; Honorary degree, Doctor of Engineering, University of Maine 1938; numerous other recognitions

Died:

Jan. 27, 1993, at Port Jefferson, New York.

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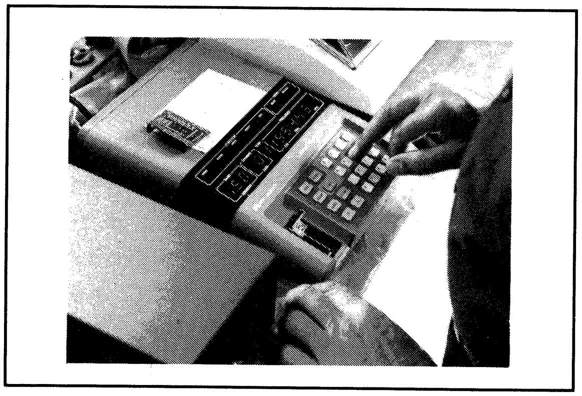

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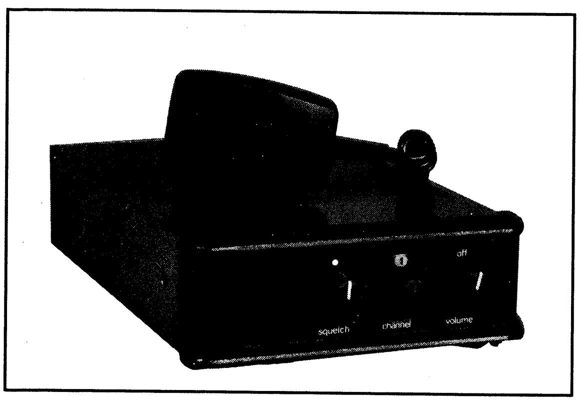

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Inspiring The Youth

By Carole Perry, WB2MGP

So you have some free time and you're looking for a worthwhile endeavor to sink your teeth into! I have just the project for you!

There is no better investment in the future of our society than to influence the development of children in a positive way. For the large number of retired, successful, and vital members of the Radio Club of America, a visit to your local school may have more of a profound effect than you can begin to imagine.

More than 12 years ago, an innovative principal in a local intermediate school in Staten Island, New York gave me the opportunity to write the curriculum for a pilot program in the Industrial Arts/Technology Department at his school.

When I observed the excitement that could be generated with the students who had been labled "losers" or "reluctant learners," I knew that the proper presentation of this material could give these kids a second chance to succeed in school.

Knowing that there was an increasing problem in the schools with the short attention spans of teenagers and the lack of high motivational courses being offerred, I tried to come up with a program that would have appeal to all the children; not just the brighter students. "Introduction to Amateur Radio" fit the bill perfectly.

Fifteen years ago I worked for an electronics manufacturing company as an educational consultant. I called upon my contacts and resources from that period of time to help me develop materials that would be appropriate and exciting for the children to use in the amateur radio classes.

Curriculum package

What evloved over the years was a curriculum package that any highly motivated teacher can use in the classroom to add a little "zip" and excitement to whatever subject he or she may be teaching.

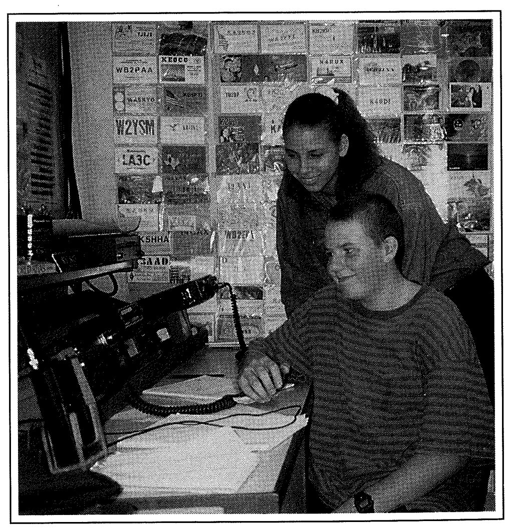
When I observed the excitement that could be generated with the students who had been labled "losers" or "reluctant learners," I knew that the proper presentation of this material could give these kids a second chance to succeed in school.

The beauty of using amateur radio in the classroom is that the myriad of skills and techniques involved allows every child a chance to be good at something; even if it's only learning how to speak clearly and succinctly on the radio, or how to locate places quickly on a map or globe, or how to send their names in Morse code.

There are more than 425 children a term who come through my program; and almost all of them will leave feeling better about themselves and more positive about the school experience.

Guest speakers

One of the keys to success in the pro-



Visits from guest speakers motivate students to do better. Matt, KB2OJI, and Bianca speak to a local businessman via radio about paying a visit to their class.

gram is my policy of inviting guest speakers with different expertise to visit my classes. This is where any member reading this can play a role.

You might not have the time or inclination to set up weekly demonstrations in a classroom or to set up an after school program, but even one lively demonstration or talk in your own area of interest and expertise can have a real influence on the youngsters.

In an age where there are lots of negative forces competing for the time and minds of young people, I really believe that all responsible adults have an obligation to do what they can to help keep the kids on the right path towards becoming productive members of society and good citizens.

I've had blind and wheelchair-bound ham radio operators visit my classes and "inspire" the children with their stories of determination and perserverance. About 5% of my students have some kind of physical or learning disability, and they love the chance to be exposed to these great role models.

When someone from the outside takes the time to visit children in a school, you convey the message that these youngsters are important and special enough for you to come to them and share your experiences with them.

Contacts with astronauts

My classes have been fortunate enough to have had radio contacts with some of the astronauts from the Johnson Space Center. After each contact I always ask the kids what they like the best about speaking with them.

Inevitably, the answer is that they felt "special" because the astronauts took the time to talk with them and to answer their questions.

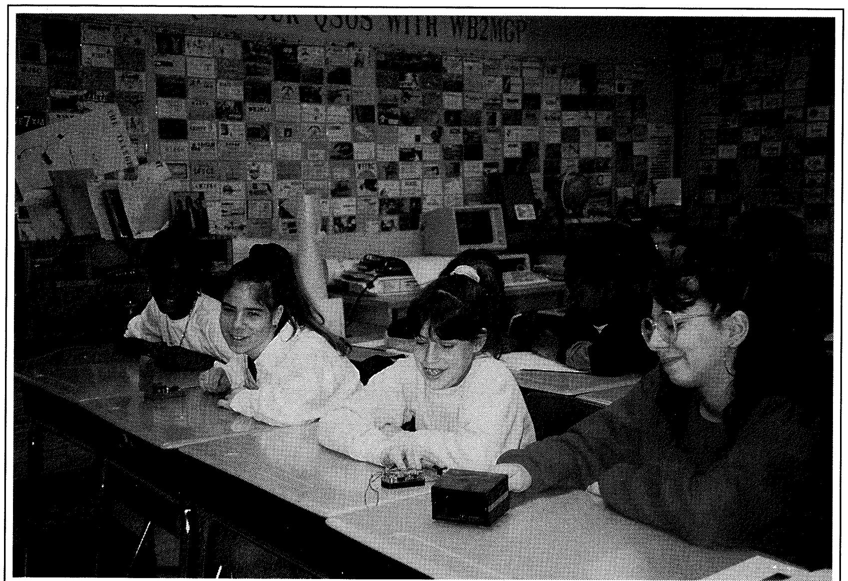
The same reaction takes place when local business people in the electronics industry or aerospace industry visit our classroom.

Many kids today aren't in a position of having a significant amount of positive adult influence in their lives. I can see tangible evidence of just how important this adult intervention is.

If you are a ham radio operator, you can ignite all kinds of excitement in a classroom setting with a live demo. Work with a teacher who can reinforce what you teach with follow-up lessons.

Don't be surprised when you get invited to come back again. Before you know it, you may even have the

(Continued on page 33)



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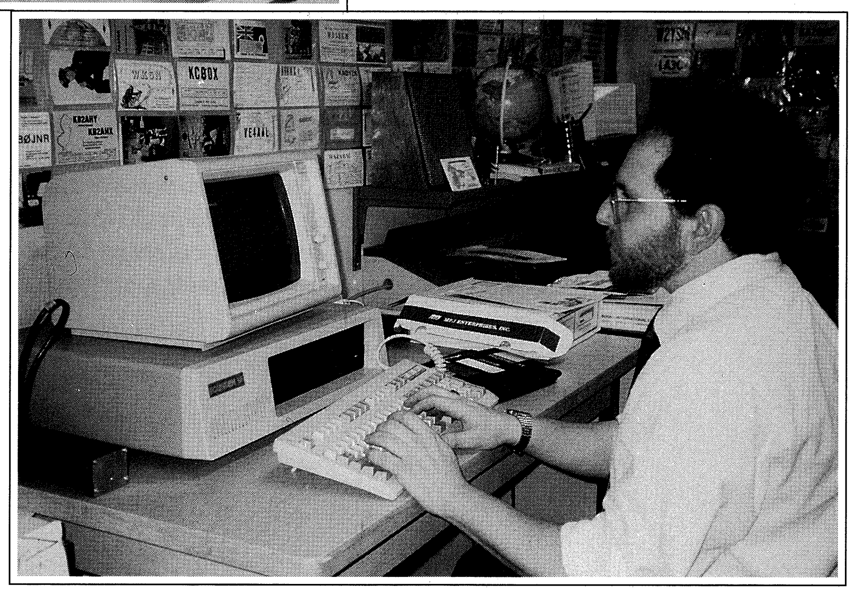
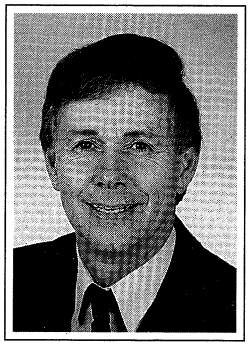
Combining the eagerness and curiosity of youth with the wisdom and experience of age is a winning combination in a classroom. The kids respond eagerly to guest speakers.



▶

Andy Funk, KB7UV, visited the classroom to help to set up a packet radio station. He told the kids how amateur radio influenced his choice of a career as a technician at WCBS-TV, New York.



Fixed Service Radio in The Netherlands

By Louis Meulstee PA0PCR

This paper, concluding a series of three, deals with the most colorful and fascinating part of Dutch radio history: the long-distance fixed radio communications service.

A vast number of available historical records and references in this field were reviewed, and the story of Kootwijk radio, the first Dutch long-distance fixed service radio station, was selected as one of the most interesting.

For just a few hours during the night when conditions were unfavorable, the alternator transmitter PCG would give relief.
This was only the start of the very tempestuous development of the shortwave service of Kootwijk radio, which is actually continued up to today.

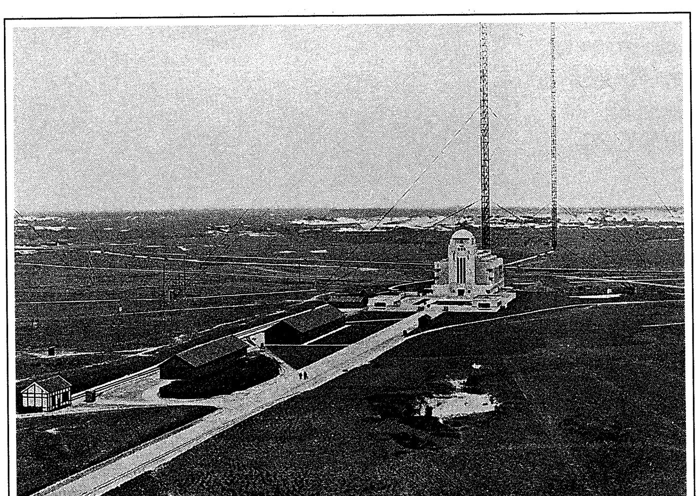
Although the Kootwijk station was built initially for linking the homeland Holland to its former East Indies colonies (now Indonesia), traffic was soon expanded to many other countries.

The initial transmitter, a Telefunken alternator for VLF operation only, was virtually obsolete by the time the station was inaugurated. Much of the traffic was soon taken over by shortwave transmitters operating on a fraction of the alternator's power. Nevertheless, the alternator remained operational for regular traffic (e.g., to the USA) and during some nighttime hours when shortwaves were unreliable on the Dutch East Indies link.

Besides the technical and historical details, other interesting station aspects, such as architectural features, are dealt with. A further reason for selecting Kootwijk as subject for this paper is its present status as a fully operational primary PTT Telecom HF transmitting station and the recent addition the station's main building to the Dutch List of Historical Monuments.

The history of Kootwijk radio would not be complete without mentioning its initial counterpart: Malabar radio in the Dutch East Indies.

Though briefly discussed here, in a future article the author will provide a more comprehensive description of the fascinat-



'...in the middle of an infertile, desert like, plain...' Kootwijk radio was photographed about 1923 from top of the water tower. Five masts are arranged in the corners of a hexahedron, and a sixth mast (near the main building) is located in the center. The masts are connected by copper wires that form the aerial in the shape of a umbrella, which was a configuration Telefunken commonly used at the time. Only three of the huge 212 meter masts are visible. Note the 'B' building, nearest to the main building, which housed the station's first shortwave transmitters.

ing history of the 2.4 Megawatt "big arc" transmitter of Malabar radio and the magnificent work of Dr. ir de Groot.

To provide a wider understanding, it was considered essential to provide relatively more space to the case history and historical background of Kootwijk radio.

The history of radio and of major radio stations is often loaded with (inter)national politics and internal quarrels, and the Kootwijk station history is no exception. Competition among colonial departments in Holland and the Dutch East Indies government made the life of contemporary PTT radio engineers most difficult.

Dutch colonies

During the second Boer War (1899-1902) between England and the two South African republics, cable telegrams to South Africa were censored by the British, who had direct control of the cables where they passed through Aden.

In Holland, which at the time was strongly biased towards the Boers, this obvious measure was especially felt. This incident was, no doubt, the reason why the idea of independent communication from Holland to its colonies was conceived.

After the Boer War, independent communication to the Dutch East Indies was sought by means of the inauguration of the German-Dutch Cable Company, opening way to telegraph from Dutch East Indies to Europe via the USA or via China and Siberia. However, very soon, indications of British influence on the USA cable were apparent, and very early in World War I (after the capture by the Japanese of the Island of Yap), the solution proved to be a failure.

Before World War I, several plans were devised for radio communication between Holland and its East Indies colonies, the scheme by Professor van der Bilt being the most promising and advanced. His ideas were linked with the projected British Imperial Wireless Chain of three intermediate relay stations: Tripoli, Italian East Africa and Ceylon.

In early 1914, the plans were abandoned because World War I made it clear that the intermediate stations would have been as vulnerable as cables.

In 1916, as a war-time measure, all British controlled cables (i.e. between neutral Holland and Dutch East Indies) were again censored. As a result, the Dutch East Indies government, which suffered the most, made immediate plans toward the final solution: direct radio communication to its homeland.

Dr. ir de Groot

In 1908, C.J. de Groot, a brilliant *practical* scientist, arrived in the Dutch East Indies, appointed to a function at the Dutch East Indies PTT telegraph department.

However, displaying interests in and possessing sound knowledge of the field of radio, he quite soon was assigned to direct the installation of a chain of radio stations in the Dutch East Indies for local communication. The experience with propagation among the stations, not very much understood in those days, enabled de Groot to obtain a large proportion of knowledge.

This culminated to his famous Ph.D. dissertation "Radio-Telegrafie in de Tropen"[1], which he promoted at the Delft Technical University during his leave in 1916. One of his major (and historically best known) statements of the dissertation was "...direct radio communication between Holland and the Dutch East Indies without the use of intermediate stations is a political necessity and technically feasible..."

Two names are clearly marked in the history of Dutch radio: (left) Prof. dr ir N. Koomans (1879-1945) and (right) Dr. ir. C.J. de Groot (1883-1927). With de Groot in Dutch East Indies and Koomans in the motherland, PTT had two equally gifted and progressive leaders.

In late 1916, just before leaving Holland, de Groot visited the Telefunken Company where he was offered the loan of a receiver to listen to the German radio station at Nauen. On his return trip to the Dutch East Indies, he made a detour to the USA, staying two days

[1] "Radio-Telegraphy in the Tropics", the text of the dissertation printed in a limited edition, was bound in the Dutch East-Indies and prepared on very fine cloth, and is now a highly sought collector's item.

at the Federal Telegraph Company, where he purchased a 100 kW Poulsen arc. There, de Groot received instructions on how to increase the power of this type of arc transmitter, which would enable him to make direct contact with Honolulu Radio and thence via neutral USA to Holland.

However, during de Groot's absence, it was shown that powerful European stations such as Nauen, Eilvese, Bordeau and Carnarvon were received quite regularly in the Dutch East Indies.

This gave de Groot confidence in his initial plan: direct radio communication with Holland. Of course, his ideas were welcomed and backed up by the Dutch Indies Government, which gave his plans almost unlimited credits.

When the Federal Telegraph Company arc transmitter arrived in August 1917, work had already been much advanced on the transmitting station site.

Mountain gorge aerial

Because of the war, no adequate supplies of steel were available for building the planned tall aerial masts. This led to Dr de Groot's splendid idea in using a mountain gorge to suspend an inverted L aerial. In the Malabar area, very near Bandoeng (Java), a suitable site with the right orientation was quickly found.

In November 1917, a temporary installation with an improvised aerial had been completed and was operating on either 8,000 or 16,000 meters. Of course, only one-sided communication would be possible because no suitable transmitter had yet been built in Holland.

The initial power source, a makeshift arrangement including a spare generator of the Batavia Electrical Tramway Company driven by a borrowed aircraft-engine, limited the power of the Federal arc to only 40 kW. From that time onward, regular signals were given on the hours of the day which were regarded as most suitable for communication to Europe.

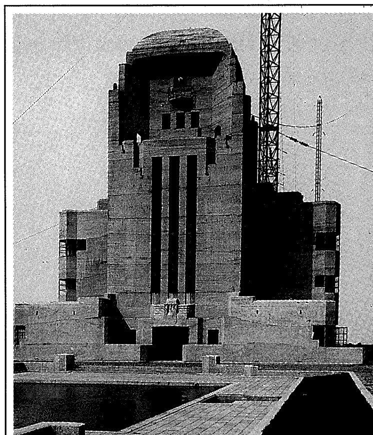
Messages were sent to Holland (i.e. the Dutch Naval Telegraph Service) but as apparently no suitable receiver seemed to be available, none were received.

Naturally the East Indies Government was not very pleased with this excuse, and in an Dutch East Indies paper of that time exceedingly strong language ("treason") was used to describe the failure.[3] According reports of the Dutch East Indies government, the apparent refusal to listen for messages caused a delay of more than a year for the whole project.

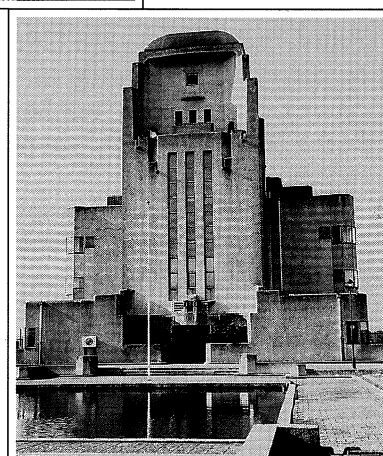
Later on in 1918, because still no steps had been taken in Holland to listen to the transmissions, a 3-valve receiver made in Dr de Groot's workshops was sent to Holland on an armored cruiser of the Royal Dutch Navy. Earlier on, it had been found that the borrowed Telefunken receiver was not really suitable; a new receiver had been developed locally and this type was hurriedly copied and sent to Holland.

During the journey, the Malabar transmitter was heard regularly. Even at the longest distance, the antipodes of Malabar at the crossing of the Panama canal, clear reception was recorded. That was a record distance for reception at the time. A new generator, powered by a water turbine, had been installed by then to increase the transmitter power to about 200 kW.

In mid 1919, upon the receiver's arrival in Holland, a receiving station at De Meent (in the center of Holland) was built, partly as a private venture and partly at the expense of the Dutch East Indies government (!), and almost instantly Dr de Groot's signals were heard.[7] Only after a struggle of one-and-a-half years and the intervention of the East Indies government, the first milestone, a direct radiopath, although one-sided, was achieved. By that time, the war was over and the cable blockade had been lifted.



This is the main building's front entrance and cooling pond at Kootwijk Radio in 1924.



This is the main building's front entrance and cooling pond at Kootwijk Radio in 1993. Apparently, nothing has been changed since 1924 except the tall aerial masts.

Big Arc

Although the original Federal arc had been modified to raise the power to about 200 kW and the provisional mountain aerial had been improved, communication was still considered as not yet very reliable.

Dr de Groot decided to build a more powerful arc transmitter with a primary energy of approximately

2,400 kW and, additionally, to extend the mountain aerial. With this arrangement, he calculated that communication would be possible over a much longer part of the day. Because Dr. de Groot's work is not generally known, except in the Dutch language, the author has made this story a subject for a more extensive future article.

No coal for Holland...

In 1917, the Dutch government had been advised about the purchase of radio equipment for communication with the Dutch East Indies.

Two competitors were considered to have the capability of completing the project: the British Marconi Company and the German Telefunken Company. However, as it happened, one of the Governmental advisers, Le Roy, a former director of the German-Dutch Cable Company who was pro-German and who was connected to Telefunken, the Marconi Company, quit.

In September 1918, the order was given to Telefunken. The whole project included building a transmitting and receiving station in Holland and the same combination in Dutch East Indies, both technically identical to the powerful German radio station at Nauen.

In 1917, anticipating a possible big order, Telefunken had dispatched, at its own expense, a temporary 100 kW alternator transmitter for Dutch East Indies to establish improvised communication for Holland via the German Nauen station.

This measure was not really accepted by East Indies officials, and the transmitter lay dormant at a Surabaya store. After a while, the transmitter was installed because instructions telegraphed from Holland insisted that it be installed and, if it were not, Germany threatened to stop the export of coal to Holland.[5]

The site of the temporary Telefunken alternator transmitter, not very far from Malabar, was ready in late 1918. During the 1919 experiments, the station proved much weaker than the Malabar arc, primarily due to its lack of power and relatively small aerial.

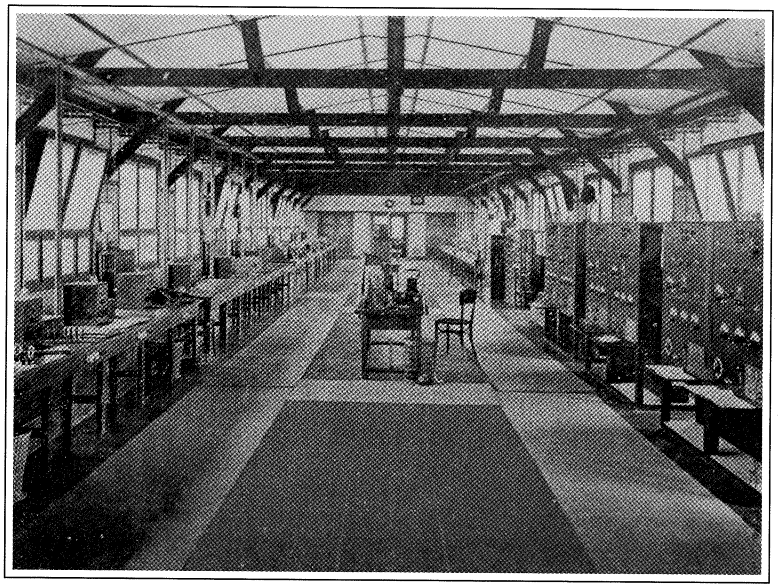
Receiving station

In late 1919, as part of the Telefunken contract, a receiving station had been built under the supervision of Dr. ir Koomans (of whom we will hear more later) at Sambeek, in the southeast of Holland, about 70 km from Kootwijk.

The completion of the Sambeek receiving station started a friendly competition between the Dutch PTT station and the De Meent station of the Dutch Indies government.[7] But as the Sambeek station was gradually improved and modernized, the reception station of De Meent could not keep pace and was forced to close. However, its necessity had been proved by then.

Telegrams received from Dr de Groot's arc or the definite 400 kW Telefunken alternator (which had been installed by then using part of Dr de Groot's Mountain gorge aerial) were further dispatched by line. In 1924, the Sambeek station was transferred to a site near The Hague, much nearer to the radio-office in Amsterdam and providing easier access and, consequently, closer contacts with the PTT radio laboratory.

However, the receiving conditions proved to be quite unfavorable, and quite soon another transfer was made to Noordwijk radio (NORA) on the North Sea coast, where it remained until 1950.



This is the interior of the receiving station Noordwijk Radio (NORA) as it appeared about 1936.

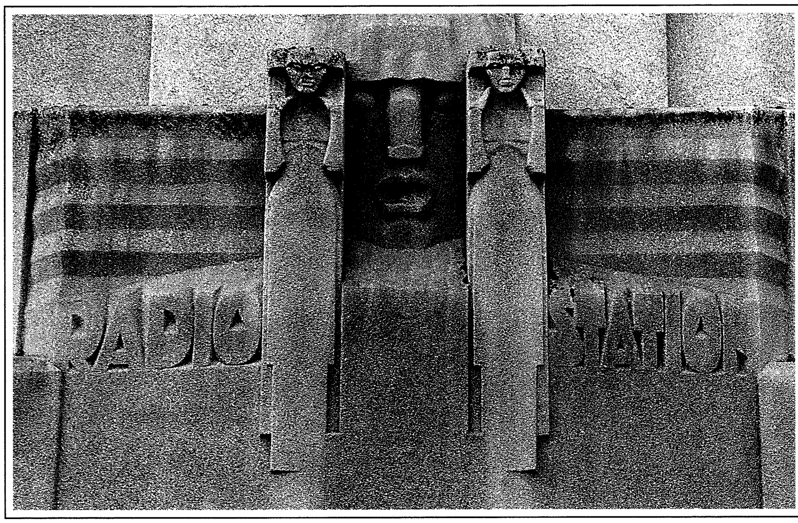
In December 1918, work on the Dutch transmitter station had already been started after a suitable site was found in the center of Holland where the state owned a vast area of land unsuitable for agriculture or forestry. Consequently, the land was very cheap, and work started immediately.

Kootwijk

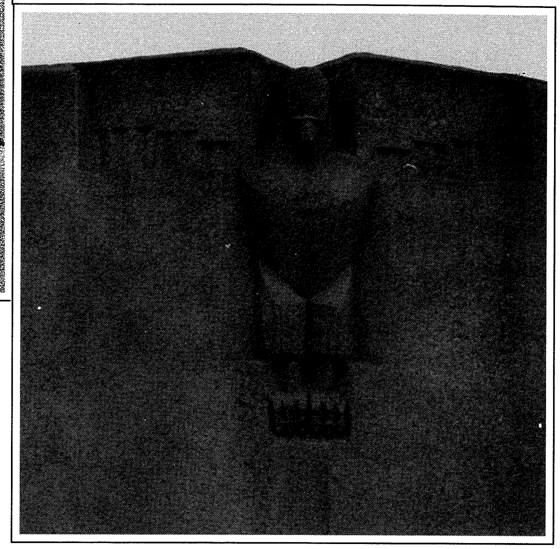
The transmitter site, near the village of Kootwijk, was (and still is) in the middle of an infertile, sandy, desert-like plain. It took six months to have the site leveled and made suitable for building.

The station building was designed by J.M.Luthmann (1890-1973), an architect of the "Amsterdamse school," a variation of the international Art Deco. There were no specific requirements when he took the job of the architectural design.

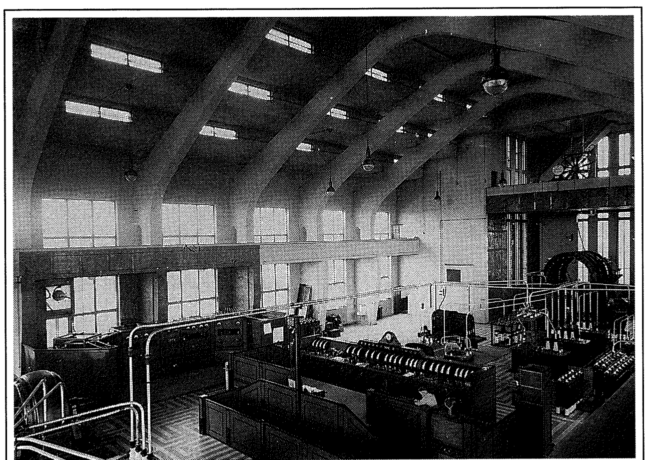
A short visit to the contractor, Telefunken, and to the German high power station at Nauen did not give



Above the Kootwijk station main building entrance is an allegoric sculpture (created by H.A. Van der Eijnde) depicting the transmitting station (the huge 'mouth') accompanied by two receiving stations (small listening figures).



At the back of the main building a stylized Eagle (also created by sculpturer H.A. Van der Eijnde) can be seen. With this sculpture, Van der Eijnde, inspired by German expressionism, paid homage to the alternator transmitter's designers. Particularly after World War II, this sentiment was out of favor. Nowadays, most people explain the eagle as the symbolized free flight of radio waves.



In the late 1920s, the hall in Kootwijk radio's main building housed the Telefunken alternator transmitter for station PCG. By then, valve-technology MF transmitters for European traffic had been installed (far left, beneath the windows).

Visible at the extreme left is one of the two alternators, in the center the control desk. Behind the desk are the saturated core transformer frequency multipliers and aerial inductances. The frequency of the alternator had been changed from 6,000 Hz to 5,600 Hz, and most of the traffic was concentrated on 16,800 kHz. Consequently, some of the frequency-multiplier equipment had been removed as no longer being necessary.

The design of the roofform touches the bows of the beams at right angles, making it possible to put up transom lights. With this configuration, Luthmann transformed the circle into right angles, as is easily seen in this picture.

This is how the hall in Kootwijk radio's main building looks today. Notice the former PCJ broadcast transmitter in the center of the hall with its hatches open, awaiting final restoration.

him anything to go on. Later Luthmann expressed: "...I just had to build a large building with a main hall and tower, definitely no wood or steel nails to be used, and above all it had to be completely dry...."

A design in reinforced concrete seemed to him to be the obvious (and only) choice. It was not really a daring idea because many other contemporary large buildings had been made with this material. It allowed construction of seamless walls and provided broad range construction possibilities of such as wide spans and hanging constructions.

Still, the Kootwijk radio station was Holland's first large building constructed with an architectural design using the skeleton, outer cladding and decoration made of concrete.

A 'cathedral in the desert'

In early 1920, construction work on the station main building commenced, and it took almost two years to complete.

In the meantime, the six 212-meters-tall aerial masts and the huge umbrella-type aerial had been erected and an extensive earth mat had been dug in.

Luthmann's monumental station building (officially known as the "A" building) had a specific style, not an exact example of the "Amsterdamse School," but showing other influences such as expressionism.

Some people compare the building with a Greek temple; others title it as a "concrete cathedral"; and a technical student of the Sudan, posted to the station for a few weeks, spoke of a "moskee."

"...another Dutch building where classical conception determines design, yet where modern structure is expressed, is the Radio Station at Kootwijk, designed by J.M.Luthmann. It is not difficult to see this as a transformed Greek temple where instead of a comparatively heavy stone construction it has a lightness of aspect, seen especially in the treatment of windows, made possible by steel...."— A. Whittick, 1974.[8]

It is remarkable that a great many past and present station visitors are deeply impressed, undoubtedly by the mystic atmosphere of the huge building situated in a remote inhabited area.

When approaching the station from the main road, the station main building can be seen at the end of a long straight lane.

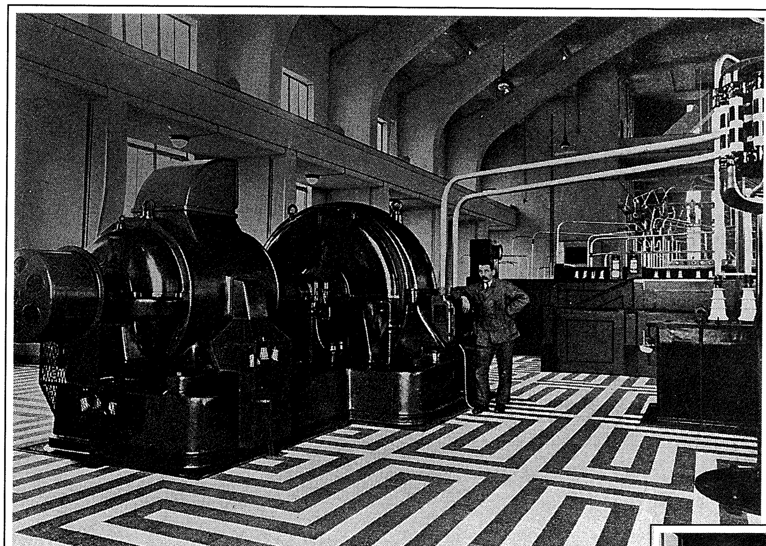
Entering the main entrance, one can still feel the atmosphere of the past, emphasized by the fact that recently, large parts of the interior, painted more than quarter of a century ago, have been restored to their original condition.

A professor of architecture of the Delft University invariably takes his students every year to the Kootwijk station to show them the remarkable architectural details.

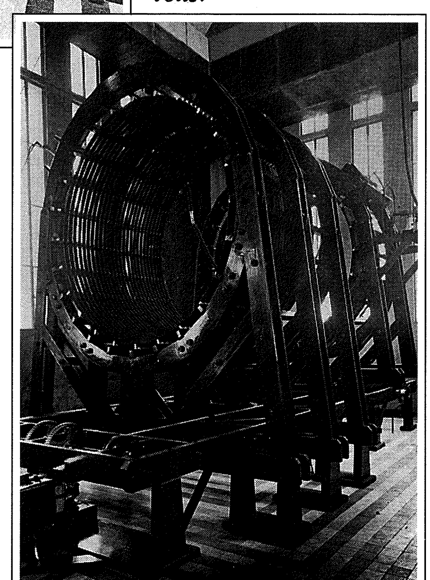
Telefunken alternator

In the early days of radio, VLF (very long waves) were considered as most suitable for long-distance communication. Technically, only a few systems generated enough RF power.

The Telefunken transmitter, station call sign PCG,



This is one of the two Telefunken motor and alternator combinations. Some time after this picture was taken, the PTT fitted the alternator with an electronic device that kept the alternator frequency highly stable, replacing the initial mechanical system. Water pumped through a system of tubes in the stator cools the alternator. Its output is 400 KVA at 800 volts.



The huge aerial inductance and variometer used a sliding construction designed and made by the Dutch PTT. It proved to be a great improvement, enabling a continuously tunable aerial adjustment. Notice the typical period style pattern of the floor tiles. The original tiles were still in use in 1993, as shown in the picture at the bottom of page 14 and the picture on page 20.

included an Alexanderson type alternator with saturated core transformer frequency multipliers providing the choice of a very limited number of frequencies (3x, 4x or 6x the frequency of the alternator). The output power of the alternator was about 400 kW, and the RF current at the feeding point of the aerial was approximately 350 A.

The frequency of the alternator was initially 6,000 Hz, resulting in operating frequencies of 36 kHz (8,333 meters), 24 kHz (12,500 meters) or 18 kHz (16,666 meters). Later, because of international agreements, it was necessary to change the frequency to 5,600 Hz, resulting in 16.8 kHz/17,800m or alternatively 11.2 kHz/26,700m. In practice, the alternator operated on 16.8 kHz for most of its life.

Alternator transmitters are most reliable and easy to maintain, though more expensive and less flexible in frequency coverage compared to an arc transmitter.

The initial frequency stability of the Telefunken alternator was rather poor. In 1925, the PTT radio laboratories had designed an electronic device that increased the stability considerably. Other improvements of the alternator transmitter had by then been accomplished by the PTT radio laboratories.

Obsolete

On Jan. 18, 1923, the first operational two-way contact with the Dutch East Indies was established on a frequency of 36 kHz (8,333 meters).

A few months later, on May 7, public service was inaugurated. Operating times were (as anticipated) only when the radio path was in the dark (Holland about 1900-2400 hrs, East Indies about 0200-0700 hrs, both local time).

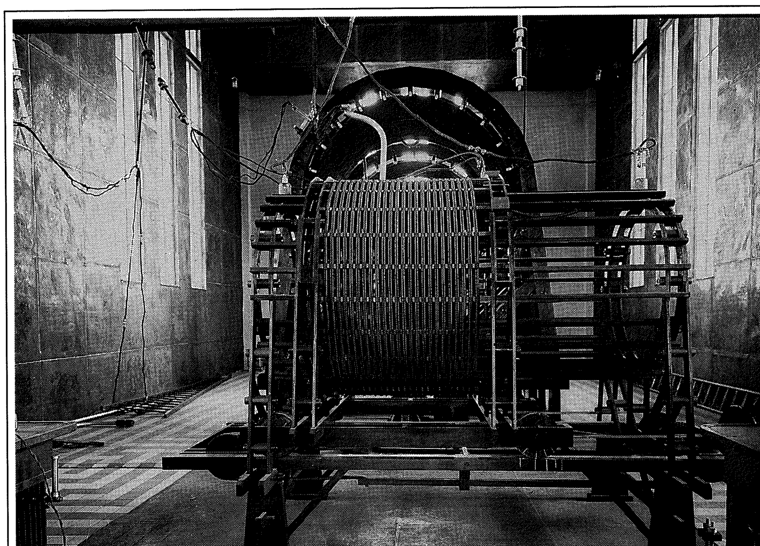
All traffic was concentrated at a central point, the radio terminal in Amsterdam. From there the Kootwijk transmitter was keyed via cable. The reception station at Sambeek (later Noordwijk radio) was similarly connected. This arrangement was quite sensible because many of the telegrams for the Dutch East Indies were addressed to destinations in the Amsterdam business area.

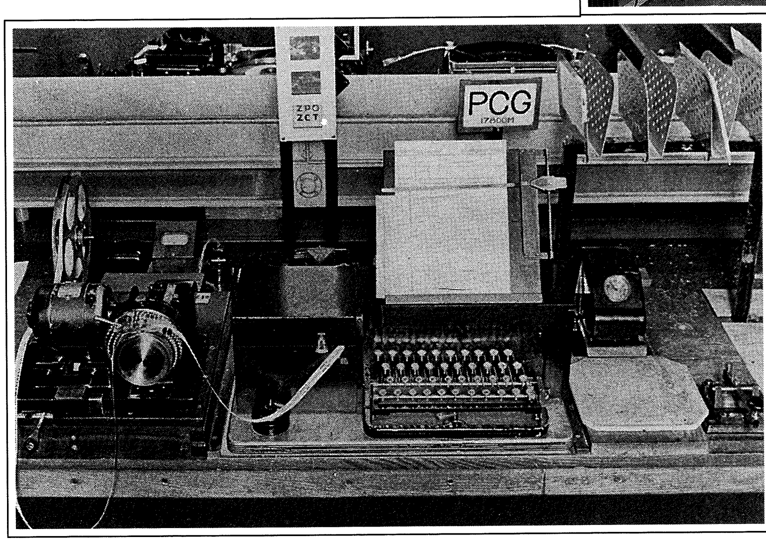
In late 1924, in an attempt to increase the rather limited traffic hours of the Holland-Malabar link, traffic was re-routed by using the Malabar-San Francisco radio route, thence by cable to New York and finally by the New York-Kootwijk radio link.

However, the advent of high-power valves and the discovery of the possibilities of shortwave made the alternator obsolescent. By the late 1920s, the PCG alternator transmitter was only used for transmissions to New York (European traffic on VLF and LF had already been taken over by a number of valve transmitters) and as a stand-by transmitter for the Dutch East-Indies link in case the shortwave link would fail.

Short wave

In December 1921, American amateurs bridged the





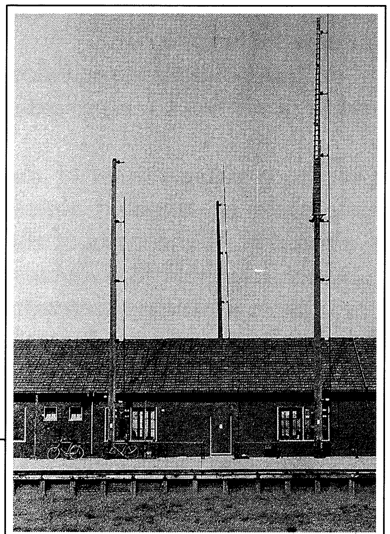
The aerial transformer is in front of the huge aerial tuning/variometer. Notice the copper screening at the walls of the tower.

This is the operating position of PCG alternator transmitter (operating on 17,600 meters, according the indication) at the Amsterdam Radio terminal. The telegrams are first typed by means of a keyboard of the perforator (center) providing a tape which runs through a high-speed Morse transmitter (left). Notice that an ordinary Morse key (right) is available as a stand-by!

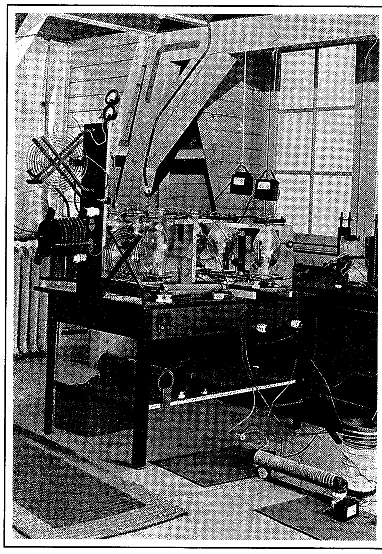
Atlantic Ocean on short waves using very low power.[10]

The first two-way shortwave amateur contact between Holland (call sign PCII) and the USA (2AGB) was established on Dec. 23, 1923.[12] It is interesting to note that the original and complete PCII transmitter used during these contacts is in the PTT museum.

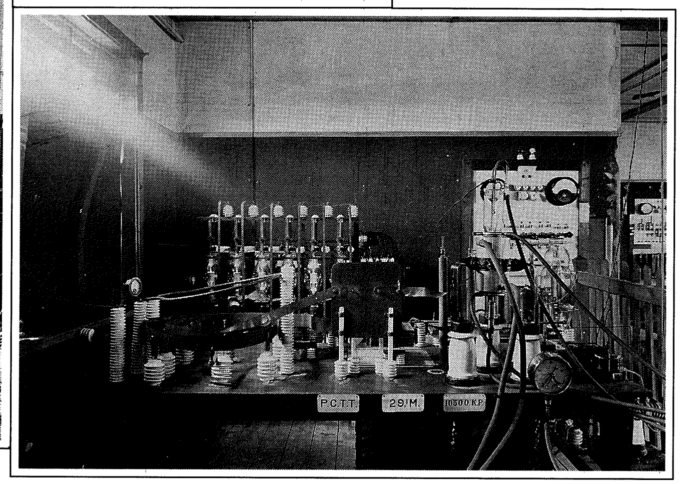
Although contemporary professionals were very skeptical and warned about overoptimism, work on a proposed shortwave link started in 1924. Again, the Dutch East Indies were ahead, and on Feb. 17, 1925, the shortwave transmitter ANE, located in Bandung, Java, was received with a very strong signal in Holland on a



In 1925, at the start of the shortwave era Kootwijk radio's 'B' building housed the four initial short wave transmitters. Notice the use of simple vertical aerials. In the 1930s and until its destruction in 1945, the building housed a 1,875 kHz AM broadcast transmitter.



First Dutch telegraphy shortwave transmitter, call sign PCMM, was designed in early 1925 by the PTT radio laboratories in a very short time in order to reply transmissions of Dr de Groot's "ANE" transmitter at Malabar. Notice the provisional construction on a lab workbench. The transmitter power was limited to 2 kW because air-cooled tubes were used. 'PCLL', the radio lab's second provisional shortwave transmitter of, operational a few months later, had a water-cooled tube and allowed more power. Its design stand model for the four initial Kootwijk radio shortwave transmitters in the 'B' building.



This is transmitter PCTT, one of the four provisional shortwave transmitters in the 'B' building.

wavelength of 95 meters.

Only a few months later, Dr. ir Koomans completed the first shortwave transmitter located at the radiolaboratory. It was an instant success. On Aug. 17, 1925, only about two years after the inauguration of the alternator transmitter, this provisional transmitter (call sign PCMM) became operational, keyed from the radio terminal in Amsterdam, and soon to be followed by a second more powerful transmitter (PCLL).

In early 1926, four transmitters of the PCLL type were hurriedly installed in the "B" building at Kootwijk radio. The frequencies of the four transmitters were divided in the wavelengths between 16 to 51 meters.

This division allowed a simple arrangement to switch from one frequency to another, providing a nearly 24-hour radio link. For just a few hours during the night when conditions were unfavorable, the alternator transmitter PCG would give relief.

This was only the start of the very tempestuous development of the shortwave service of Kootwijk radio, which is actually continued up to today.

The simple vertical quarterwave aerials were soon replaced by more complex beams. Dr. ir Koomans has done sterling work in this field and has gained a number of patents: e.g., the Koomans array.

In the late 1920s, a new shortwave site was built, only a few kilometers away from the alternator transmitter site, leaving the obscure B building for a more spacious complex (building C, D,E and F) and enabling the erection of large beam aerials. In 1928, a reliable 24-hour radio link to Dutch East Indies on shortwave was achieved, due to the improvements of both stations.

Threat of privatization

It is little known that the shortwave service saved the VLF link from being discontinued despite high operating losses.

In 1923 and 1924, it was found that the alternator transmitter service was losing money because of high operating costs and a reduced interest in sending expensive telegrams by means of a service which was only available for a limited number of hours a day.

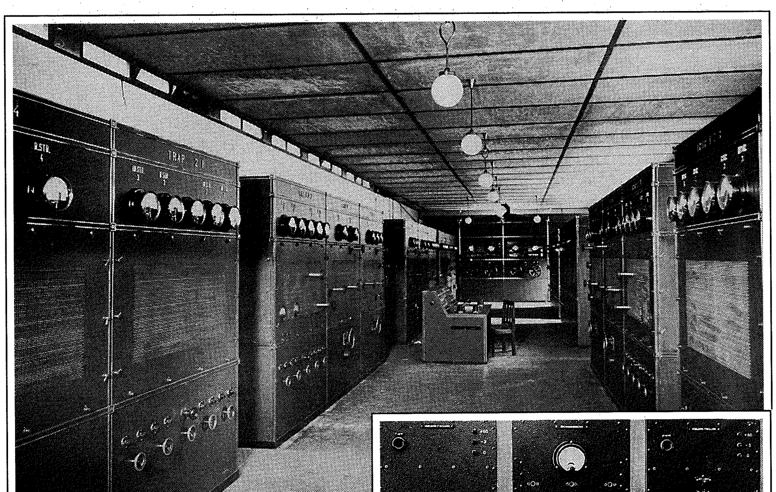
In 1925, a report of an independent commission advocated the privatization of all fixed service radio links.

However, because of the positive results of the shortwave service, which could be operated almost throughout the day at a fraction of the costs of the alternator transmitter, and because the radio laboratories were able to produce reliable shortwave transmitters at only 1/15th of the price of a commercial manufacturer, the board of ministers decided to maintain the fixed service at the PTT.[14]

In addition to transmitters of fixed service, Kootwijk radio housed a number of shortwave transmitters for Scheveningen radio, the Dutch coastal station for maritime services. The limited space at Scheveningen radio's transmitting site (primarily MF transmitters to carry traffic at distances as far as 1000 km) along the Dutch coast did not allow for a large expansion.

In 1927, the first shortwave transmitter for maritime service was installed, and this service gradually expanded to become a large proportion of the station's traffic.

Not mentioned in this paper are the numerous fixed-service, long-distance shortwave links to many countries, including traffic on LF to various European countries.



This interior view of shortwave building 'D', taken about 1935, shows the 80 kW SSB transmitters developed by the PTT.

Single-sideband telephony

In 1927, the first experimental (semi-public) telephony link to the Dutch East Indies was opened.

Feb. 28, 1928, saw the inauguration of a public radio-telephony link to Dutch East Indies, the longest direct radiotelephone link in those days.

In the years that followed, many improvements were carried out, such as extensive aerial arrays, crystal control and, most important of all, the introduction of single-sideband.

The application of single-sideband on shortwave was again a world first in 1933. Only one year later, all the Kootwijk transmitters serving the East Indies had been converted for single-sideband. In 1935, Koomans and his team increased the capacity by putting two telephone circuits and two telegraph circuits over one transmitter. In 1937, experiments showed that this could be increased to four telephone circuits plus a number of telegraph channels over one single-sideband link.[11]

Radio for the Nazis

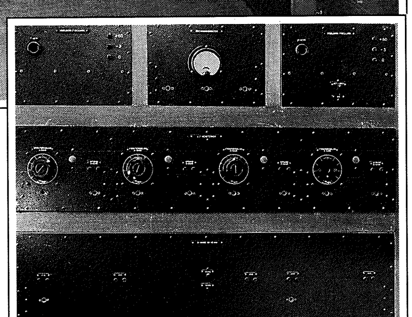
On the 11th of May 1940, the second day of the of the German invasion of Holland, the Kootwijk station was occupied by the Germans. It was taken over and soon was used for German war purposes.

During the war, the VLF alternator transmitter PCG was primarily used for transmitting encoded messages to submerged U-boats in the North Sea and parts of the Atlantic with a range of about 1,000 miles. Many of these messages were decoded by the British, cracking the Enigma code (codename "Ultra").

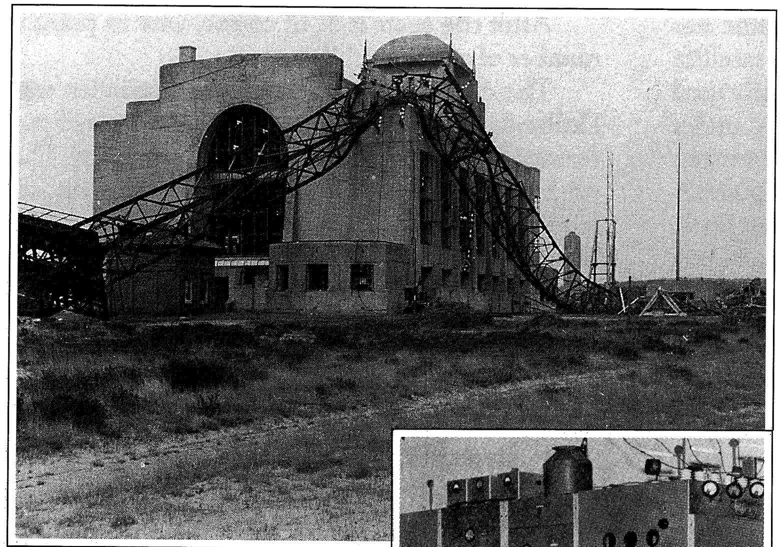
That the code had been cracked might explain the lack of any large scale air attacks on the station during the war—the Allies gained more information when the station was operational!

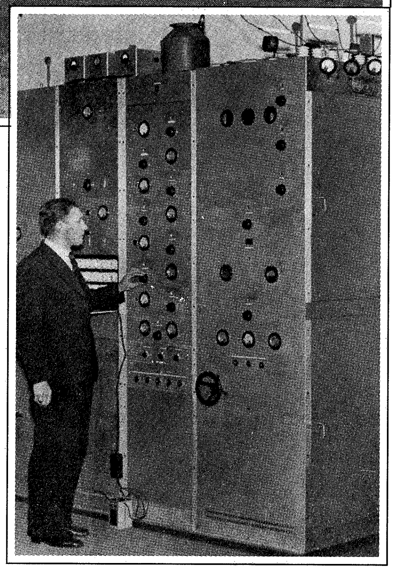
It was attacked only a few times by low-level long-range RAF aircraft, and a few 2 cm holes in the rails of the crane in the main building hall are sinister marks of a dark period.

The 1,875 KHz broadcast transmitter, located in the "B" building, its aerial slung to one of the PCG aerial masts, was used for propaganda and for relaying Radio Bremen, known as



Of the pre-war single-sideband receivers previously used at the NORA receiving station for one the Dutch East Indies fixed service links, this is the only one remaining. Each receiver fills three 6-foot-high cabinets. (Only the RF unit is shown here.) Notice the use of a National HRO-type tuning dial to control the receiver's local oscillator. The receiver has been moved from the PTT Museum to Kootwijk radio to find a place in historic surroundings.





In April 1945, the retreating Germans left the station after destroying most of the technical equipment including the six 212-meter aerial masts. One of the collapsing masts hit the main building. However, thanks to the building's strength, virtually no real damage was done.

Secretly hidden under the eye of the Nazis during World War II, this was Kootwijk radio's first operational transmitter after the war.

"Sender Friesland" (not very appropriately though, because the province of Friesland is in northern Germany).

It is interesting to note that the single-sideband receivers of the reception station at Noordwijk radio (NORA) were extensively used by the Germans for intercepting the secret (scrambled) high-command radiotelephone link between England and the USA.[13]

In April 1945, the Kootwijk station was destroyed by the retreating Germans. The six aerial masts were blown down, and the alternator transmitter PCG was destroyed by explosive charges. In 1944, most of the shortwave transmitters had already been removed and transported to Germany.

Postwar period

In 1945, many of the buildings were damaged, and all the technical equipment had to be entirely rebuilt.

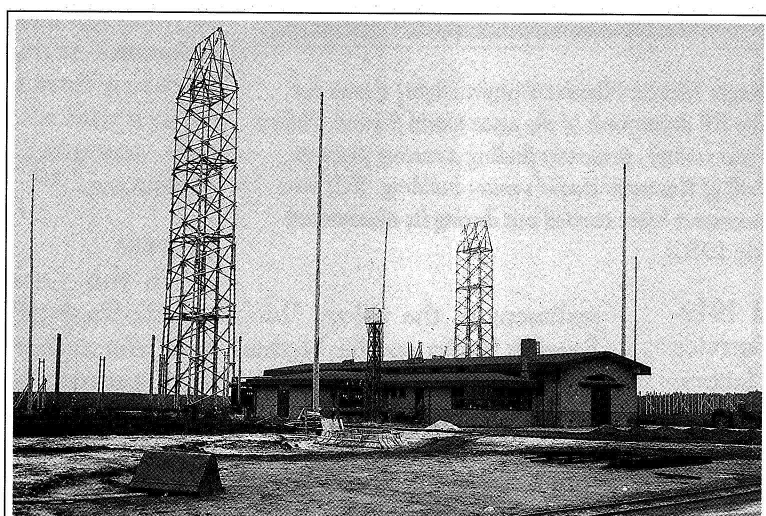
A single 3kW transmitter that had been under construction and that was nearly completed, had hurriedly been disassembled in May 1940 and had been hidden from the Germans during the war. This transmitter was reassembled first and, in October 1945, it was put in operation for traffic to New York.

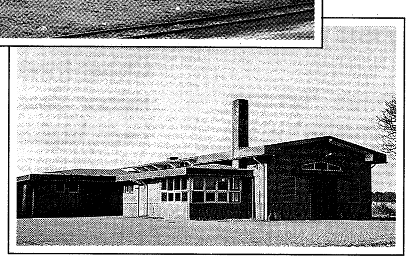
Two battered 40 kW transmitters were later found on a railway track in Germany and, in 1946 they were put in operation again.

In 1946, fragments of the demolished masts were used to erect two 200-meter masts carrying aerials for two LF transmitters for European traffic. Because the days of VLF and LF were numbered, they were only used until the mid-1950s.

Because they no longer were in use, one of the two huge masts was demolished in 1966 and the other in 1980.

During the early postwar years, Kootwijk radio saw a rapid expansion of the number of transmitters and reached its highest number in the mid-1950's. In 1954, the station had about 53 shortwave transmitters for global communication and two LF transmitters for European traffic.





This is the exterior of shortwave building 'D' about 1935.

In this 1933 picture of shortwave building 'D' in 1993, virtually nothing has changed, except that the wooden aerial masts have been removed.

Kootwijk radio today

The fixed-service radio communication at Kootwijk radio ceased in the 1960s, having been superseded by modern transatlantic cables (after 1956) and a decade later by satellite communication.

The importance of mobile (maritime) traffic has increased considerably, despite the boom in satellite communication. Kootwijk radio is now primarily used for long-distance (worldwide) maritime traffic under the control of the Dutch coastal station Scheveningen radio. It also serves as a worldwide shortwave maintenance and service link for KLM Dutch Royal airlines.

It is remarkable how much of Kootwijk radio's original buildings are still intact, though nowadays many are not used for their original purpose.

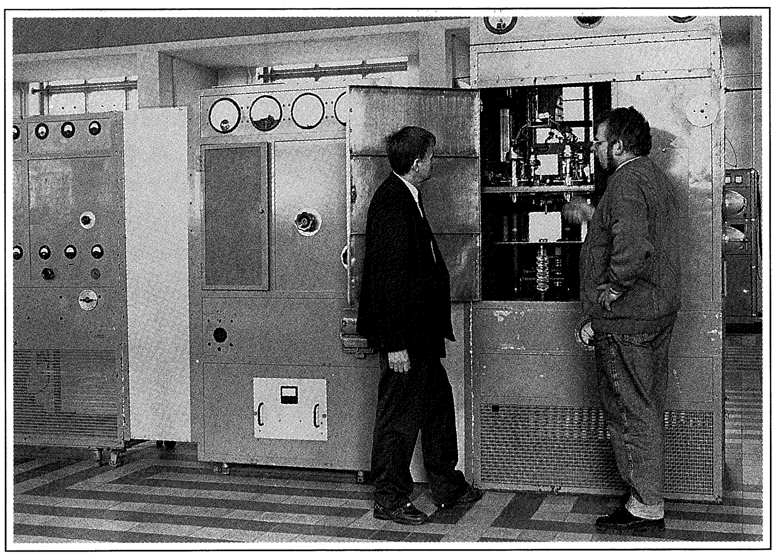
The main "A" building is fairly unaltered. The entrance hall has recently been restored to its original state.

Other buildings by Luthmann, such as the watertower, a former hotel and station personnel houses are apparently unchanged.

Most of the former shortwave buildings of the 1920s are now in use as PTT offices.

Old meets old

Recently the prewar broadcast transmitter PCJ, which won fame for its historic worldwide broadcasts in the late 1920s and 1930s, has been moved from Philips, Eindhoven, to Kootwijk. It has found a worthy place in the hall of the main building, actually on the same spot where the PCG alternator transmitter was operational for many years.



Kootwijk radio station manager Martin Nieuwenhuizen (right) shows the author the finer details of the RF driver unit of the once world famous Philips PCJ short wave broadcast transmitter, presently finding a resting place in worthy surroundings: the hall of Kootwijk Radio's main building. PCJ was built in 1927; many improvements were carried out during its operational life, which ended in the early 1950s.

In retrospect

It is characteristic that during the period 1919-1940, the development and operations of fixed-service radio was done completely in the sphere of the laboratory.

Such laboratory development was not very strange though, because Prof. ir Koomans, as director, had direct control over the radio laboratory and both the Kootwijk and NORA radio stations.

In spite of British air attacks, German "sprengkommando's" and the passage of time, Luthman's main station building is still as strong as ever. Having a unique design, it has recently been put on the Dutch list of National Monuments, which should save the building from destruction.

After the years it is, of course, easy to point out a number of apparent failures.

The choice of the Telefunken alternator was, for Holland, not one of the worst failures, considering its reasonable stability and its extreme reliability. There is no doubt that a powerful arc transmitter with its harmonics, or the synchronized disk, which might have been installed by the Marconi Company, would not have been kept and tolerated until 1945 as the alternator was.

In 1918, when the alternator was purchased, the rapid developments of valve technology and discovery of shortwave's possibilities could not really be foreseen.

It is remarkable that the Telefunken Company gave Dr. ir de Groot a contemporary modern receiver in 1916, but when the Dutch East Indies desperately asked Holland to listen to its improvised arc transmitter in 1917, apparently no receiver was available. The story goes that Telefunken refused to lend a receiver unless the company was contracted to build both stations.

Eventually, it appeared that the Telefunken receivers were unsuitable. Dr. de Groot had constructed his own receiver in early 1918, and Dr. Koomans soon replaced his Telefunken receiver with a "...circuit invented by Armstrong...."[15]

Epilogue

In this final installment in the trilogy "Mobile Radio/Paging/Fixed Service Radio in the Netherlands," the author has highlighted a small but fascinating impression of the role of the Dutch PTT in the field of radio communications.

To keep the stories readable for a wide audience, technical details have been kept to the minimum. Other interesting facts, however, including apparently minor details which are not generally known, have been highlighted.

Acknowledgements:

The author is indebted to Martin Nieuwenhuizen, present station manager of Kootwijk Radio, whose

enthusiasm for the history of his station was a great stimulation in preparing this paper.

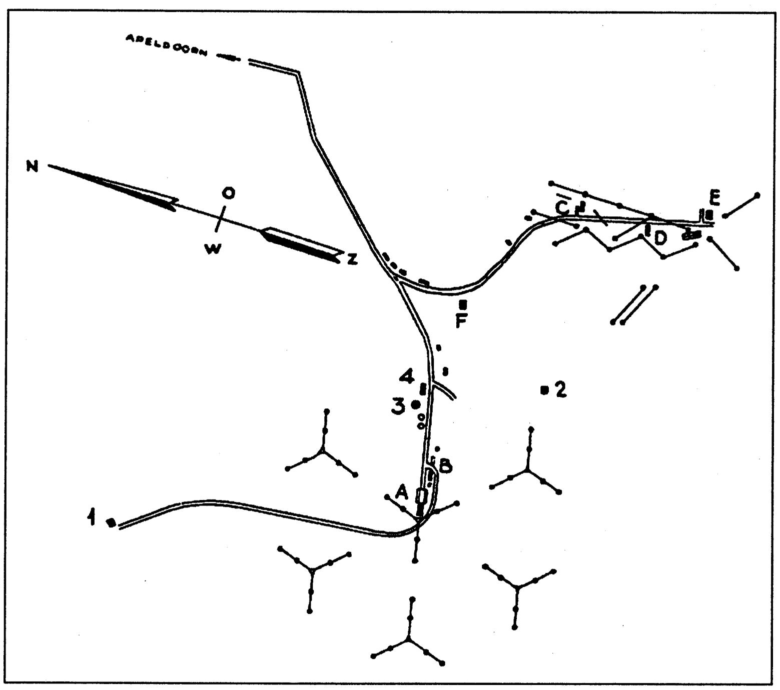
Posthumous thanks go to Kaye Weedon (M), for encouraging the author to undertake further study of the work of Dr. ir de Groot and his contemporaries.

Present-day pictures were ably made by the author's father, Anton Meulstee, who, despite his venerable age, came along during several visits to the station that included long walks along the huge site.

All other photographic work of this and the previous papers in *The Proceedings*, including reproductions of contemporary photographs, was Anton Meulstee's job, and he has turned in sterling results.

Thanks go to the photographic section of the PTT Museum, the Hague, Holland, for providing a great proportion of contemporary photographs used in this paper.

The text of the three parts was read by the author's English friend, John Taylor, G0AKN, and was changed according his valuable advice.



This map shows the Kootwijk radio facility in about 1936, including (A) the main building with the PCG alternator in the center of six aerial masts; (B) the initial shortwave building, at the time housing the 1,875 kHz AM broadcast transmitter; (C, D and E) the shortwave buildings and shortwave (Koomans) arrays; (F) the control building; (3) the water tower; and (4) the hotel.

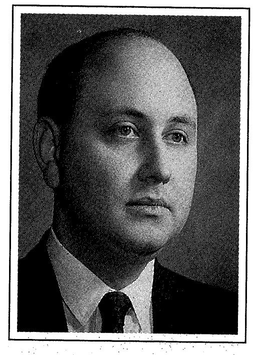
References:

A complete list of references (mostly written in the Dutch language) would easily fill a number of pages. Only a selection is made of the most essential.

1. Radio-Telegrafie in de Tropen, Dr. ir CJ de Groot, Ph. D. dissertation Technical University Delft, June 5, 1916.
2. PKX-Bandung, the story of de Groot's mountain gorge antenna and giant arc transmitter at Malabar, Java, 1917-1927. Text of a slide sequence by Kaye Weedon (M). 3rd ed, 1981.
3. History of the Establishment of Wireless Communication between the Dutch Indies and the Netherlands, and an account of the work done in this connection, Indie Weerbaar, Vol. 4, Aug 1921, pp 4-33.
4. Radio Telegraphy in the Dutch East Indies, The Radio Review, VolII, Nov. 1921, pp 574-582.
5. German influence over Dutch Wireless, The Wireless World, September 1919, pp 328-329.
6. Over en uit, (75 years of PTT radiocommunication 1900-1975), B.Hoogland/ J.Tours, PTT Telecom BV, Jan. 1989.
7. Radio-leven, W. Vogt, ("Life with Radio, a quarter century pioneer work in a modern trade"), Scheltens & Giltay, Amsterdam, 1931.
8. European Architecture in the 20th Century, Arnold Whittick, New York, 1974, pp109.
9. The Wireless Transmitting Station Malabar, Brochure, Governmental Post-, Telegraph- and Telephone Service, Bandoeng, May 1929.
10. The story of the First Transatlantic Short Wave Message, 1BCG Commemorative Issue of *The Proceedings of the Radio Club of America*, October 1950.
11. Single-Sideband Telephony applied to the radio-link between the Netherlands and the Netherlands East Indies, N.Koomans, Proceedings IRE, 1938, pp 182-206.
12. The history of PCII, brochure PTT Museum, n.d.
13. ...Und lauschten für Hitler. Die Abhörcentralen des Dritten Reiches, G.W.Gellermann, Bernard & Greafe Verlag, Bonn 1991, ISBN 3-7637-5899-2.
14. Geschiedenis van de rijkstelegraaf 1852-1952, Dr E.Ten Brink/C.W.L. Schell, PTT, The Hague, 1954.
15. De ontvangmiddelen te Sambeek (The reception station at Sambeek), Dr ir N.Koomans, Radio Nieuws, 1923, pp 337-344.

Wireless Communications: Where Are We?

By Dr. Gregory M. Stone and Karen Bluitt



Stone

Tremendous pressure is being placed on the radio spectrum as a natural resource worldwide.

As a response to this pressure, the introduction of adaptive communications philosophies represents the dawn of a new era in mobile wireless communications. (One example is Motorola's Astro family of digital radio communications products.)

In the United States, bandwidth-efficient and spectrum-efficient technologies soon are to be mandated by the Federal Communications Commission (FCC) in its far-reaching *spectrum refarming* efforts. (Spectrum refarming is expected to mean new technical and operating characteristics and some new frequency assignments for many private land mobile radio users.)

Similarly, the universal deployment of digital cellular telephone, digital personal communications systems and wireless local area networks (LANs) will be predicated upon the exploitation of such advanced technologies.

The process of setting standards is not standing still, meanwhile. For wireless LANS, the IEEE has its 802.11 standard initiative. Similar efforts are under way for wireless electronic private automatic branch exchanges (EPABXs).

Public safety radio communications includes radio services for law enforcement agencies, police departments, fire departments and emergency medical services. Many of these agencies are represented by the Associated Public-Safety Communications Officers (APCO), which is spearheading an initiative called Project 25 to develop and promulgate a standard for advanced, next-generation narrowband digital communications for public safety radio communications.

It is no wonder that many people in the radio communications industry believe we are on the verge of a new era—a communications revolution with a voracious appetite for the emerging proliferation of low-cost, multimedia digital technologies.

Internationally, there are many communications initiatives that depend upon the radio frequency spectrum.

Among them are programs such as:

- the Future Public Land Mobile Telecommunications Services (FPLMTS), for which a standard should be adopted by 1994-1995 and for which equipment should be fielded by 1995-1996.
- the Aircraft Correspondence Service (ACS).
- low-earth-orbiting satellite systems (LEOSS).

All are vying for part of the radio spectrum resource.

The long-term future of all wireless communications will be based upon code-division multiple-access (CDMA) direct-sequence spread-spectrum techniques employing hybrid time-frequency-hopped channel access methodologies overlaid upon vast blocks of spectrum.

Vocabulary

This new era, in a bemusing way, brings with it a "new" vocabulary.

No longer is the word *radio* used to define radio frequency spectrum media. Instead, as an echo of the earliest days of Hertz and Marconi, we call our new-found media simply *wireless*.

Similarly, the advent of this "new" technology has led to a strange twist: What last year was referred to as *digital* now is being touted by the technology marketers as *analog*. The *new digital*, they say, is the one, the only, *true* digital. There apparently is marketing magic in the word *digital*, and magic such as that must be reserved for the latest products!

The flurry of standards-setting activity makes a constructive contribution to technology.

For example, the IS-54 digital cellular specification effort helped to focus interest on improved vocoders and modulation techniques.

In Europe, the Groupe Speciale Mobile (GSM) standards-setting efforts have stimulated technology development. (The new vocabulary has visited here, too: GSM, they say, now stands for Global System for Mobile communications.)

Other standards address portable (wireless) telephones, such as CT-2 and Digital European Cordless Telecommunication (DECT).

As for wireless LANS, while work on the IEEE 802.11 standard continues, the Europeans already are pursuing a Hyper-LAN specification. (*Hyper* stands for *high-performance*.)

Each of these standards-setting efforts will contribute toward driving down the cost of advanced, but necessary, technologies.

How these efforts will coalesce globally is unknown. Complicating matters, at least as far as private land mobile radio in the United States is concerned, is the reconfiguration of all land mobile radio operators below 512 MHz via spectrum refarming. This action will have a profound effect upon digital technologies as they are fielded, including their features and limitations.

Spectrum refarming driven technologies

In its spectrum refarming effort, officially named Private Radio Docket PR92-235, the FCC is proposing major changes in how wireless private (as opposed to *public* or *radio common carrier*) radio services below 512 MHz are regulated and operated.

For example, the FCC proposal is an effort to provide for "enhanced" spectral efficiency, which the FCC hopes will increase the number of available channels in several bands by 300% to 500%.

According to the FCC, one way of achieving this "efficiency" is to reduce channel spacing to 6.25 kHz or, possibly, 5.0 kHz. The FCC proposes two emission masks, one for 5 kHz channel spacing in the 72-76 MHz, 150-174 MHz and 216-222 MHz bands, and a second emission mask for 6.25 kHz channel spacing in the 412-512 MHz band.

Occupied bandwidths are limited to 4 kHz with 5 kHz channel spacing and 5 kHz with 6.25 kHz channel spacing. These figures translate into the occupied bandwidth being 80% of the total channel bandwidth or spacing.

Under this scheme, the proposed emission masks will provide 40dB of attenuation at the edge of the authorized channel (not bandwidth), 50dB of attenuation at the edge of the adjacent channel's authorized bandwidth and 65dB of attenuation thereafter.

Narrower frequency-division, multiple-access (FDMA) channels do not necessarily mandate the use of digital technologies. A proven 50-year-old analog technique dressed up in the form of amplitude companded single-sideband (ACSSB) is a likely and potentially aggressive candidate for the new channels that may provide cost-effective narrowband communications.

The earlier form of ACSSB, actually amplitude companded *double*-sideband, initially was used for handling transatlantic telephone traffic in the 1930s, and its operational parameters and capabilities are well known. So, too, are various digital techniques.

ACSSB, though, may be implemented in many ways, including digitally.

When analog is still analog

It is important to keep in mind, though, that ACSSB is and remains *analog* when it transports analog bandlimited voice (300-3,400 Hz) that is subjected to syllabic amplitude companding. The combination of linear frequency translation with syllabic amplitude companding implemented in a digital signal processor-based (DSP) system results in an *analog* transmission effected through robust *digital means*.

Conversely, transmission of information in discrete terms, rather than through continuously variable physical quantities, fits the definition of *digital*. Thus, DSP-based direct-conversion linear frequency translation in concert with high-level digital modulation (such as 16-state or 32-state Quadrature Amplitude Modulation or QAM) and certain adaptive channel linearization techniques (such as McGeehan's Transparent Tone-In-Band [TTIB] with Feed-Forward Signal Regeneration [FFSR]) may be used to effect a very bandwidth-efficient *digital* implementation.

Because this method uses direct linear frequency conversion, the occupied bandwidth at the radio frequency is proportional to the baseband bandwidth that has been frequency-translated. Of course, "non-linearities" in the transmission and detection systems cause occupied bandwidth to increase. This "spread" is considered in the practical implementation of these technologies.

RF power amplifiers are analog devices, but if the information they carry is innately digital, the process may be considered to be digital, although it possesses both analog and digital characteristics. In this context, some people prefer to call a digital modulator/RF transmitter and demodulator/detector an *modem*.

Emerging applications

To accommodate emerging multimedia applications involving integrated digital voice, digital text and digital imagery or video, bandwidth-efficient digital implementations are necessary to exploit the very limited occupied bandwidths proposed with either 5 kHz or 6.25 kHz channels.

Compared to today's digital practice, though, how much improvement is necessary?

Consider, for example, Project 25's proposed channel format. If it becomes a standard in a 12.5 kHz channel, a gross channel data rate of 9.6kb/s will be required. Thus, in terms of bandwidth efficiency (and assuming a 9.6kb/s gross channel data rate), at a 10.0 kHz occupied bandwidth, a bandwidth efficiency of 1.04 b/s/Hz is achieved, increasing to 1.92 b/s/Hz as the authorized occupied bandwidth is reduced to 5.0 kHz and 2.4 b/s/Hz at 4.0 kHz.

For a 9.6 kb/s gross channel data rate, given the roll-off factors of practical filters and assuming that the intersymbol interference (ISI) is controllable, it appears as though 4-ary or 4-level modulation such as QAM may be suitable to use with 6.25 kHz channel spacing in a linear implementation.

On the other hand, with 5 kHz channel spacing and the proposed emission mask, 8-ary modulation (with a practical and achievable bandwidth efficiency of 2.4 b/s/Hz minimum) would be required to effect a 9.6 kb/s channel rate.

In the early 1980s, we were advocating the use of a 7.5 kHz channel bandwidth for a very bandwidth-efficient digital cellular telephone communications system. Then, it appeared that, given the state of available technology, the highest cost-effective information rate that could be sustained in a 6.0 kHz information bandwidth within a 7.5 kHz channel was approximately 10 kb/s.

This scheme was predicated on a bandwidth efficiency of 1.7 b/s/Hz. Our concept at the time ignored the signaling overhead necessary to effect certain system management functions. Instead, it concentrated on a very robust half-rate error-detection-and-correction (EDAC) coding. At the time, about 1986, these proposals met widespread opposition. Today, in 1993, similar and even more aggressive operational modalities are becoming commonplace.

The question arises: What happened between 1986 and the present to bring acceptance?

In a nutshell, digital signal processing technologies have advanced. What some alleged was not economical to implement six or seven years ago in monolithic or hybrid technology now is implemented easily through dramatically more powerful DSPs. With the current price vs. performance ratios of commercial DSPs, one doubts whether the current proposals are pushing the development of the art. In fact, DSP-controlled linearized power amplifiers may permit operation at *any* phase angle output load while maintaining linear operation.

Today, one may purchase equipment off the shelf that operates at a gross data rate of 9.6 kb/s in a 12.5 kHz channel, such as Astro, which is Motorola's initial version of advanced narrowband communications equipment. If the occupied bandwidth is 20% of the channel bandwidth, Astro-type technology has a current bandwidth efficiency of 0.96% b/s/Hz. Thus, we view Astro as the first type of *advanced narrowband digital communications* (ANDC) technology to become commercially available.

If ANDC were compared to today's 12 kb/s digital voice systems that operate in a 25 kHz channel, ANDC's current bandwidth efficiency of 0.96 b/s/Hz would represent almost a 75% improvement compared to the approximately 0.6 b/s/Hz bandwidth efficiency of the 12 kb/s systems. This comparison neglects the fact that at 9.6 kb/s, ANDC provides for embedded signaling that 12 kb/s continuously variable slope delta (CVSD) modulation systems cannot provide in a 25 kHz channel.

(By the way, it is these 12 kb/s *digital* voice systems that some people have taken to calling *analog* in a peculiar way of trying to differentiate them from other digital systems.)

Additionally, in the public safety community, Project 25 is slated to produce a forward-looking standard for interoperable, advanced narrowband digital communications.

ANDC equipment that complies with the standard initially will operate in a 12.5 kHz channel using a gross channel data rate of 9.6 kb/s. Voice digitization will be effected at approximately 4.4 kb/s with the use of a vocoder technique called Improved Multi-Band Excitation (IMBE).

Embedded encryption, such as Digital Encryption Standard (DES), and signaling are proposed, along with a modest quantity of error detection and correction. The result will be a gross channel rate of 9.6 kb/s.

For the initial implementation using compatible quadrature differential phase-shift keying (QDPSK) RF modulation, the system will operate at 12.5 kHz channel spacing. The compatible architecture is configured to provide a graceful conversion and migration to 6.25 kHz or possibly to 5.0 kHz channels later.

This migration may be complicated by the authorized bandwidth provisions of the spectrum refarming proceedings, along with the associated technical parameters related to emission shape factor and channel spacing. This would necessitate improving bandwidth efficiency from 0.96 b/s/Hz to approximately 2.4 b/s/Hz to accommodate the 9.6 kb/s gross channel rate.

The Astro ANDC product predates the standards process and embodies the best of today's commercially available digital technologies.

Unlike the current Project 25 standard, the Astro product is designed to be backward-compatible with current digital systems based upon 12 kb/s CVSD with DES encryption, over-the-air rekeying and multikey capabilities.

Other backward-compatibility modes, including trunking, will provide for more cost-effective migration between current technologies and those of the future.

Fortunately, such enhanced products will be the logical outgrowth of competition in a "standards-based" environment where the standards specify the base level of interoperability, giving manufacturers the flexibility to be innovative with specific enhanced capabilities.

Long-term outlook

The digital revolution spearheaded by Motorola's Astro and likely to be boosted by both Project 25 and spectrum refarming is the first step toward pushing the development of the *generic* or *universal* radio.

We believe the future is in direct-conversion linear translators employing linear up-conversion and down-conversion, which have all the operational or personality determining features defined by specific software customized by the user. Thus, with the possible exception of the final RF amplifier, the radio, whether it is handheld, mobile or fixed, would be a *generic* article. Soon the development of very broadband linear DSP-controlled RF amplifiers may include them in the generic category.

Similarly, multimode, multisystem interoperability could be activated easily by programming a software-defined radio in such a way that sequencing the *mode* or *function* selector automatically selects one of the radio's preprogrammed interoperability options.

Hypothetically, one preprogrammed mode would be the 900 MHz band, 5 kHz channel trunked configuration, a second interoperable mode might be a 150 MHz band 12 kb/s CVSD with DES encryption, and another interoperable mode might be 900 MHz band, 12.5 kHz channel analog very narrowband analog FM with 2.5 kHz frequency deviation. A software-based article would offer such flexibility.

Even this much flexibility might not tell the whole story.

There are many definitions and interpretations of *spectrum efficiency*, and we do not agree with all of them, including some that are widely accepted.

For example, one notion we have difficulty with concerns channel access methodology.

Another notion we disagree with is that cellular frequency reuse, controlled interference ratios, power control, reduced antenna heights, directional antennas and frequency coordination defacto foster improved bandwidth efficiency. They do not. In fact, some of these techniques broadly applied to diverse/disparate systems could actually inhibit deployment of bandwidth efficient technologies.

Instead, the use of covert waveforms and advanced signal processing holds the real key to greatly improved spectrum-use efficiency, obviating the need to resort to such premature techniques as stated above.

The current trend of continually reducing the bandwidth used by FDMA systems is merely a stopgap, but an important step, nevertheless. Bandwidth reduction improves *bandwidth* efficiency, but over the long term, radical (e.g., 1,000:1 or greater) spectrum efficiency improvements will not be achieved through FDMA, despite the use of the parochial techniques of cellular frequency reuse and power control.

The long-term future of all wireless communications will be based upon *code-division multiple-access* (CDMA) direct-sequence spread-spectrum techniques employing hybrid time-frequency-hopped channel access methodologies overlaid upon vast blocks of spectrum.

This final step will require a radically new technological direction based upon the integration of bandwidth-efficient digital time-frequency-hopping *multiplexing* techniques with a spectrally efficient application of overlaid direct-sequence, spread-spectrum transmission techniques based upon highly covert waveforms.

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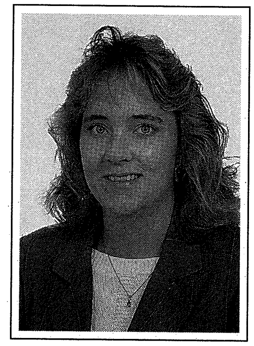
***Karen Bluitt** is a principal engineer with the high-technology research and development firm of SPARTA, Inc. She is a member of IEEE, ACM and Society of Women Engineers. She is listed in* Who's Who in Science and Engineering.

The opinions expressed in this article are solely those of the authors and do not necessarily represent those of their employers or other staff members.

Radio Club Banquet Honors Link, Other Contributors



By Jane Bryant

Fred M. Link, the father of land mobile radio communications and a leader in the wireless industry, said goodbye to his reign as Radio Club of America president after 25 years at the helm.

He passed the president's gavel to Stuart F. Meyer, industry consultant based in Vienna, Va., at the group's 83rd Annual Meeting in New York City on Nov. 20, 1992. Link's contributions to mobile radio communications encompass decades, and he remains active in the radio industry.

Currently, Link consults for eight industry corporations in the United States, United Kingdom and Australia. The Radio Club of America, one of the oldest electronic associations in America that was established in 1909, named the Fred M. Link Award in 1986 to honor Link, the first recipient.

Link is a Fellow of the Institute of Electrical and Electronic Engineers (IEEE) and serves in the group's Vehicular Technology Society. He serves as a director for the Telocator Science and Educational Foundation and for the National Association of Business and Educational Radio (NABER).

Link's 60 years-plus experience in the two-way radio industry include numerous contributions to radio communications. Link's company based in New York, the Fred M. Link Company, opened for business in 1931, a company he owned and operated until 1949. The company became the recognized leader in police communications during the 1930s.

As Link stepped down from the Radio Club president's post, industry members at the club's banquet remembered his accomplishments.

"I want to thank Fred not only what he has done for the Radio Club, but for what he has done for radio," said Ray Trott, president of Raymond C. Trott Engineering Consultants, Irving, Texas. "Fred was the man that jump-started radio. His radios were a contribution to the Allied Forces victory during World War II."

"I started in this industry 26 years ago, and the first person I met was Fred Link, and he has been a mentor ever since," say Jay Kitchen, president of NABER, Alexandria, Va.

Link received acknowledgment and congratulations letters for his mobile radio accomplishments from President George Bush and from then President-Elect Bill Clinton.

"I want to thank everyone for 25 years for responsibility for the Radio Club," he said. I am not getting out of the business—I'm simply passing on the responsibility and gavel to Stu Meyer."

Fred Link (left) presents Ake Lundquist, president and CEO of Ericsson, Stockholm, from 1989 until his retirement Nov. 1, with the Sarnoff Citation. The award is bestowed each year to an individual who has made major contributions to the development of international radio communications.

Radio industry contributors

Mobile radio industry members received awards for their contributions to the radio industry during the annual Radio Club of America meeting. The Radio Club promotes and honors the pioneers and leaders Award presentations include:

☐ *Armstrong Medal* — Paul Gruber received this honor for major contributions to the design and development of tropospheric scatter communications systems and for work in the perfection of the Diana Moonbounce radar.

☐ *Sarnoff Citation* — Ake L. Lundqvist, president and CEO of Ericsson, Stockholm, from 1989 until his retirement Nov. 1, was awarded the Sarnoff Citation. The award is bestowed each year to an individual who has major contributions to the development of international radio communications.

☐ *Henri Busignies Memorial Award* — Stuart F. Meyer received this award for his leadership in the Radio Club of America and in associated communication organizations.

☐ *Allen B. DuMont Citation* — William F. Bailey was presented this award for major contributions to the theory, practice and standardization of the art and

science of television.

☐ *Jack Poppele Broadcast Award* — George Jacobs, P.E., received this award in recognition of outstanding engineering contributions in the development of international broadcasting and communications.

☐ *Special Services Award* — Joseph S. Rosenbloom, Esq., was recognized for his long an valued services as vice president/counsel of the Radio Club of America.

☐ *President's Award* — June Poppele received this award for contributions in counseling and guiding the Radio Club of America through this last decade.

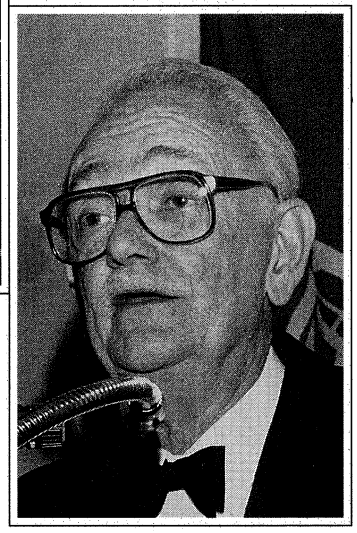
☐ *Lee de Forest Award* — was bestowed upon Louise Ramsey Moreau for contributions in researching the history of women in communications and for preserving the history of telegraph.

☐ *Fred M. Link Award* — went to Al Gross in recognition of his inventions and development of hand-held radio transceivers.

☐ *E. F. Johnson Pioneer Award* — George J. Apfel received this award for major contributions in the development of wireless microphones and crystal testing equipment

☐ *Ralph Batcher Memorial Award* — was presented to Thomas S.W. Lewis for recognition of his leadership

Connie Conte of Tele-Measurements greets guests at the Radio Club's annual dinner and awards presentation in New York City.



Raymond C. Trott serves as master of ceremonies.

in preserving the history of radio to the general public through his writings and radio and television productions.

1992 Fellows

Dr. Thomas S.W. Lewis, author of *Empire of the Air: The Men Who Made Radio*, a book on the early days of radio and its pioneers, was elevated to Fellow and served as the keynote speaker at the meeting.

Lewis addressed pioneering radio history in his speech, as well as radio's future. "We should support the preservation of archives," he said. "We should

Communications Symposium

During the afternoon before the annual dinner and awards presentation, the Radio Club of America sponsored the Communications Symposium.

Presentations during the symposium range from scientific papers to informal talks, slide programs, films and video programs.

The 1992 symposium, organized and conducted by Maxine Carter-Lome, included the following presentations:

- "A Short Review of the Alexanderson Alternator" was prepared by by Bruce L. Kelley, curator of the American Wireless Association's Electronic Communication Museum, and was delivered in Kelley's absence by Ralph O. Williams.

The review covered Kelley's visits to several Radio Corporation of America high-power commercial very longwave (VLF) stations that used Alexanderson alternators. A prime factor in the formation of the Radio Corp., the Alexanderson alternator was installed in several East Coast longwave stations after World War I.

Before they were dismantled in the '50s and '60s, Kelley had the foresight and good fortune to observe and film their operation.

- "Recent Developments in Mobile Radio Systems" was prepared by Dale Hatfield, president of Hatfield & Associates.

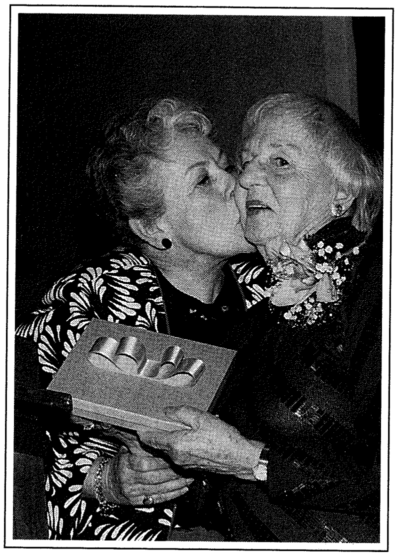
Hatfield's talk explored the recent and near-term developments in mobile radio systems and trends and concurrent developments in the landline portion of the telecommunications infrastructure as it relates to the growing inter-relationship between wired and wireless technologies and the future of mobile radio technology.

- "We're Not In Kansas Anymore: the Expanding Universe of Digital Radio Technologies" was delivered by Dr. George Calhoun, president of PowerSpectrum Inc. and the author of several books on future wireless technologies.

Calhoun's presentation explored the future of digital wireless technologies as mobile radio operators expand beyond FM into such new system architectures as TDMA, CDMA, E-TDMA and frequency hopping. Calhoun presented new ways of thinking about a very diverse and high-tech industry that will energize the whole radio community.

- "Jack R. Poppele Transmitting Station Dedication Ceremony" was a video tape of the dedication ceremony of the Jack R. Poppele Transmitting Station in Bakersfield, CA. Stuart Meyer, who at the time was the Club's executive vice president and who now is president, shared his impressions of this exciting event.

—From the symposium program



Vivian Carr presents a gift to Mildred Link for her longtime support of outgoing Radio Club of America president Fred M. Link.

strive to preserve radio history."

Roger Block of PolyPhaser, Minden, Nev., was elevated to the grade of Fellow and served as the Fellows' respondent. "We recognize the Radio Club as the meeting place for the past, present and future," he said.

Among those elevated to the grade of Fellow for contributions to the radio industry and the Radio Club are Alfonso Avallone of Franklin Square, N.Y.; Clifford E. Bade of Olmstead Falls, Ohio; Debra Baker of Chantilly, Va.; Charles W. Bostian, Ph.D., of Blacksburg, Va.; Edward S.K. Chien, Ph.D., of Fremont, Calif.; Armando Courir of Florence, Italy; Bruce G. Cramer of Jenkintown, Pa.; Brother Patrick Dowd of Paramus, N.J.; Andrew W. Ely of Manasquan, N.J.; Thomas W. Emmons of Eatontown, N.J.; J. Lawrence Evans Jr., M.D., of Englewood, N.J. and Joseph A. Fahrner of Orchard Park, N.Y.

Other industry leaders elevated to Fellow include: Randall J. Friedberg of Lewisville, Texas; John C. Geist of Silver Spring, Md.; Thomas E. Grantz of Longwood, Fla.; Dale N. Hatfield of Boulder, Colo.; Joran Hoff of Bromma, Sweden; Michael W. Hunter of Belle Mead, N.J.; Samuel A. Leslie of Forest, Va.; Marcus J. Lockard, P.E., of Houston; Irwin R. Masavage of Waldwick, N.J.; Michael J. McCabe of Quincy, Ill.; and David E. Newman of Spring, Texas.

Rounding out the new Fellows are John O'Dowd of Norcross, Ga.; Raymond Palma of New Milford, N.J.; Joseph J. Pomparelli of Cherry Hill, N.J.; Donald L. Porter of Verona, Wis.; James R. Rand of Little Rock, Ark.; Richard G. Richardson of Minneapolis; Anthony J. Russo of Franklin Lakes, N.J.; J. Sharpe Smith of Washington, D.C.; Leo M. Vashrow of Schenectady, N.Y.; Gary P. Wallin of Manchester, N.H.; Col. Robert C. Walton of San Jose, Calif.; Clarence W. Weaver of Dallas; and Ralph T. Wehking of Cincinnati.

Jane Bryant (F) is co-editor.

Inspiring the Youth...

(continued from page 9)

teacher studying for an FCC license.

The important thing to remember is, that no matter what you come to share with the kids, make it lively and exciting so they'll want to learn more about what you have to say.

Bring lots of visuals, videos, pictures, and handouts for the kids. Keep the presentation brief; and appropriate to the age level of the children.

Involve the students

Try to involve as many of the students as possible in your demonstration or presentation. Check with the teacher ahead of time to get background information about who your audience will be.

I have been on "combat duty" with 6th, 7th and 8th graders for many years, and I have seen the impact of an amateur radio program on many of their lives. Never underestimate the effect you can have if you get into a school and stimulate interest in the teachers, administrators and children for some kind of technology program.

When you set up your initial contact with the teacher or principal, make sure you go in prepared. Be ready to answer all the questions and objections you are bound to hear.

Also, go in armed with documentation of other school successes and exciting press releases that are available. Please don't reinvent the wheel! This is where I can be of help. Contact me, and I will send you a whole "propaganda package" of goodies to put before an administrator in a school.

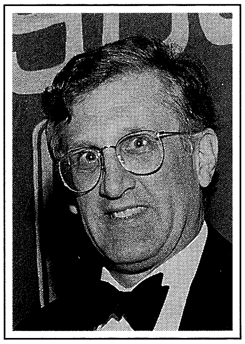
Packaged program

My principal and I have put together a package for this purpose that is free and available to anyone with a serious desire to help out in a school. If you get to the point where the school becomes interested in setting up a regular ham radio program, then you can contact me for information about my curriculem package which is specifically designed for using amateur radio in the classroom to motivate kids in all other areas of the school's curricula.

Don't hesitate to call or write if I can be of help. I can be reached at (718)983-1416, fax or phone, or at P.O. Box 131646, Staten Island, NY 10313-0006.

On The Shoulders of Giants

By Thomas S.W. Lewis, Ph.D.



Thomas S.W. Lewis, Ph.D., (F) is the author of Empire of the Air: The Men Who Made Radio. This is the text of the keynote speech he delivered at the 83rd Annual Dinner and Awards Presentation.

Mr. President, officers and directors, fellow honorees and newly elected fellows, I consider it a singular honor to be invited to speak this evening and I must confess that I—one who is not an engineer—feel humbled to be among so many great persons who are.

This evening I feel like Jonathan Swift's Lemul Gulliver. Gulliver, you'll remember, travelled to Brobdignag—a land populated by giants. Tonight I am a small man among many giants.

There are few places on the globe where one could find more talent at this moment than the talent concentrated in the few square feet of this room. Assembled here are those who were present at the creation of many of the electronic inventions that we depend upon in the our daily life.

Every person in this room acts a part in the saga. We stand on the shoulders of those giants of the past—the Fessendens and the Armstrongs, the Poppeles and the Bakers. It should give you a special sense of pride to know and to celebrate your rich past.

The world didn't really need those discoveries before the time that you made them, just as the world did not really need Mozart's symphonies or Shakespeare's plays before those geniuses wrote them. Now we cannot imagine living in a world without Mozart or Shakespeare, or your inventions.

This evening I want to speak of several of the Titanic figures people who have gone before you in the continuing saga of radio development: Reginald Aubrey Fessenden, Jack Poppele, Walter Ransome Gail Baker, and Edwin Howard Armstrong. I have chosen to speak of them because of their diversity and their greatness.

One was a great inventor. Two were practical radio engineers. And one, the last, was a genius. All were giants on whose shoulders you stand; people to whom we are all indebted. Their personal stories are of the discoveries and accomplishments upon which so many of us in this room have built.

Each of these Titans happens to have been a member of the Radio Club of America. Needless to say their contributions to the radio art lend great luster to this club.

Their discoveries and advances live on in our minds. Indeed, our minds have been made better by their presence at events like this one, and the ones that took place this afternoon, as well as through the publication of their ideas in the *Proceedings*.

Fessenden

The first giant to mention of course is the Canadian-born inventor Reginald Aubrey Fessenden.

Now, as his name suggests, Fessenden was as formidable a man. At the University of Pittsburgh where he taught for a time, he more than once dressed down students with the remark "Don't try to think. You haven't the brain for it."

The young men who gathered at the Hotel Ansonia on January 2, 1909 to create the "Junior Wireless Club Limited," the predecessor to the Radio Club of America, were a strong and spirited lot themselves—especially W.E.D. Stokes, the first president and Frank King, the corresponding secretary.

It is testimony to the confidence of their young minds that they asked the forty-three year old Fessenden to serve as their club's adviser with the title "Consulting Engineer." No matter how imperious Fessenden was, the youths recognized his abilities and accomplishments and were not to be intimidated.

It can be argued that in 1909 Reginald Fessenden was the most important and visionary person in the field of wireless. Certainly Marconi's commercial ventures were successful by then, but the technology that the Anglo-Italian inventor clung to, especially the coherer which he still relied upon to a great degree for receiving wireless messages, was outdated. Nor did Marconi demonstrate any interest in voice communication.

Certainly Lee de Forest several years earlier had invented the triode, the magic seed from which the electronics age would grow, and he shared Fessenden's vision of what wireless could become. But in several key areas de Forest lacked the equipment and the technical training develop his ideas.

It was Fessenden who pioneered the concept and the technology to move wireless from syntony and spark to the continuous wave. On Christmas Eve, 1906, ship operators and amateurs near his station at Brant Rock, Massachusetts heard through their ear phones: "someone speaking!" Fessenden himself read a short poem; he played "O Holy Night" on his violin; he used his phonograph to broadcast a woman singing a selection from Handel's "Largo"; and he read these verses from the Gospel of St. Luke: "And she brought forth her first born son, and wrapped him in swaddling clothes, and laid him in manger".

The inventor had presented the first radio broadcast. In a single evening Reginald Aubrey Fessenden had become the first radio performer, the first disk jockey, and the first religious broadcaster!

Fessenden was in the forefront of the entirely new concept of "broadcasting," the agricultural term for spreading seed across a field. For the most part, a wireless transmission had been a coded telegraph message directed to a single person. His vision had liberated wireless communication from the fetters of dots and dashes of the code allowing radio to become a medium accessible to all and capable of changing the world.

In the development of the wireless receiver, too, Fessenden stands as a visionary. Guided by an elementary knowledge of harmonics, Fessenden found that two incoming radio signals, each with a different frequency, could be mixed together to produce a third signal with a frequency equal to the difference between the two.

To name this phenomenon, Fessenden turned to Greek: hetero, meaning "other" and -dyne, meaning "force." In the case of the heterodyne, two different high frequency radio waves were literally forced together to produce a third wave, which he called a "beat" note, and which he hoped to manipulate.

Tests with the Navy in 1913 proved the efficacy of Fessenden's idea though not its practicality. He produced his heterodyning wave with a noisy arc generator which proved difficult to control. Fessenden's idea of heterodyning the incoming radio signal had run ahead of the available technology.

For all his vision, which at this time saw far beyond Guglielmo Marconi's, Fessenden would receive little reward. Though he had sketched the first design and had given General Electric $10,000 of his own money to create the revolutionary "Alexanderson Alternator" that made continuous wave transmission possible, it was Marconi who later gained almost exclusive control of the invention.

It was Howard Armstrong's regeneration circuit that produced a reliable radio wave at a correctly regulated frequency within a radio receiver. Fessenden won hundreds of thousands of dollars in legal actions against those who had stolen or improperly appropriated his inventions only to find his opponent's companies in bankrupt. He realized nothing.

He died in 1932, a disillusioned and bitter man, resentful, and frustrated by his failure to win either the fame or money that he was entitled to.

Poppele

Jack Poppele, the second Titan, was a very different person.

He was an engineer who went into broadcasting, and out of broadcasting itself, he made significant discoveries. A student of electrical theory at Newark Tech by day, and radio theory at the Marconi Wireless School by night, Poppele had mastered all there was to know about wireless by 1915, the year he obtained his commercial operator's license and took a job as an operator on the S.S. Iroquois, where by the way he met a fellow shipmate with the name Allen B. Du Mont.

Poppele always seemed happiest with the engineering side of radio, when he was in a position in which he could design, build and operate a radio station. He loved to translate theory into the day-to-day practice of broadcasting.

In 1922 Poppele convinced Louis Bamburger to operate a radio station from his department store in Newark, New Jersey and became the station's chief engineer at $23. a week. He designed and constructed the station's first transmitter, a crude affair with 250 watts output.

The initial broadcasts were but two and a half hours spread out in three half-hour segments during the day and a single hour long program in the evening. Between broadcasts Poppele sold radios in the department store. But that was just the beginning for Poppele and for the famous station he had created: WOR.

As chief engineer at WOR for three decades, Poppele was never content just to sit by and let the station run itself. He was always watching for new developments in the radio art; and frequently he contributed to those developments.

These men and many like them are giants whose lives and accomplishments constitute a saga about our inheritance a saga that affects every one of us every day.

It's a story that began with the work of Michael Faraday, James Clerk Maxwell and Heinrich Hertz, and continues to the present moment. Each new discovery and each new application of Clerk Maxwell's principles narrows the distance between us, affects the way we conduct our lives, and represents a new chapter of the saga.

Every person in this room acts a part in the saga. We stand on the shoulders of those giants of the past—the Fessendens and the Armstrongs, the Poppeles and the Bakers. It should give you a special sense of pride to know and to celebrate your rich past. Yet your privileged position as the actors in the latest chapter of the saga also brings with it some special responsibilities, which I hope you will consider.

First and foremost, you must recognize that our history is fast slipping from us.

On the West Coast the de Forest archives are stored in a warehouse after having been evicted from a college museum in Los Altos, California, the heart of the Silicon Valley, a land that owes an inestimable debt to de Forest's invention of the three element tube.

At Columbia University, millions of Howard Armstrong's papers desperately need preservation and organization, which cannot go forward for lack of funds. Who knows what secrets they hold, secrets that might well lead an enterprising researcher to new and more startling discoveries?

In Washington the Broadcast Pioneers Library is bursting with materials that need preservation and organization.

I find it ironic that the archives dedicated to the technology you and your illustrious predecessors have created are starving for funds while at the same time in Orlando, Florida there is a large, well endowed museum devoted to historic food containers and Tupperware.

You and I must shake off the sluggish amnesia that has gripped so many and honor those who have gone before. For members of this club, the oldest radio club, our obligation is great. Not only should we support the preservation of archives, but we should recognize that in this room is a living archive of some of the greatest achievements of this century.

I urge the Radio Club, particularly its directors, to create and fund an oral history project that would transcribe the thoughts and memories of some of those here tonight.

As I have made clear I hope, "Empire of the Air" tells only one part of the saga. There are countless engineers whom I mention only briefly or not at all, and they deserve much more attention.

I'm thinking of people like those whom I mentioned earlier and others whom I have not, like John V. L. Hogan, Harold Beverage and W. E. G. Finch. Men like these deserve our serious attention.

Second, to return to your role in the saga, you are not only inheritors of a rich history, but in many cases are participating in it. Many of you handle history every day. In the '20s and '30s a radio pioneer and engineer, George Clark, served in a variety of capacities for RCA and NBC. Clark began his career in wireless as it was then called, in 1903 and worked continuously until 1946.

He was that rare person who recognized the importance of what he was doing—certainly more so than anyone else at RCA—and he was a pack rat. He saved newspaper articles and letters, internal corporate memoranda and press releases, legal papers and patents.

The collection grew so large that his wife left him. "From that time on," Clark said, "I was wedded to scraps." Nothing went into his waste basket, but into his files. After Clark's death in 1956, the collection, 276 linear feet of it, was acquired by the Smithsonian Institution, the nation's attic.

It is an invaluable resource for anyone interested in the history of radio. In it we find letters from "Doc" de Forest, Howard Armstrong, and "Dave" Sarnoff; publicity pictures of RCA and NBC; scrapbooks filled with clippings about early feats of radio engineering, invitations to and even the seating arrangements for various dinners and luncheons, even the legal papers from de Forest's old law firm.

You, who are participating in history, can record it simply by saving. When your company throws away its records, as companies inevitably do, save them at all cost. Make sure that tape and disc archives—often the prey of some cost-saving manager fresh out of business school—end up in your attic and eventually an archive rather than in the town dump.

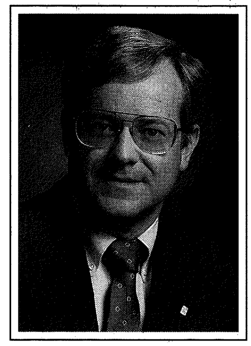
Why preserve this history? Why not let it go to the winds?

The answer to these questions lies in our need to understand. I mentioned at the beginning of this talk that there are giants of among us this evening people who have perfected a circuit, have worked out an important mathematical principle, have made a discovery. But each of us, no matter how tall stands on the shoulders of giants.

I have borrowed the phrase from Sir Isaac Newton. "If I have seen further than others," Newton once said in a letter to a friend, "it is by standing on the shoulders of giants." We must recognize who those giants were, the quality of their achievements and the nature of their vision. Without that understanding our own stature will be smaller and our future achievements diminished.

Response for Fellows

By Roger R. Block



It is a pleasure and honor to be here and to speak on behalf of this years elected fellows. I am sure there is one thing we can all agree on; it is truly an honor to be a member of this fine and historic organization.

Time has a way of making things not only better but more impressive. Not too long ago, I was in conversation with Don Bishop when the subject of Nikola Tesla come to light.

He has been an inspiration to me for many years. In fact his picture hangs behind my desk and his signature card or calling card hangs on a wall in our home in Nevada. He is by far the most underrated forefather of radio. I wish no one a similar fate in the history books.

Not too far from here in Madison Square Garden, in 1898, Mr. Tesla demonstrated, much to the delight of the on-looking crowds, a look into radio's bright future. This was several years before Marconi.

Tesla, with his toy boats, took commands from the audience as he remotely controlled the direction and speed of the boats. Many years later, there was, of course, a patent fight, and the outcome is history. What Mr. Tesla has given us, however, is more than just history, it is still alive and living.

After talking with Don, he introduced me to a man who actually met Mr. Tesla. This esteemed gentleman commenced telling me how he had several informal luncheons with Mr. Tesla. I was in awe!

Today, thinking back to that living history lesson, I still treasure every minute of that three-hour conversation. It was my first talk with Fred Link and my first introduction to this fine institution.

I think all of us at one time or another has met, worked with, or has been with a notable person that we have great feelings of respect and admiration. Interestingly, they are oftentimes older than ourselves, and yet they are, after all, real people.

It is this thing called time that effects our perception of the now and elevates the past to a higher plane. Sometimes we may find that we don't appreciate the people we have amongst us now; nor do we give enough credit and encouragement to those who are attempting to follow in our footsteps.

For this year's elected Fellows, what makes our Radio Club of America so important to us?

We recognize it as the meeting place for the past, present and for the future. The past to be recognized, the present to be inspired to strive harder, and the future to be in awe and to know what can be accomplished with vision, hard work and persistence.

RCA is a storehouse of information and living history ready to be tapped. Things tried long ago may not have worked then, but may be feasible tomorrow.

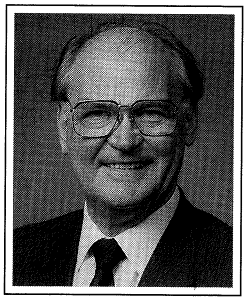
The Club, to me, is like the friendly glow of a tube filament. Yes, I remember hollow state, the predecessor to solid state. The stuff that you could see, and it made you feel all warm and fuzzy inside. Our Club is like that, a shining light of hope to those who need its help and encouragement.

It gives the love and good feelings that come with helping others too. RCA is a club which every member can be proud to say, "I'm a member."

At the present time, the ranks of people interested in RF continues to decline, as any college curriculum will show. We seem to be a dying breed.

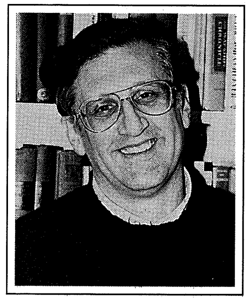
For the future, it should be a top goal of all club members to continue to interest young people in radio. Not just operators, but people really interested in every aspect

Honors and Awards – 1992



SARNOFF CITATION
AKE L. LUNDQVIST

Awarded for major contributions to the development of international radio communications.



RALPH BATCHER MEMORIAL AWARD
THOMAS S.W. LEWIS, Ph.D.

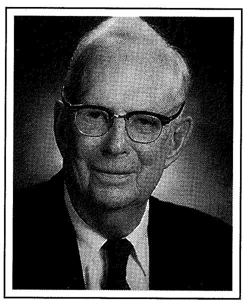
Awarded in recognition of leadership in presenting the history of radio to the general public through his writings and radio and television productions.

HENRI BUSIGNIES MEMORIAL AWARD
STUART F. MEYER

Awarded for his leadership in The Radio Club of America and in associated communication organizations.

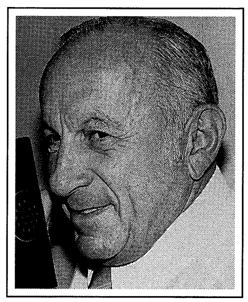
E.F. JOHNSON PIONEER AWARD
GEORGE J. APFEL

Awarded for major contributions in the development of wireless microphones and crystal testing equipment.



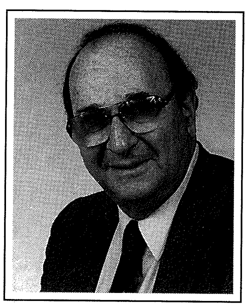
ALLEN B. DuMONT CITATION
WILLIAM F. BAILEY

Awarded for major contributions to the theory, practice and standardization of the art and science of television.



FRED M. LINK AWARD
AL GROSS

Awarded in recognition of his inventions and development of hand-held radio transceivers.

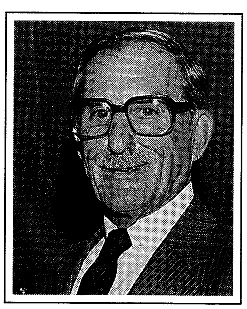


JACK POPPELE BROADCAST AWARD
GEORGE JACOBS, P.E.

Awarded in recognition of outstanding engineering contributions in the development of international bradcasting and communications.

LEE deFOREST AWARD
MS. LOUISE RAMSEY MOREAU

Awarded for contriubtions in researching the history of women in comunications, and for preserving the history of telegraphy.



SPECIAL SERVICES AWARD
JOSEPH S. ROSENBLOOM, ESQ.

Awarded in recognition of his long and valued services as Vice President/Counsel of The Radio Club of America.

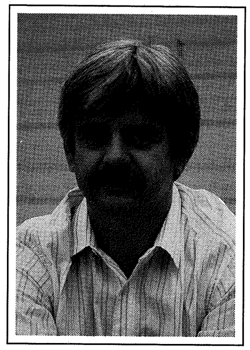
PRESIDENT'S AWARD
MS. JUNE POPPELE

Awarded for contributions in counseling and guiding The Radio Club of America through this last decade.

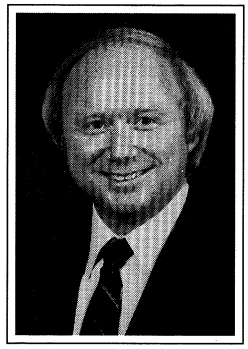
Getting Ahead of Nyquist and Shannon

Redefining the technology of next generation modems

by Dr. Rainald Schoneberg and William Cole



Schoneberg



Cole

A new fail-safe technology for bandwidth- and power-efficient data communication systems works perfectly on typical land mobile radio channels at actual speeds above 9,600 bps, without needing synchronization and equalization.

Today's computer language is zeros and ones: Letters, numbers and even pictures are represented by strings of these two basic units, called *bits*.

A letter can be identified by a string of eight bits. A picture normally requires a string of millions of bits.

Data communication deals with transferring zeros and ones from one computing device to another. This communication may be from a personal computer (PC) to a printer, from an automatic teller machine (ATM) to a bank's mainframe computer or from a pressure sensor to a control unit.

Hardwired data links

Various standards exist for *local* connections.

The most widely used bi-directional standard is RS-232, which defines the physical and logical ways of transferring zeros and ones. It is character-based, serial and asynchronous.

Ten zeros and ones are sequentially transmitted for each character: a start bit, eight data bits and a stop bit. Transmission and reception speeds are selectable from 75 bits per second (bps) to 19,200 bps. Hence, as many as 1,920 characters per second (cps) can be exchanged each way.

Radio, telephone data links

Modems are the mainstay of the *remote* data communication industry.

They are required to convert data to audio and back again. Each successive modem generation offers an impressive array of new bells and whistles. Speeds greater than 50,000 bps are advertised.

Data compression

In reality, 2,400 bps and 9,600 bps modems dominate.

Faster transmissions are achieved through data compression. A text of 2,000 letters is reduced, for example, to 800 characters by eliminating redundancies, and only those 800 characters, which represent instructions and letters, are transmitted. The gain in speed is achieved by software programs simple enough for many high school seniors to write.

Synchronization

Why does it usually take at least one minute to send a page of text from one facsimile machine to another?

This new technology has been named AHEAD, an acronym for asynchronous halfwave encoding and decoding. It bypasses the limits of the Nyquist and Shannon rules by avoiding audio signal manipulations at fixed time intervals (frequency domain approach). Instead, it assembles halfwaves chronologically in response to data without a signaling rate (time domain approach).

The answer is *synchronization*. Before a modem (built into a fax machine) actually transmits data, it has to negotiate format and speed with the receiving modem and get the timing right. This process is an *overhead* that reduces the effective speed, a fact that often is omitted from advertisements that include modem speed figures.

Asynchronous

Many modem uses are *question and answer*.

For example, a corporate database is interrogated, and the information is displayed, or a purchase with a credit card is submitted and authorized. Relatively few zeros and ones have to be transmitted each

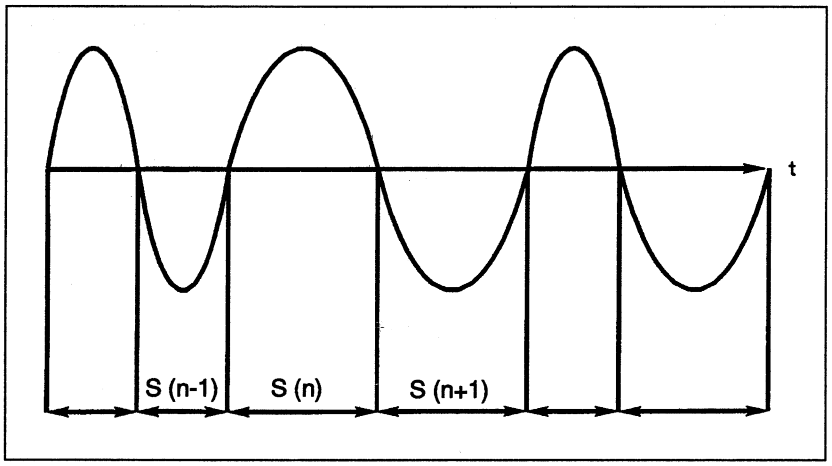


Figure 2. *A 1 is encoded into a halfwave of length 200 microseconds and a ∅ into a halfwave of 160 microseconds.*

pending on the corresponding bit value.

At the receiving end, a sequence E(1), E(2), . . ., E(m), . . . can be determined by measuring the elapsed time between two consecutive zero crossings. This sequence is—according to the invention—in the simplest case, related to the transmit sequence by the formula:

$$E(m) = A*S(n-1) + B*S(n) + C*S(n+1)$$

where

A, B and C are positive constants with A + B + C = 1.

If, for example, A = 0.2, and C = 0.3, then the substream. . ., 0, 1, 1, 0, . . . of bits generates a transmit subsequence. . ., 160, 200, 200, 160,. . . and results in a receive subsequence of . . ., 192, 188, . . ., because 0.2*160 + 0.5*200 + 0.3*200 = 192 and 0.2*200 + 0.5*200 + 0.3*160 = 188.

Once the coefficients A, B and C are sufficiently known, the recovery of data at the receiving end is possible. The measured receive sequence of elapsed time durations is compared to all possible transmit sequences via the above formula, and the transmit sequence generating the best match is considered to have been used at the transmitting end.

Finding or adapting the coefficients A, B and C is easy.

Experimenting with empirical sets yields excellent estimates in a short time which are usable during extended lengths of time for whole groups of voiceband channels and transceivers, such as radios and telephones.

Staying 'AHEAD'

This new technology has been named *AHEAD*, an acronym for *asynchronous halfwave encoding and decoding.*

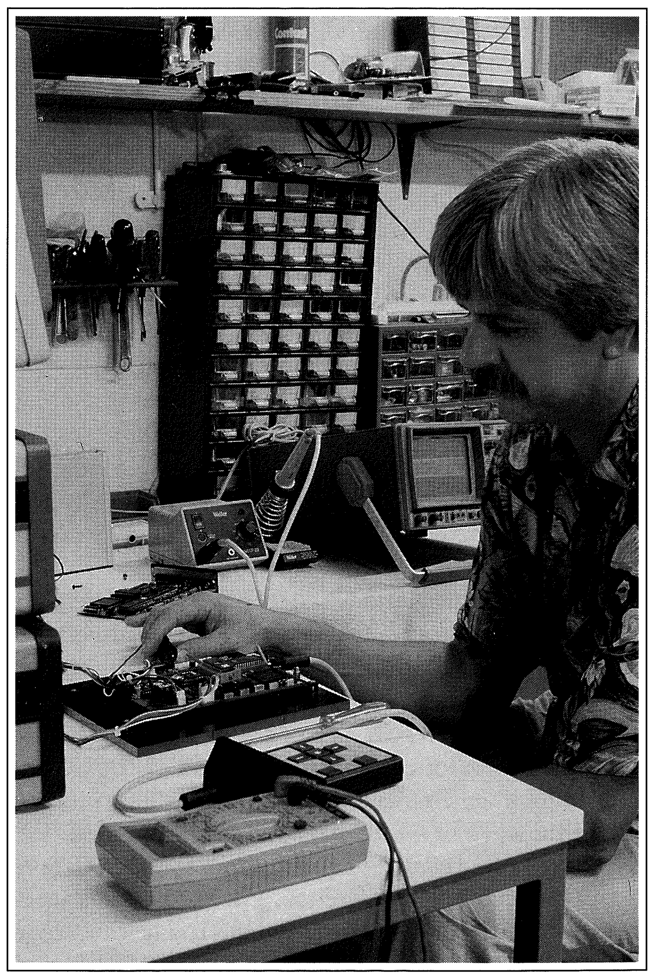
It bypasses the limits of the Nyquist and Shannon rules by avoiding audio signal manipulations at time intervals of fixed duration (frequency domain approach). Instead, it assembles halfwaves chronologically in response to data without a signaling rate (time domain approach).

The decoding does not eliminate intersymbol interference but takes it into account. Channel effects are quantified and the data is recovered by using neighboring past and future halfwaves to explain resulting halfwaves at the receiving end.

To turn AHEAD, as explained so far, into a complete modem, a certain *start signaling* is required. Naturally, halfwaves come to mind. Selecting a third frequency (for example, 2,083Hz, with a halfwave time duration of 240 microseconds) gives an easy solution.

Each encoded character (composed of eight bits) is preceded by a fullwave with a period of 480 microseconds (which is equal to two halfwaves with durations of 240 microseconds). This preamble allows the receiver to detect and decode a character simultaneously in the voiceband channel.

A truly asynchronous, character-based and fast modem is thus defined. Each character is encoded into a symbol of time duration less than or equal to 2,080



Author Schoneberg conducts a lab test on the prototype modem.

microseconds (8*200 + 480 = 2,080), so that at least 480 characters can be transmitted per second, a rate superior to a standard 4,800 bps modem.

Choosing four frequencies at or above 2,500Hz and encoding two bits (dibits) into one halfwave defines an AHEAD modem, which can transmit in excess of 960 characters per second using the same design. This rate compares to a transparent 9,600 bps modem.

But why go through all this trouble to arrive at 4,800 bps and 9,600 bps modems, which have been around for decades? Here are at least ten reasons:

(1) AHEAD modems are the first truly asynchronous modems at speeds higher than 1,200 bps. Single characters are transmitted in a little more than one or two milliseconds. There is no overhead.

(2) The modems are frequency-based. *Frequencies* stabilize faster and are distorted less than amplitude and phase. Using only frequencies to carry information gives AHEAD modems the edge over all higher-speed modems when used with less-than-ideal voiceband channels and, in particular, mobile radio channels.

Because amplitudes and phases are not relevant, existing radio transceivers can be used. *A speaker output and a microphone input are all that is needed.* No other modem technology can work this way.

Even the automatic gain controls (AGCs) used in many radios pose no problem. Traditional radio data links with speeds higher than 2,400 bps require access to the voltage-controlled oscillator (VCO) or other internal radio components. AHEAD can achieve 9,600 bps and more without any connection to a transceiver's internal components.

(3) AHEAD is fully developed for physical speeds as high as 10,000 bps and still has potential for improvements in features.

For example, the start signaling can be varied to provide an addressing scheme with no overhead.

For another example, selecting 16 frequencies at or above 2,500Hz and encoding four bits into one halfwave yields an AHEAD modem with throughput speeds higher than 19,200 bps. And this is an *asynchronous modem.*

As a third example, AHEAD modems have built-in encryption. The defining frequencies and channel parameters must be known to detect and decode data.

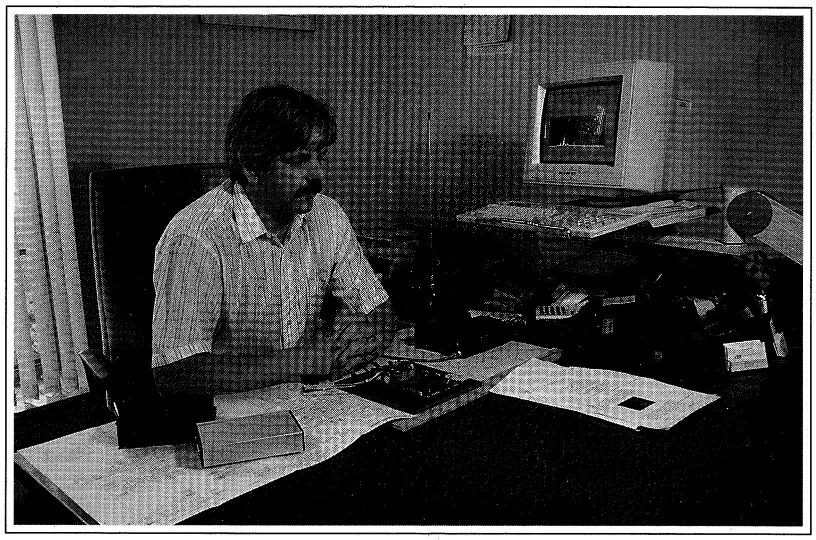
(4) AHEAD is highly spectrum-efficient.

The absence of a signaling rate and the continuous phase symbols reduce the requirements to passage of a band, which includes the defining frequencies. Voice and data or data and video signals thus may coexist without problems.

(5) The modems are basically digital.

Simple microcontrollers can be used to implement the technology, guaranteeing low manufacturing costs and allowing miniaturization. In addition, operating environments are fairly unlimited. (See Figure 3 (next page).)

(6) AHEAD modems are self-learning.



Author Schoneberg uses a computer to program the prototype modem for use with off-the-shelf radio communications equipment.

New voice communication equipment is easily interfaced. Manufacturers can implement a function that learns the basic characteristics of the entire channel without user interference.

Once established, those characteristics (called *profiles* in the context of AHEAD) can be used over a wide range of setups. No tuning, trimming or understanding is required. In contrast to existing modems, this procedure is necessary only once. Optional real-time adaptations can only improve the performance.

(7) AHEAD is software-based.

Changing frequencies or parameters or features is reduced to the exchange of programs. Imagine what this means in terms of serviceability and updates.

(8) AHEAD is universal.

This patented techology can be used with all voice transmitting equipment. The same modem is suitable for telephones and radios.

Prototypes have been tested over telephone systems in Europe and North America. The same prototypes were used in conjunction with HF, VHF and UHF radio equipment with excellent results.

Because the future has in store various combinations of telephone and radio technology for voice communication, AHEAD arrived at just about the right time.

(9) AHEAD is efficient.

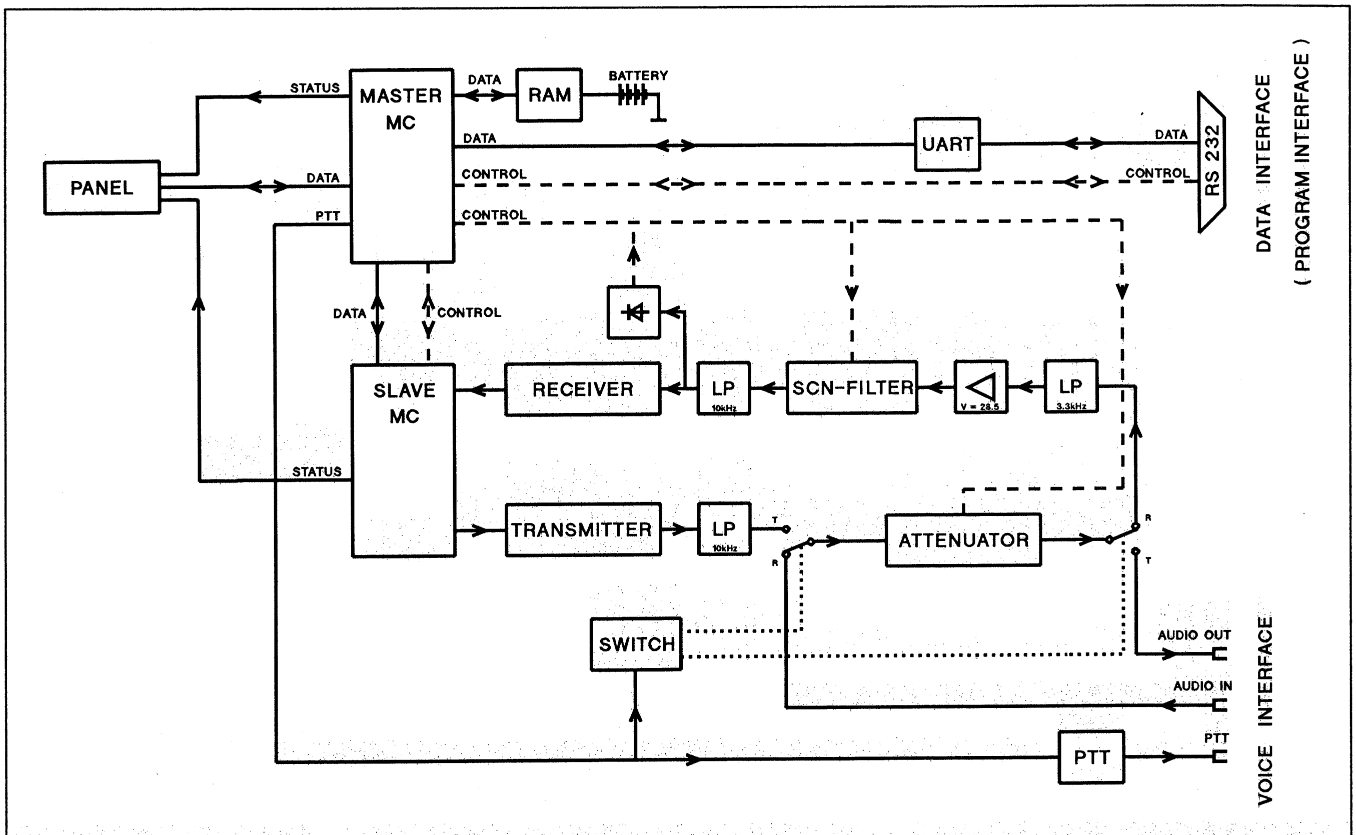


Figure 3. *This is the block diagram of a prototype modem design that has been tested over telephone systems in Europe and North America. The same design was used in conjunction with HF, VHF and UHF radio equipment with excellent results.*

Tests have shown that AHEAD modem error rates are far superior to those of all other modem technologies. They exceed those of FSK, which is the most robust modem technology in use today.

(10) AHEAD uses existing communications equipment for data links.

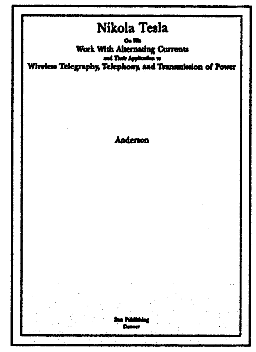
No special or modified radios are needed. Even acoustic coupling to a radio channel or telephone line yields excellent results—And all this at a speed higher than most modems in use today.

Dr. Rainald Schoneberg *received his M.Sc. and Ph.D. degrees in mathematics from the Technical University of Aachen, Germany, in 1975 and 1977, respectively. He was assistant and, later, professor at the universities of Aachen, Bonn and Iowa. After advancing in various industry data processing positions, he is currently heading research and development at Comacs Enterprises, Inc. in Orlando, Florida. A prototype modem built according to Schoneberg's patent is used as an example in this article.*

William H. Cole *(F) started in the radio communications industry in 1967, working for Motorola Communications & Electronics Inc. In 1971, he joined Secode Electronics as marketing manager. In 1977, he moved to Harris Corporation's RF Communications Division as international sales manager for Africa, Europe and Latin America, later advancing to become director of national marketing. Since 1983, he has held senior-level sales, marketing and general management positions with TacTel Cellular, Repco and Sinclair Radio Laboratories. He is president of Diversified Resources Inc., an Orlando, Florida-based sales and marketing consulting organization.*

Book Review

Nikola Tesla On His Work With Alternating Currents and Their Application to Wireless Telegraphy, Telephony, and Transmission of Power



Reviewed By Roger R. Block

Leland I. Anderson's book *Nikola Tesla On His Work With Alternating Currents and Their Application to Wireless Telegraphy, Telephony, and Transmission of Power* is a must read for all history and radio buffs.

It clearly describes the inner thinking of Tesla, the man, in a way never done before. You get to read Tesla's own words as spoken in a 1916 pre-hearing interview with his legal counsel. This interview never was intended to be made public, but as you read this book, a presence will transcend you to that moment. It is truly a magical transformation in the time domain.

Many new things are brought to light. Interestingly, Tesla had tried to persuade the Navy to sponsor shipboard radio communications after he publicly demonstrated radio remote control of toy boats in 1898. Congress, however, only appropriated $750,000 to John Hays Hammond Jr. after Tesla's patent had expired.

Anderson gives no doubt as to who is the real inventor of radio. He pictures Tesla's actual equipment and patent drawings, and in the text, Tesla is asked by his counsel to describe how each worked.

Unique (non-commutated) rotating dc generators, along with other damped generators, Tesla explains, are the forerunner to his continuous (CW) "mechanical signal" generators. These patented generators had tremendous output power and were used (by Pickard), together with Tesla's "antenna," to transmit signals 200 miles to 300 miles easily. Even the Navy indicated that Tesla's equipment design, covered in his 1900 patents, was the best.

The excitement of looking back almost 100 years is that we know the outcome. The irony is that we have the knowledge to know what does work and how it works.

Tesla's idea for power transmission is the same for information (radio). Anderson documents, in Tesla's own words, his reasoning for how it works. The earth, he explains, is a conductor, and the upper atmosphere is another conductor, but not as good.

The earth is like a balloon (sic) filled with water. As the transmitter, like a pump, slowly "vibrates" the earth (an elastic medium), these vibrations carry to all parts of the globe.

If another tuned "pump" (receiver) is placed some distance away, it will recover power from the transmitter. If the frequency is too high, the vibration will not be felt, and it will die like a ripple on a pond.

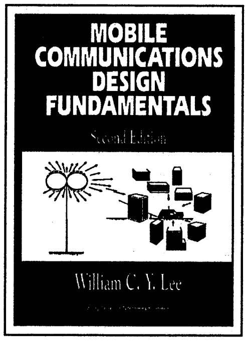
It is the earth conducting the energy,; therefore electromagnetic (EM) radiation should be avoided because it only radiates in a non-elastic medium—air. From this theory, the intent to minimize EM leads Tesla to a heavily loaded tuned antenna, all coil with a capacitive hat, which produces extremely high voltages. Tesla refers to requiring 4,000,000 volts of "pressure" to transmit power and information around the globe.

In a later part of the book, Anderson pulls at our hearts as he includes foreclosure proceedings on Wardenclyffe, the site of Tesla's greatest dream for wireless transmission of power and messages, which turned into his financial ruin. Tesla spent $750,000 on the project, and the final dismantling of the specially constructed tower was a major blow to him.

Interesting to read, this book still had me backing Tesla in the hope that history could be rewritten. Unfortunately, in the end, Tesla followers may find reality a bit depressing, but well worth reliving.

(Twenty First Century Books, P.O. Box 2001, Breckenridge, CO 80424-2001.)

Roger R. Block (F) is president of PolyPhaser Corp. in Minden, NV.



Book Review

Mobile Communications Design Fundamentals, 2nd Edition

Reviewed by William D. Cheek, Sr.

"The Next wave of wireless phones could generate $30 billion a year" — *New York Times*, Dec. 30, 1992.

The most recent addition to the acclaimed series on mobile and cellular communications written by William C.Y. Lee, Ph.D. (F), *Mobile Communications Design Fundamentals, 2nd Edition*, offers designers, researchers and students an up-to-date, invaluable guide to the theoretical framework of mobile radio communications and how such systems are designed.

The book covers:

- leading-edge personal communications service (PCS), microcell and code-division multiple-accesss (CDMA) systems.
- the differences between fixed and wiereless radio systems, including the new FCC-promoted PCS systems.
- design parameters for both base and mobile units.
- troubleshooting approaches that help to solve problems associated with each system.

Lee's book strongly emphasizes effective system design with a thorough treatment of the obstacles to effective communications, including: noise, path loss, building penetration, multipath, terrain, fading co-channel interference and intermod.

Lee goes in depth to discuss propagation variables of how hand-held cellular phones are operated, offering examples of relative gains and losses associated with operation in the vertical plane at head-height to the horizontal at chest-height.

Lee incorporates a profusion of illustrations, equations, graphs, charts and models to convey the principles of path and propagation engineering and analysis of mobile communications problems to just about any practical depth. Lee seems to leave few stones unturned in his search for excellence of mobile communications.

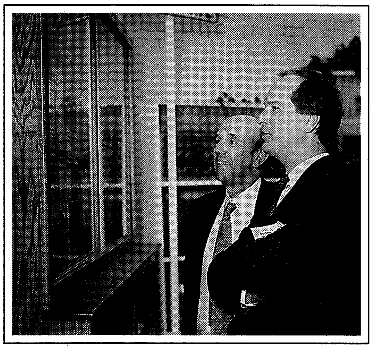
Mobile Communications Design Fundamentals, 2nd Edition, will prove to be a day-to-day handbook for the practicing engineer to a state-of-the-art, ready reference for the educator to a pertinent and modern textbook for the senior- and graduate-level student of mobile communications.

Mobile Communications Design Fundamentals, 2nd Edition, by William C.Y. Lee, Ph.D., vice president and chief scientist, Applied Research and Space, PacTel Corporation, 6.5 inches x 9.5 inches, illustrated, 372 pages, cloth-bound, $59.95. Published by John Wiley & Sons Inc., 605 Third Ave., New York, NY 10158-0012.

William D. Cheek, Sr. *is the author of* The Scanner Modification Handbooks, Vols. 1 & 2; *the publisher and editor of* The World Scanner Report; *and the system operator of* The Hertzian Intercept BBS, *619-578-9247, 6 p.m. to 1 p.m.*

He is the owner of COMMTronics *Engineering, San Diego.*

Museum Opening Marks Johnson Company Anniversary



E. F. Johnson chairman Bill Weksel (M) (left) and vice-chairman Bob Davies take a look at some of the events that shaped the radio communications industry in the E. F. Johnson company museum. The museum was renovated as part of Johnson's 70th anniversary year celebration.

With a snip of the scissors, E. F. Johnson Company chairman Bill Weksel (M) and vice-chairman Bob Davies marked the beginning of Johnson's 70th anniversary year by opening a newly remodeled company museum in Waseca, MN.

"The E. F. Johnson Company has played a significant role in the history of radio communications," Weksel said. "Johnson people have made contributions in commercial broadcasting, amateur radio, two-way land mobile radio and even cellular and air-to-ground telephones. It's a heritage we intend to preserve and build upon."

The company was founded by Edgar F. Johnson, an electrical engineer who opened a mail-order radio parts business in 1923. Johnson, who was a Fellow in the Radio Club, filled customer requests for hard-to-find parts by designing and making the parts himself. Johnson died in 1991.

By the late 1930s, E. F. Johnson was building mobile radio sets for local police departments. A successful line of amateur radios in the late 1940s quickly led to Johnson's commitment to the land mobile radio business.

During the 1980s, E. F. Johnson went through a series of corporate owners, including Western Union. Weksel and Davies bought Johnson from Arkla Inc. in August 1992.

The renovated, 700-square-foot museum is located in E. F. Johnson's Waseca Operations Center, the company's main engineering and manufacturing facility. More than 350 products from the company's 70-year history are on display in the museum, along with samples of Johnson's current radio communications products.

The museum also displays photos, articles and other historical items such as the U.S. Army-Navy "E" banner awarded to E. F. Johnson for manufacturing excellence during World War II.

Today, E. F. Johnson is a leading manufacturer and marketer of radio communications products, systems and services. Johnson products are sold worldwide, both directly and through an extensive network of dealers.

The company headquarters is in Minneapolis.

E. F. Johnson Company chairman Bill Weksel (M) (foreground, left) and vice-chairman Bob Davies are ready to celebrate the opening of the renovated company museum and the beginning of Johnson's 70th anniversary year. Looking on is the E. F. Johnson management team: (l-r) VP-International Fred Hamer Sr. (F); Sr. VP-Marketing Michael Kaye; VP-Finance Scott Bocklund; VP-Engineering and Technology Bob Beckmann; VP-North American Sales Jeff Fuller (M); VP-Operations Ernie Glass; and VP-Human Resources and General Counsel Amy Bromberg.

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TREASURER'S REPORT FOR FISCAL YEAR 1992

(October 1, 1991 — September 30, 1992)

REVENUES

Dues Collected & Applied	$14,175
Other Member Fees	1,285
Sections Operations - net	169
Banquet - net	2,157
Advertising Sales	10,105
Pins & Plaques Sales	2,349
Interest on General Funds	740
Publications Sales & Misc.	1,455
TOTAL Revenues	$32,435

EXPENSES

Publications	
Printing & Supplies	$8,359
Mailing Expenses	3,620
Meeting Expenses	3,527
Office Expenses	
Printing & Stationery	716
Postage	1,013
Telephone	96
Computer Expenses	609
Executive Secy Fees	2,320
Legal & Accounting	900
Pins & Plaques - net	36
Miscellaneous	148
TOTAL Expenses	$21,344
NET Revenues less Expenses	$11,091
Other Adjustments (net) (see note -->)	15,510
Net Increase in Fund Balanc	$26,601

BALANCE SHEET

ASSETS

Inventory & Receivables	$5,891
Section & Banquet Funds	19,603
Cash in Bank - Operating	34,928
Investments - Securities	33,903
GNMA Certificates	82,181
Fed Home Loan Mtge	7,594
Putnam Fund	35,393
Fed Natl Mtge Assn	29,775
TOTAL Assets	$249,268

LIABILITIES

Prepaid Dues	$11,247
Prepaid Banquet Tix-92 Banquet	0
Prepaid Advertising	0
Fund Balances:	
Scholarship Funds - Principal	130,870
For Distribution	13,925
General Funds - Op'g Balance	41,030
Reserve for Oprt'g Deficits	15,059
Life Member Fund	18,383
Legacy Fund	4,507
Other Assets & Liab-Net	14,247
TOTAL Liabilities	$249,268

N.B. Other adjustments include contributions to funds, scholarships and grants awarded, earnings on funds and changes in values of investments.

SCHOLARSHIP & GRANTS FUNDS

	Capital	Available for Distribution	Totals
Opening Balance Oct. 1, 1991	$125,199	$14,143	$139,342
Contributions	5,671		
Interest Earned		11,283	
Scholarships & Grants Awarded		(11,500)	
Ending Balance Sept. 30, 1992	$130,870	$13,925	$144,795

The Radio Club of America, Inc.

Founded 1909, New York, U.S.A.

WORLD'S OLDEST RADIO COMMUNICATION SOCIETY

APPLICATION FOR MEMBERSHIP

Date: ____________________

TO: THE EXECUTIVE COMMITTEE

I hereby apply for membership in THE RADIO CLUB OF AMERICA, INC. and agree, if elected, that I will be governed by the Club's Constitution and By-Laws as long as I continue to be a Member.

____
Signature

Full Name: ____________________
(FAMILY NAME) (GIVEN NAME) (INITIAL) (CURRENT AMATEUR CALL)

Home Address: ____________________
(STREET) (CITY) (STATE) (ZIP CODE)

Business Address: ____________________
(ORGANIZATION) (DIVISION)

____
(STREET) (CITY) (STATE) (ZIP CODE)

Telephones: Home (____)__________, Business (____)__________ Ext. ________

Birthplace ____________________ Date of Birth: ____________________

Education and memberships in other clubs and societies: ____________________

In what particular branch of the Communications Art are you most interested? ____________________

Present occupation: ____________________

In what year did you become interested in electronic communications? ____________________

Previous experience (indicate approximate dates): ____________________

Please list the names of two or more members to whom you are personally known and who will sponsor you. A letter of recommendation must be submitted by one of the sponsors, and entered on the reverse side, before submission to the membership chairman.

Sponsors

Mail this application to the Membership Chairman, Mrs. Vivian Carr, at 645 Hoey Avenue, Long Branch, NJ 07740, with $25.00 entrance fee, plus $40 for three year's dues, in U.S. funds. made payable to The Radio Club of America, Inc.

(OVER)

(12-1-88)

The Radio Club of America was founded in 1909 by a group of the industry's pioneers, and is the oldest active electronics organization in the world. Its roster of members is a world-wide Who's Who that include many who founded and built the radio industry.

The Club's objectives include promoting cooperation amongst individuals interested in electronic communications and in preserving its history. The Club administers its own Grants-in-Aid Fund to provide educational scholarships from tax free contributions of the Club's members and business organizations.

The Club publishes and distributes its PROCEEDINGS twice a year.

EXTRACTS FROM BY-LAWS

ARTICLE II — ENTRANCE FEE AND DUES

SEC. 1. The entrance fee for new members shall be Sixty-five dollars ($65.00) which includes the cost of the Club pin, membership certificate and dues for three years.

SEC. 2. The dues payable by Members, Senior Members, and Fellows shall be Fifteen dollars ($15.00) per year or, in the alternate, Forty dollars ($40.00) for a three-year period. Honorary members and Life members shall be exempt from the payment of dues or fees.

Recommendation of sponsor:

FOR OFFICIAL USE

Date Application received: ____________________

Admitted to Membership: ____________________

Date and Amount of Dues Received: ____________________

Membership Certificate and Card issued on: ____________________

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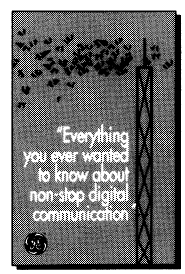

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