AMATEUR RADIO: AN EXAMINATION OF ITS HISTORY AND ITS CONTRIBUTIONS TO SOCIETY

by

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FOREWORD

Amateur radio is a unique phenomenon spawned out of man's desire to communicate and a developing technology of electronics. At present more than 257,000 Americans are licensed by the Federal Communications Commission to engage in two-way radio operation. These private citizens and their counterparts throughout the world operate under both national and international regulations.

Formal recognition of the role of amateur radio was given by the International Telecommunications Union in 1927. This organization, which controls radio frequency allocations among nations, defined amateur radio as a service in the following terms:

> A service of self-training, intercommunications, and technical investigations carried on by amateurs, that is, by duly authorized persons interested in radio technique solely with a personal aim and without pecuniary interest.[1]

The ability of private citizens to communicate with each other irrespective of national boundaries and regardless of ideologies poses an intriguing situation in international affairs.

The author has been an active amateur radio operator since junior high school days. The thrill of that first conversation across town with homemade equipment lingers even today.

At the flick of a switch it is possible to talk to a Chilean businessman who tells you, with great concern, about the lack of snow upon which his country depends for

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[1]International Telecommunications Union, Radio Regulations, (Geneva Switzerland, 1959) Chapter I, Article 1 No. 78.

water. The temperature in Kansas is 96° but it's winter there in the shadow of the Andes.

The next exchange may be with a Japanese high school boy who is interested in United States politics. How does the nominating convention work, he asks. His English is good, but in the pauses you can hear the rustle of his Japanese-English dictionary as he struggles to express himself.

The next call might be from an urban Lebanese, in the Import Export business, he tells you. He knows the United States well. How far from Kansas City are you, he queries. He is expansive when asked about Beirut. A beautiful city, he begins, but very warm tonight.

There is a Russian, loud and clear, but with a fluttering sound that identifies signals coming across the North Pole path. Remember to refer to his country as the USSR, not Russia, or he may politely correct you. What is his interest? A major international contest among radio amateurs. He has been practicing for months, placed second in the world last year, and hopes he can do better, he confides.

And so it goes. The accents may seem strange but good will in the voices of the operators comes through clearly. The world seems smaller and somehow more friendly than news headlines indicate.

The writer wishes to acknowledge a debt of gratitude to those pioneers who made it all possible.

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CHAPTER I

THE PURPOSE

The purpose of this thesis was two fold. The first of these purposes was to examine the history and trace the progress of amateur radio. How, in a world political environment that negates against communications by private citizens across geographic and ideological boundaries, had the hobby grown and flourished? The second purpose was to identify and evaluate what amateur radio has contributed to the affairs of man.

Literature devoted to amateur radio is technically oriented. Little consideration has been given to the sociological and economic side of the hobby. The role of the amateur in furthering the technical advancement of the science of radio communications is well documented. A void exists in reporting other facets of the hobby. This thesis seeks to fill that void.

This thesis is organized in chronological order, beginning with the early experimenters in the field. These pioneers were, for the most part, amateurs in the true sense of the word. The various steps in the growth of the hobby are treated in depth. Separate chapters are devoted to the economic and sociological aspects of amateur radio.

The literature review includes books and periodicals dating back to the advent of radio. Since radio is relatively new, much of this material is available for study. A research project, using an amateur radio station, was conducted by the author to determine the "country of manufacture" of radio equipment in use by foreign amateurs.

THE DISCOVERY OF RADIO

The first practical demonstration of communicattons by radio waves was conducted by Guglielmo Marconi in 1896. This young Italian, only twenty-two at the time, is generally considered to be the father of radio. He could be more aptly described as the first to see commercial possibilities in laboratory experiments.

Almost 100 years before Marconi's demonstration a Spanish physicist, Salva, proposed sending signals over the 120 mile ocean gap between Alicante, Spain, and the island of Majorca. No attempt was made, however, to implement such a transmission. Salva's theories were shown to be workable by Sommering, a Bavarian mathematician, in about 1810, but no practical application was made of the discovery. One reason was that, although Sommering could clearly demonstrate the flow of current through a body of water, he lacked suitable equipment for receiving signals. The telegraph had not yet been invented.[2]

An American, Samuel Morris, conceived and demonstrated the telegraph in a period from 1832 through 1835. He conducted several experiments in wireless communications but concluded that direct connections by wire were necessary for reliable operation.

The first real demonstration of signals passing through the air for any appreciable distance was accomplished by a Washington, D. C. dentist, Dr. Mahlon Loomis. In 1865 he conducted an experiment between two mountain tops in West Virginia. A kite connected to earth by a copper wire was sent aloft from each mountain. Each

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[2]William R. Wellman, "Men of Radio," CQ Magazine (January, 1952), p. 36.

kite was attached through the wires holding them, to a sensitive galvanometer, the other terminal of which was connected to a coil of wire buried in the ground. By alternately opening and closing a switch in one of the kite wires, the meter at the second kite, eighteen miles away, registered the interruption.

While acceptance of this feat was never unanimous, it is now generally construed as the first signal transmission through space utilizing "natural static" for operating power. Loomis labored until his death in 1886 to achieve popular recognition. Congress considered, but did not pass, an appropriation for fifty thousand dollars to finance further research. Today the only trace remaining of this pioneer in radio is the term "aerial" which Loomis coined to describe the wires that held his kites.[3]

THE BEGINNING OF SCIENTIFIC EXPLORATION

Credit for the discovery of the scientific fundamental principles of radio must be shared by several people. Principal among these is James Clerk Maxwell.

A physicist and writer, Maxwell was born in Edinburgh, Scotland, in 1831. He was a precocious youngster who preferred studying science and mathematics to play. His friends regarded him as an eccentric and nicknamed him "Dafty."[4] It was not until Maxwell began his college work that he gave evidence of his remarkable powers of deduction. Maxwell became a professor of experimental physics at Cambridge. His research extended into the fields of heat, principles of dynamics, and kinetic theory of gases.

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[3]Clinton B. DeSoto, "Two Hundred Meters and Down" (Concord: Rumford Press, 1936) p. 11.

[4]William R. Wellman, "Men of Radio, "CQ Magazine (March 1952), p. 20.

Early in his life he developed an inquiring turn of mind which led him to speculate about many natural phenomena that were often taken for granted by the scientists of his day. One subject of his speculation was the nature and propagation of light. How did light travel from one point to another? Through what kind of media did it travel? Maxwell postulated that light traveled with a wave-like motion and went on to develop mathematical formulas to prove his theories. He went further and stated that electricity and light were both electro-magnetic and that they were just different manifestations of the same thing. In support of this idea, he called attention to the fact that both traveled at the same speed of 186,000 miles per second.

Although not a shred of evidence had been found to prove the existence of electrical waves, Maxwell stated that such waves existed. He theorized that when discovered they would be found to have a wavelength greater than light waves and, like light, would be capable of reflection.[5]

HENRICH RUDOLPH HERTZ

Maxwell's theories remain classics of scientific thought. They remained unsubstantiated for years after his death in 1879. By this time scientists had begun to suspect the nature of electricity. The final proof of Maxwell's work awaited the arrival of a brilliant German, Henrich Rudolph Hertz. It was he who discovered the predicted "radio waves" and invented a means of generating them in the laboratory.

Born in Hamburg in 1857, Hertz graduated with university honors and became a full professor at twenty-seven. In a sketch of his life published in the Journal of the

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[5]Ibid. p. 20.

Smithsonian Institute shortly after the scientist's death in 1894, he was depicted as a shy, retiring man who shunned publicity. He was however, according to the author, a brilliant and charming conversationalist in French, English, German, and Arabic and a teacher of extraordinary ability.

With the use of charged coils, Hertz produced and transmitted the first true radio waves over short distances in his laboratory. He did not visualize his discovery as a new method of communication. He proved Maxwell's theories by measuring the waves and reflecting them with large metal mirrors.

EDOUARD BRANLY

The next step in the progress of radio was supplied by Edouard Branly, a professor of physics at the Catholic Institute in Paris. Branly had become interested in physiology, especially in the study of nerve structures. He was fascinated by the observation that a nerve consisted of a mass of closely packed fibers. Apparently, it was his idea to develop an electrical counterpart of such a structure that led him into a research project to investigate the properties of fine particles massed together. This subject had been given some attention by earlier scientists, and one of them had developed a lightning arrestor for telegraph lines which used finely powdered carbon. When a tube filled with carbon dust was connected between the elevated telegraph wire and ground, it offered high resistance to the flow of direct current in the telegraph line. However, an alternating current that resulted from a lightning stroke lowered the resistance. This conducted the lightning to ground without harming the telegraph equipment.

Branly found that carbon or metal particles would act in this manner while under the influence of an induction coil spark as well as when exposed to lightning discharges.

He learned further that the effect was the result of a clinging together, or cohesion, of the particles.

In 1891 Branly described his work to the French Academy of Science. Sir Oliver Lodge, an Englishman who was familiar with Henrich Hertz's work, saw an immediate application of Branly's "coherer," as Lodge chose to call the device. It may be that Branly did not realize that the induction spark coil was producing Hertzian (radio) waves, but Lodge certainly understood the principles involved. Lodge used the Hertzian generator and the Branly coherer to send and receive radio waves over a distance of one hundred yards.

Branly, who is nearly forgotten today, received the Nobel prize almost thirty years later for his work in developing the detector (receiver) of radio waves.

Edouard Branly lived until 1940 and saw his country invaded by the Nazi armies. As he witnessed the use of radio propaganda broadcasts to divide the sympathies and allegiances of the French people, he was disappointed and disillusioned. He expressed his regret publicly that his invention had helped make radio possible.[6]

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[6]Ibid. p. 66.

CHAPTER II

GUGLIELMO MARCONI

Now with the elements of radio established in university laboratory experiments, the time was right for a giant step forward. It was the destiny of a visionary young Italian, Guglielmo Marconi, to see the possibilities that lay ahead.

Marconi was born near Bologna, Italy, in 1874. His parents were well-to-do, and young Marconi was tutored at home until he entered Leghorn Technical Institute at fifteen. It was at Leghorn that Marconi learned the telegraph code as a diversion from his regular studies. While vacationing in the Alps in 1894, Marconi read of Hertz's death. The article recounted the experiments of sending waves across the room without wires. Marconi was intrigued. He recalled equipment he had used at the university which generated powerful Hertzian waves and the telegraph code he had learned as a boy.

Was this not a communications system? Marconi discussed the idea with his brother, and they immediately set to work to try out the idea. By the spring of the next year they were able to send and receive messages over a distance of almost one mile. First experiments had shown that the simple detector used by Hertz was not sensitive enough, and a modified version of Branly's coherer was substituted with good results.[7]

The Italian government was not interested in Marconi's offer to demonstrate his equipment. At the urging of his mother he took the system to England. Sir William

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[7]Walter K. Towers, Masters of Space (New York: Harper and Brothers, 1917), p. 204.

Preece, the director of Posts and Telegraphs, was impressed by the young man and asked for an official demonstration. These tests were an unqualified success. So successful were the tests that the Italian government asked him to return and make a series of tests with their navy.

The world's press reported the English and Italian test, and Marconi's fame spread rapidly. Scientists viewed this newcomer as an upstart who had invented nothing. As they pointed out, he had merely gathered up the work of others into one system. Marconi returned to England only eighteen months after his first trip. Sir William Preece had laid the groundwork of the Marconi Wireless Telegraph Company Limited. The firm was capitalized for half a million dollars. Marconi received one half of the stock plus $75,000 in cash. He was twenty-three years old.

An excellent insight into the situation is this editorial from a British Magazine, The Electrician, July 30, 1897.

> "We record today the registration with a capital of 100,000 pounds in handy one pound shares, of the Wireless Telegraph and Signal Company Ltd., which, perhaps, it is needless to say, proposes 'to acquire from Signor Guglielmo Marconi certain letters of patent.' From the ever-flowing stream of paragraphs and articles which the daily papers have been flooded since Signor Marconi's arrival in this country, we inferred that his discoveries would before long form the basis of a commercial undertaking.
>
> "There, is of course, absolutely nothing reprehensible in this, since science is in these days nothing if not a mode of making money. At the same time, when the latest product of Maxwell's fundamental equations, and Hertz's fundamental experiments becomes the raison d'etre of a joint stock company to which the British public may conceivably be asked to subscribe, Signor Marconi's labours must be examined in a commercial spirit; that is to say we must ask exactly what he has accomplished, exactly what is the industrial utility of the work done, and exactly what is it that may be validly covered by a patent.
>
> "Now the general principles underlying Signor Marconi's apparatus are well known, so that there can scarcely be anything in them of a master patent. And

much of the same may be said of all the component parts of his radiator -- which is of the Branly-Lodge pattern. Of course a novel combination of 'old instrumentalities' may be as commercially valuable as a master patent, if not more so, provided the combination protected is so far superior to all other possible ones, that, practically speaking, it holds the field. In our opinion Signor Marconi could only defend, with any reasonable chance of success, a pattern of this later kind. Hence intending investors in a company owning the Marconi patents would do well to make sure that expert opinion supports the contention that the particular devices proposed to be employed far transcend all others in range, reliability and ease of manipulation. If that be the case, which for ought we know, may well be so, there still remains the question of what commercial use is going to be made of wireless telegraphy. So long as it remains in its present stage of development its sphere of usefulness must obviously be an exceeding limited one. Of course it may develop into something very different, in which event, provided valid patents are taken out and shrewd business men are at the helm, the original shareholders may revel in gold without going to the far-distant Klondyke. But then these off-chances are more to the taste of speculators, with whom we have nothing to do, than of investors."

The editor of The Electrician summed up the situation accurately. The British public, however, ignored the note of caution and the issue was sold in short order. Shortly after the formation of his company was completed tests on the Salisbury plain were successful over a distance of thirty-four miles. Over the next four years a series of spectacular demonstrations took place. The equipment was made more portable and the British navy outfitted several ships with his equipment.

The academic community which had shunned Marconi as an opportunist began to rally to his cause. One reason for this change of attitude was Marconi's public insistence that he had built on a foundation of principles laid down by others.

Distances continued to increase, first to seventy, and then to ninety miles. The world was excited by the ever increasing range and reliability of Marconi's wireless system. The United States sent delegations to view operations as did most of the major powers.

In late 1899 Marconi felt ready for the major test of spanning the Atlantic. A powerful station was built at Poldhu, Cornwall, on the southwest tip of England. By December of 1901, Marconi was at St. John's, Newfoundland, with the most advanced receiving station of its time. After several delays a huge kite bearing the antenna was in place, and on December 12 the station in Cornwall was heard. When Marconi released the news, a tremendous wave of excitement swept the world.[8] Everybody was talking about wireless. Few feats have kindled the imagination of so many people at one time. The world was on the brink of a revolution in communications.

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[8]E. D. Mairiner, "Wireless Before 1900" CQ Magazine, (January 1967) p. 96.

CHAPTER III

"DO IT YOURSELF" WIRELESS

The imagination of Americans was given a real prod by Marconi's transatlantic tests. A group of eager amateur experimenters had been working with electricity for years. Backyard telegraphs with their wires running down the alley to link these enthusiasts together were a common part of the scene in the late 1800's. Based on a tradition that embodied the American education for education's sake, large numbers of citizens experimented endlessly to gain knowledge. No thought of reward, other than that of knowing how and why, entered their heads. The same spirit that prompted the lyceum, chautauqua, and other forms of self education ran strongly through the main stream of American culture.

Thousands began work on their own wireless stations. Publishers read their audience correctly, and in a period from 1900 to 1904 over 115 articles on wireless appeared in publications of the day. Magazines such as Independent, Current Literature, North American Review of Reviews, Century, McClures, Cosmopolitan, Overland, Womans Home Companion, Delineator, Atlantic Monthly, and Harpers Weekly carried the word to waiting readers. Many of the stories contained construction data since the equipment was relatively simple, and it was not beyond the ability of the reader to build.[9]

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[9]Clinton B. DeSoto, Two Hundred Meters and Down (Concord: Rumford Press, 1936) p. 16.

By June of 1904 the problem of interference between radio stations, both commercial and amateur, was so great that President Theodore Roosevelt appointed a board to study the problem.

The first international agreements on radio were signed at Berlin in 1906 by twenty-seven nations, including the United States. This protocol document did not mention amateurs. They were not even considered, since under old-world monarchial methods there was no place for such a thing as "amateur" radio.

United States amateurs paid little attention to early attempts to control them. Equipment improved, and one discovery touched off another in a chain reaction. Almost every major development was made by an amateur. As late as 1912, amateurs were definitely better equipped than most commercial stations, including the Army and Navy.

A feud developed between the commercial and amateur operators. A conflict of this sort probably could not have arisen in most countries but in the United States, if a commercial operator wanted to do any work, it was usually necessary to make a polite request of the local amateurs to stand by for a while. If the request was not polite or hard feelings had developed, the amateurs might not stand by, and the lesser equipped commercial station did not work. Many times a commercial operator would tell an amateur to shut up and often the reply was "Who the hell are you" or "I have as much right here as you, shove off."

Actually the amateur had as much right as the commercial to the frequency. There is no authoritative record of amateurs interfering with important distress

communications. On the contrary, many weak emergency signals were picked up and relayed by this ever growing group of operators.[10] The problem of interference was principally one of the "state of the art." Each spark transmitter took up immense space in the radio frequency spectrum.

Amateurs did not sense the momentous event that was to change their role in the scheme of things. One of those odd turns of fate was about to transpire. It was roughly equivalent to giving the Indians the worthless lands in Oklahoma only to discover years later that they rested on a sea of valuable oil.

After several false starts, Congress passed a bill aimed at bringing some order to the problem of radio interference. The legislators, or more likely their commercial radio advisers, had an inspiration. Rather than stir up a hornet's nest of opposition from amateur radio operators by prohibiting them entirely they could be given the utterly worthless part of the spectrum below two hundred meters. The law passed in August 1912. The radio amateurs had the worthless territory but, unknown to anyone at that time, they had the best portion by any criteria. It seems ironic, but from the advent of radio transmission, it was assumed that the longer the wavelength the more effective it was for communications. The true case was, of course, quite the opposite.

One other major provision of the law was the mandatory licensing of each radio amateur and a limit on the power of the station. The Secretary of Labor and Commerce was given the responsibility of issuing the licenses. By the end of 1913, over

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[10] Ibid.

two thousand of these licenses had been issued. The number of amateurs, however, was estimated at over five thousand. The heritage of individualism was a strong factor in the wholesale disregard for the new law. The two hundred meters meant anything from two hundred fifty to three hundred seventy-five meters. The power limit of one kilowatt could be stretched to two or three kilowatts without too much danger of detection. A certain amount of courtesy towards government and commercial stations was necessary in order to avoid trouble.

Similar to the Federal Communications Commissions problems of today, too little money was available to implement much enforcement of the law. In addition the Secretary had to issue a license to every applicant. By mid-1914, over five thousand licenses had been issued and estimates placed the number of radio amateurs at ten thousand. As radio progressed, it became a more stable science. The amateur was becoming more interested in communications, and perhaps less interested in experimenting.[11] A new phase of amateur radio was developing.

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[11]The American Radio Relay League, Fifty Years of ARRL (Newington, Connecticut. ARRL, 1965) p. 9.

CHAPTER IV

THE WIRELESS CLUB ERA

By 1909 amateurs began to organize. The first club was the Junior Wireless Club of New York. The idea caught on and groups organized in almost every major city. One club, sponsored by the magazine Modern Electronics, claimed four thousand members by 1911.

The Radio Act of 1912 may have been partially responsible. Badly defeated, the amateurs felt a need to band together in order to present a united front against further legislation. Americans had always been great "joiners," and, with increasing numbers of young men turning to radio for education and entertainment, it was a natural development.

In 1914 Hiram Percy Maxim, a brilliant engineer who had already achieved fame through his work in developing the automobile, conceived the idea of a national radio organization. The basic principle tying the group together was to be the formation of relay nets by the amateur operators. Stations had a limited range, but by passing a message from one to another, they could progress across the country.[12]

By March 1915, six hundred stations were participating. Funds were a great problem for the new American Radio Relay League as the club was called. Maxim and the other club officers decided that a magazine devoted to amateur radio would serve the purpose of uniting the members and raising funds for its operations. The

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[12] Ibid, p. 11.

magazine QST was begun.[13] It was to serve as the voice of the amateur not only in the United States but throughout the world.

The scorned two hundred meter band was proving its worth. Kilowatt stations were reporting ranges of one thousand miles or more. Amateur stations once again outperformed the best military and commercial stations, despite restrictions on power and frequency.

WORLD WAR I

In April 1917, as the United States entered the war, all licensed amateurs received the following letter from the chief Radio Inspector of the Department of Commerce:

"To all Radio Experimenters,
"Sirs:

"By Virtue of the authority given the President of the United States by an Act of Congress, approved August 13, 1912, entitled, 'An Act to Regulate Radio Communications,' and of all other authority vested in him, and in pursuance of an order issued by the President of the United States, I hereby direct the immediate closing of all stations for radio communications, both transmitting and receiving, owned or operated by you. In order fully to carry this order into effect, I direct that the antennae and all aerial wires be immediately lowered to the ground, and that all radio apparatus both for transmitting and receiving be disconnected from both the antennae and ground circuits and that it otherwise be rendered inoperative both for transmitting and receiving any radio messages or signals, and that it so remain until this order is revoked. Immediate compliance with this order is insisted upon and will be strictly enforced. Please report on the enclosed blank your compliance with this order; a failure to return such blanks promptly will lead to a rigid investigation."

"Lieutenant, U.S. Navy,
District Communication Superientendent."

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[13] Ibid. p. 43.

Figure 1. Cover of the first QST Magazine, 1915.

DECEMBER, 1915 **Q S T** NUMBER 1

CONTENTS.

Issued by Hiram Percy Maxim and Clarence D. Tuska
Hartford, Conn

Figure 2. Contents page of the first QST. This publication is still the principal voice of radio amateurs.

Amateurs enlisted by the thousands as the Signal Corp, Navy, and Air Service called for volunteers to man their radio equipment.

There can be no question of the importance of the part the radio amateurs played in the winning of the war. The superiority of Allied, and particularly American, communications was the deciding factor in many moments of close struggle during the fighting on all fronts. The reason for this superiority is well-described by Lieutenant Clarence D. Tuska, then secretary of the ARRL, who discontinued publication of QST with the September 1917, issue, and volunteered. His standing as an amateur caused the military authorities to place him in charge of the organization of radio training in the Air Service with an officer's commission, without an hour's preliminary instruction. Concerning his experiences in training war-time radio operators at Camp McClellan, he has said:

> "The amateurs have come across in the case of the Army... I have turned out a whole lot of operators for the Air Service and have become pretty well acquainted with the type of human it takes to make a first-class radio operator... The very first sort of a student we looked for is an ex-amateur. He seems to have had all the experience and all we have to do is acquaint him with a few special facts and he is ready for his Army job. If we can't get an amateur or a commercial radio operator, then we try to convert a Morse (wire) operator, but it's a pretty hard job. After the Morse man, we take electrical engineers, and from them on, but a man without previous experience is almost hopeless as far as my experience has shown. Of course we can make an operator of him in fifteen or sixteen weeks; whereas, the other way an amateur is fitted in as few as one hundred hours. They've surely done their bit and I am mighty proud I was one."

Concerning the performance of American radio operators in the Allied cause, Commendattore Marconi, who was in charge of signaling for the Italian Army, said:

"America is fortunate in having perfected its organization in the amateur field... American wireless men are exceptionally well qualified to take an active part in important signaling work. Much valuable material will be found in the amateur ranks, as those young men are accustomed to transmission on short wavelengths in the neighborhood of 200 meters -- the exact type of communication to which they are most accustomed."

At the conclusion of the war, the Secretary of Commerce said:

"The officers in charge of the wireless operations of our armies in France commend highly the skill, ingenuity and versatility of the licensed amateur radio operators who volunteered in large numbers for military service and served in dangerous and responsible positions."

Radio amateurs had shown, for the first time, that they constituted a vital reserve of trained manpower.[14]

WORLD NOW SAFE FOR DEMOCRACY

Signing the Armistice did not restore amateur radio to its past glory. A bill was introduced in Congress to give the Secretary of the Navy control of all radio communications. Due largely to the efforts of the American Radio Relay League and its members, the bill was defeated. Finally late in 1919, amateurs were allowed back on the air.

The prestige given radio by war experience attracted many newcomers to the art. The first year's growth of licensed stations was a ninety percent increase over pre-World War I days.

Tubes were replacing spark gaps in transmitters and crystal detectors in receivers.[15]

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[14]Clinton B. DeSoto, Two Hundred Meters and Down (Concord, N. H.: Ramford Press, 1936) p. 54.

[15]J. L. Ray, The Radio Industry (Chicago: A. W. Shaw Co., 1928) p. 245.

The war had shown the value of the tube transmitter which generated a continuous wave (cw) signal. Small military stations using a five watt vacuum tube had covered distances that were equal to the range of five hundred watt spark transmitter. In addition continuous wave took up a very narrow slice of frequency, less than one percent of that necessary for a spark transmitter. In practice this meant many stations could operate, without interference, in the space formerly occupied by the spark.

The use of vacuum tubes in the receiver greatly increased its ability to detect and amplify weak signals.

LEE DEFOREST

Radio's magic lamp, the vacuum tube, was in development as early as 1880. Thomas Edison recorded the phenomenon of electron behavior in early experiments that ultimately produced the electric light. Sir John Fleming produced a simple two element tube which was used in many of the early day Marconi commercial stations. It was, however, Lee DeForest who added a third element, the grid, to the vacuum tube and thereby paved the way for the most important application of the tube: amplification and oscillation. DeForest's achievement has been called the most important in the entire history of radio.

DeForest was born on August 26, 1873 at Council Bluffs, Iowa, and spent most of his boyhood at Talladega, Alabama. His father, a Congregational minister, was president of Talladega College for Negroes and it was expected that Lee would follow in his father's footsteps and become a minister also. It soon was evident that his interests were in things mechanical and for some time he was a participant in a struggle between his own desire to become an inventor and his father's wishes.

Finally, at the age of sixteen, he composed a rather formal letter to his father setting forth his ambition to attend Sheffield Scientific School at Yale. His father finally gave in but not before giving him a lecture on the cultural values of a classical education.

He entered Yale in 1893, and his record there, for the most part, indicates that he exercised good judgment in selecting a scientific course, but his progress was far from easy, due to the limited family finances. By working after school and during summer vacations, he was able to keep going and soon embarked upon a series of inventions that, in his mind, were designed to make him financially independent. Unfortunately, not one was a success. His financial troubles were increased by the sudden death of his father during his senior year. Mrs. DeForest, with three other children, moved to New Haven, and it was largely due to her efforts and management that he was able to continue with his college work and go on to post graduate courses. He received his doctorate in 1898.

It is certain that Dr. DeForest's interest in radio began during his years at Yale. He was fascinated by the lectures on Hertzian waves given by Professor Bumstead, and for this thesis selected a research project in the reflection of Hertzian waves from the ends of parallel wires. Early in his career he was determined to make contributions to the art that would at least rank with those of Marconi.

The three element tube or Audion, as DeForest called it, began in 1900 shortly after the inventor had graduated from Yale.

His account of this experiment states that on September 1900, he and an associate were trying to discover what effect, if any, the operation of a spark coil transmitter had on the light produced by a Welsbach burner. Apparently there was some

effect, because the light of the burner increased when the coil was energized. DeForest and Smythe, the associate, followed this line of research enthusiastically for a while in the hope that the effect was due to radio waves; DeForest had an idea that it might be developed into some kind of flame-type detector. One thing they failed to take into account was the effect on the burner produced by the sound waves set up by the spark. This, DeForest said later was a very fortunate omission, for otherwise he might never have resumed the research which eventually led to the invention of the audion.

Although it is not generally recognized, it is a fact that the audion was the result of attempts by DeForest to develop a detector based upon the action of ionized gases in an open flame. He returned to the subject in 1903, convinced that the use of hot gases offered good possibilities for detection.

When he took stock of the possible methods, he saw that there were three avenues of approach: (a) an open flame; (b) a carbon arc; and (c) gases heated by an incandescent filament within an enclosed area.

A gas flame detector corresponding roughly to the sketch of Figure 3 was arranged and afforded good results. As will be noted from the diagram, the device consisted of two electrodes introduced into the flame of a Bunsen burner; a local battery, B, was the source of current. With this device, DeForest was able to copy signals from ships in the harbor. More important was his enthusiasm which led to further experimentations.

A carbon arc was tried, but the idea was dropped almost immediately on account of the noise generated. He and his assistant, Babcock, then turned to the third

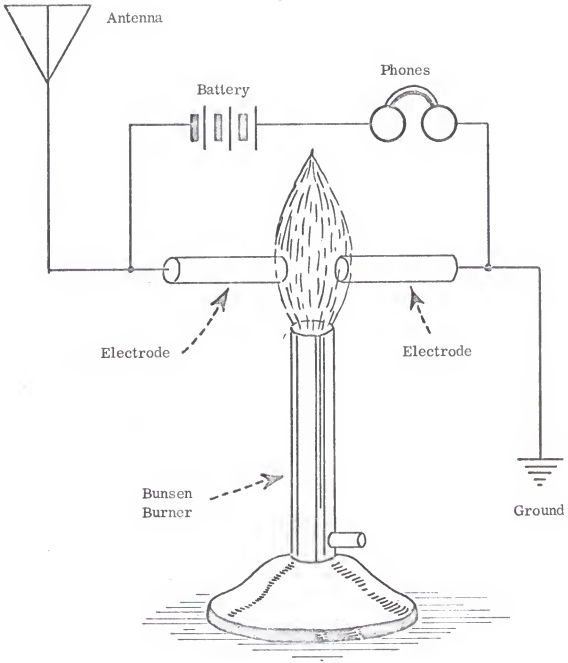

Figure 3. DeForest flame detector.

possibility--a detector based upon the employment of gases heated by means of an incandescent filament. Numerous attempts to make their own special lamps resulted in failure and this part of the work was then turned over to McCandless, a manufacturer of miniature lamps. Dr. DeForest states that at this point in his investigations he was totally unaware of the existence of the Fleming valve; at any rate, it is obvious that the use of a plate battery distinguished his invention from Fleming's.

The McCandless firm turned out for DeForest a special lamp with a platinum electrode sealed within the lamp bulb and this became the first vacuum tube detector to use two local current sources--one for the filament, the second for the plate. This was developed in 1905.

THE TRIODE

Next step in the development of the audion was the addition of the third electrode; at first it was not perforated as a modern grid would be, but was a solid electrode, similar to the plate and placed on the opposite side of the filament. At this time, the first use of a third, or C battery was recorded. Needless to say, this tube was a decided improvement over its predecessors.

The third electrode just described was not only a solid element, but was evidently located about as far from the filament as was the plate. DeForest then arrived at the conclusion that more efficient operation would be attained by locating the control electrode between the filament and the plate. It was obvious from the first that the electron flow would be impeded by imposing a solid piece of metal between filament and plate. A piece of sheet platinum was then made up and drilled

with numerous holes to permit passage of electrons. This was sent to McCandless and sealed inside a lamp. The discovery meant that this device with its control grid was not only a superior detector but that, most important of all, it would amplify feeble currents. This led to vast changes in the radio industry. The patent on the audion amplifier, No. 841,387, was granted on January 15, 1907--the most valuable patent in the entire radio field and one of the most valuable ever issued by the United States Patent Office.[16]

[16]William R. Wellman, "Men of Radio" CQ Magazine (January 1953) p. 35.

COMMERCIAL EQUIPMENT

The "do it yourself" phase of the art was passing. The Radio Corporation of America ran advertisements featuring not only components but complete stations. The day of illegal operations drew to a close as amateurs made successful efforts at self-policing, urged on by the ARRL.

ON A GOOD NIGHT YOU CAN HEAR PITTSBURGH

On November 2, 1920, a Pittsburgh amateur, Frank Conrad began broadcasting music over his new wireless telephone set. His call letters were 8XK. Many people who had not been interested in amateur radio bought receivers to hear this station. Several thousand were sold in the Pittsburgh area alone. Commercial interest, sensing a moneymaking opportunity, erected stations in New York, Chicago, and Springfield, Massachusetts. Broadcasting had been born.

By 1922 there were sixty licensed broadcast stations and half a million listeners. Five hundred applications for new stations were pending. The operation of amateur stations interfered with many of these stations. The listening public demanded that something be done. The 1912 law was no longer adequate to cope with these new conditions.

LAWS AMENDED

Secretary of Commerce Herbert Hoover called a conference of prominent radio experts to Washington, in 1922, to discuss the problem.

The final report of the conference recommended that legislation be enacted to give the Secretary of Commerce adequate legal authority for the effective control of the establishment of all radio transmitting stations except amateurs, experimental,

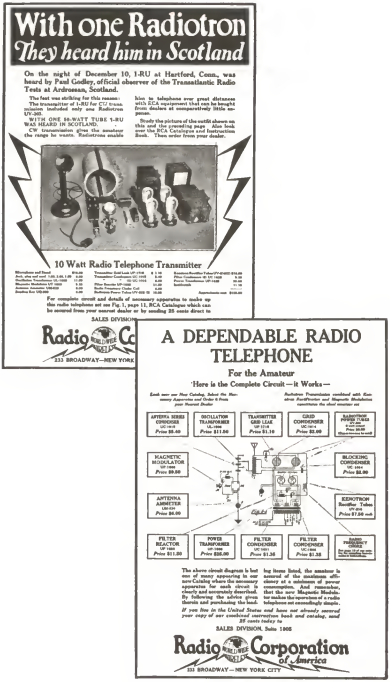

Figure 4. QST advertising in 1921 featured ready to operate equipment for the first time.

and government stations. For amateur stations, the conference recommended the assignment of territory between 150 and 275 meters, of which the region between 200 and 275 meters was to be shared with technical and training school stations. The balance was to be assigned exclusively to amateur telegraphy and telephony. A restricted amateur wavelength of 310 meters was set aside for use by a limited number of inland stations, to be assigned only where it was necessary to bridge large sparsely-populated areas or to overcome natural barriers. The report also defined amateurs for the first time:

"An amateur is one who operates a radio station, transmitting or receiving, or both, without pay or commercial gain, merely for personal interest or in connection with an organization of like interest."

The 14,179 licensed amateur stations were safe. Actually privileges had been increased rather than curtailed.

CHAPTER V

THE BIG CHANGE

As equipment improved, the amateur operators looked for new feats to accomplish. An active group of enthusiasts in Britian made an attempt to span the Atlantic the next logical step. In February 1921, tests were arranged through the ARRL and QST Magazine for some two dozen United States operators to transmit test signals while about two hundred fifty British experimenters listened. Manufacturers in both countries offered prizes for the best performance. Not a single signal was heard.

Disappointed, the Americans arranged to try again in the fall. Taking no chances, they decided to send the best operator and receiving equipment available overseas to back up the British efforts. Paul Godley was their unanimous choice. A test of his equipment near London quickly showed Godley that interference and noise were too strong for the scheduled tests. A site in Scotland was chosen as a better receiving location and the equipment was installed and tested satisfactorily.

On December 7, 1921, in a wet, wildly flapping tent at the very edge of the sea, American Paul Godley waited for the test to begin. The bleak Androssan moor was the perfect spot for noise free reception.

Thirty American signals were copied that night by Godley. Many of the British listeners were successful in hearing several of the United States test stations. The hobby would never be quite the same again.

For ten bitter-cold rainy days, Paul Godley made his home in that drafty tent, headphones glued to his head, and fingers taut on the dials of his superheterodyne receiver, usually with just one witness at his side.

The twenty-seven selected stations transmitted during the reserved periods and every American amateur who could get a set on the air shot signals at him during the open time. On December 16 he closed down, and the next day he packed and was on his way to London.

That amateur signals, transmitted with the meager maximum power of one kilowatt on the despised wavelength of two hundred meters could cross the Atlantic had been successfully demonstrated for all time. The ARRL's transatlantic message bill of $1,900, incurred in reporting the results of the test, proved that! Of even greater importance, however, was the fact that more than two-thirds of the stations that had got across were using cw, and that the average of their power was appreciably lower than that of the spark transmitters. Here was an argument that could not be laughed off. The definite, incontrovertible superiority of cw over spark had been demonstrated. The rank and file began to concede the victory to the slide rule minority. It was a year before spark was generally relegated to the scrap-heap, three before it sank into oblivion. But with the lesson of December 1921, blazoned before the eyes of amateur radio, the future of tube transmission was assured.

Tests across the Pacific were successful and conversations between Hawaii and West Coast amateurs became a common occurrence. No longer was the American operator tied to the next town or state but he became a world traveler. By 1923 Australia and New Zealand was a bedlam of Yankee signals. More than ten thousand miles were spanned by a single five watt vacuum tube transmitter.

As amateurs gained experience the value of the shorter wavelengths became apparent and the rush was on to move to these formerly ignored frequencies.

The international aspect of amateur radio, having demonstrably become permanent, the ARRL in middle 1924 officially adopted Esperanto as its international auxiliary language. This official endorsement was about as much recognition as Esperanto ever received. Amateur use of it was negligible. Instead, there sprang up an amateur-made international language understood by amateurs everywhere, commonly termed "QST-English." This form of communication is based on the English language, or more correctly, the abbreviation of words in the English language, together with an admixture of the international code of "Q" signals and a few relics from the old Morse wireless expressions. The abbreviation of words to save transmission time had, of course, long been a habit of American amateurs. The process usually consisted of the elimination of vowels, double letters, and similar "superfluous" characters and syllables. Thus "very" became "vy," "see you later" and "see you again" became "cul" and "cuagn." "I have here message number twelve from Sleepy Eye, Minnesota" was transmitted "Hr msg nr 12 Sleepy Eye Minn." "Distance" was "dx," "operator" was "op," "worked" "wkd," "good morning" "gm," and so on. Sometimes, when the word itself was not shortened, code letters that required less time to transmit were substituted, as "sine," with its seven dots and one dash, for "sign," with seven dots and three dashes. From the wirelines came such expressions as "73," meaning "best regards," and "88," meaning "love and kisses." "C" was "yes," "n" was "no." A long list of "Q" signals permitted the statement in three letters of almost any expression employed in normal radio intercourse, as "QSO:" "I can communicate with ----," and "QSL:" "I give you acknowledgment of receipt." (These definitions are the ones currently in use).

So there grew the amateur's international language. Just as those in other countries adopted the American's form of call signal when they themselves had no licensed call (perhaps the majority of amateurs outside the United States had no licenses in those early days), so they adopted his idiomatic language. Foreign amateurs who knew English to any extent at all read QST religiously; when they passed the information therein along to the compatriots, they used the American idiom. The early contacts over the air all employed this odd but effective form of radio shorthand.[17]

During the summer of 1924 the governments of the United States, Canada, France, and Italy requested the cooperation of amateurs in the development of the short waves they had discovered. All of these tests were experimental in character, and they denoted the intense world-wide interest in the new developments.

INTERNATIONAL AMATEUR RADIO UNION

Just as American amateurs felt a need to band together for organized action in the early 1900's, a feeling spread among the world's amateurs that an international organization was needed. Part of this urge was prompted by a natural fraternal feeling for fellow operators and part by a growing resistance to amateur activities on the part of many governments.

Founded in 1924 the IARU had as a stated goal the fostering and coordination of international two way-communications. From the twenty-four nations originally represented in the first formal meetings at Paris in 1925 the IARU had grown to sixty-three participating in 1968. After a few struggling years the group became an

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[17]Clinton B. DeSoto, Two Hundred Meters and Down (Concord: Rumford Press, 1936) p. 93.

international federation of national societies. The American Radio Relay League was chosen as the permanent headquarters for the Union and still occupies that position.

The IARU has achieved a high degree of international recognition. The Union has been active in all of the international conferences concerned with frequency allocations. QST, the ARRL magazine, devotes space each month to the activities of the individual societies that make up the organization.

NEW REGULATION AFFECTS THE AMATEUR

In the fall of 1927 Congress replaced the Wireless Act of 1912 with new legislations. Control of all radio stations was removed from the Department of Commerce and given to a new regulatory body, The Federal Radio Commission. The FRC continued the policies already established and except for minor modifications little change was made. For the first time in any United States statute, however, the word amateur was used in describing the licensed radio experimentor.

INTERNATIONAL REGULATIONS

The first meeting concerned with the international aspects of radio communications took place in Berlin in 1903. Rivally between commercial firms, that would not allow stations using one company's equipment to work stations using a competing firms apparatus, resulted in much confusion. In an attempt to bring order a preliminary protocol was signed at Berlin on August 13, 1903, by Germany, Austria, Spain, the United States, France, Great Britain, Hungary, Italy, and Russia. This protocol was limited to traffic between shipboard and costal stations, and was of only impersonal interest to amateurs.

On November 3, 1906, twenty-seven nations signed the "International Wireless Telegraph Convention" in Berlin. This was actually nothing more than the final draft of the 1903 protocol. Amateurs were not mentioned, nor were they even considered, for under the old-world monarchial methods then employed, there was no place for such a thing as amateur radio. Perhaps the greatest historical significance of this convention insofar as amateurs were concerned is the fact that it first officially adopted the term "radio." General use was not to be made of this word, however, for many years to come.[18]

Congress did not ratify the 1906 Berlin agreement until 1912. This was just in time for the United States delegates to attend the London conference of 1912. It was the intention of the treaty nations to meet every five years. World War I resulted in postponement of the next International Radiotelegraph conference until 1927.

Held in Washington, this conference could have put an end to amateur radio forever. The technical changes that had taken place since 1912 were tremendous. What had been considered the relatively simple problem of frequency allocations had assumed nightmare proportions as the number of stations grew. Most important for radio amateurs, the attitude of many nations had turned against them. Most European countries had, by 1927, established radio as a government monopoly similar to the telegraph and mail systems. Any messages transmitted by amateur radio could mean a loss of revenue. In addition, amateurs had demonstrated and widely publicized their ability to talk with each other almost anywhere in the world. To some this constituted a threat to national security. In many European countries the amateurs consisted of

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[18] Ibid p. 16.

mature intellectuals and scientists whose viewpoints in some cases did not correspond to that of their militaristic governments. Many countries considered that amateurs could easily become involved in political intrigue. This point had not arisen in the United States because most United States amateurs were youthful enthusiasts with little interest in politics, and the democratic form of government was largely unconcerned with overthrow attempts. One point in the amateurs' favor was their performance in war time. A trained reservoir of radio operators and technicians was invaluable to any country in the event of war.

Prior to the conference Germany and Switzerland had made proposals that would have put an end to the hobby. Germany proposal read as follows:

> "The conditions for permitting private radio-transmitting installations should be fixed by an international convention. It frequently happens that the right of the state concerning the transmission of messages is violated by these stations. Since it is to be feared that this state of affairs might assume too large proportions, only stations open to public service, upon which it is incumbent to observe international conventions, should be authorized to transmit. At the most, in establishing definite restrictions concerning the power radiated and wavelength, only those transmitting stations for scientific or technical purposes operated by entirely competent persons should be permitted to operate."
>
> "In addition, it might be of interest to examine the means by which the operator of unauthorized stations might be prevented."

Switzerland proposed the following text:

> "The establishment by individuals... of radiotelegraph communications between several countries exclusively intended for the exchange of private correspondence of interest only to... an individual is forbidden."[19]

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[19]International Bureau of the Telegraph Union, Propositions pour la Conference Radiotelegraphique de Washington: Berne Switzerland, 1926. p. 27.

In 1925 Switzerland had adopted regulations concerning amateur and experimental transmission so severe and expensive that two years later none of the numerous Swiss amateurs could yet afford a license.

Other countries including Great Britian, Italy, and Hungary, had equally stringent regulations in mind.

The American Radio Relay League lead the attack for the world's amateurs. The reason for leadership was threefold. The United States contained the largest, most active, and most technically advanced group of hobbyists. The leadership of the International Amateur Radio Union was in their hands and the United States government was favorable towards maintaining the amateurs status.

THE STRUGGLE

The 351 delegates attending the conference represented 74 nations. United States Secretary of Commerce Herbert Hoover had previously been chosen as president of the conference and opened the meeting on October 5, 1927.

The group divided into subcommittees in order to form workable sized groups. Many problems were settled but that of the amateur remained as one of the most difficult. Due primarily to the insistence of the Americans, nation after nation agreed to compromises that allowed for amateur operation. After eight weeks of argument and deliberation, a final proposal was accepted by all delegates. The frequencies formerly used by United States amateurs were reduced about one third. The amateurs in many countries got substantial increases in space allowed them.

THE MADRID CONFERENCE

In 1932, the ITU met again, this time in Madrid. This meeting drew more than six hundred delegates from seventy-seven nations. Once again discussion was aimed at getting rid of amateur radio. Support for the amateur cause was better organized, and few changes were made. Amateurs outside of the United States and Canada were formally prohibited from handling third party messages. This regulation was already in force in many countries, so little change actually took place.

THE CAIRO CONFERENCE

Cairo was the site of the next ITU conference. Convening in 1938, the meeting was unable to agree on many suggested changes, and the status quo remained, with some slight reduction in amateur frequencies.

GROWTH PATTERNS

Following World War I, the number of individuals who were licensed amateurs grew steadily. By 1928, there were 15,111 active licenses. The growth of the hobby soared as the depression gripped the country. By 1934, there were 46,360 licenses outstanding. As the depression ended, the growth curve returned to a more leisurely use. A growth of three hundred percent had occurred in five years. The expansion seems to have stemmed from several factors. Leisure time increased as available work was reduced. Cut throat competition among manufactures of radio parts lowered costs. In 1934, an amateur station could be assembled for fifty dollars. In 1929, the cost of a greatly inferior station was one hundred and fifty dollars. Many individuals turned first to shortwave listening as a hobby and, after listening in on amateur conversations,

decided to take up the hobby itself. World wide conversations were commonplace, and excited newcomers eagerly joined in this relatively inexpensive manner of traveling.

EMERGENCY OPERATIONS

The opportunity for public service was ever present as time and again amateurs furnished vital communication in flood, snow storms, and hurricanes. Each event brought publicity which attracted more people to the hobby. Emergency preparedness became almost a national obsession. The ARRL formed the Emergency Corporation. Issues of QST magazine during the 1930's was filled with detailed descriptions of emergency work accomplished.

World War II was approaching, and foreign stations went off the air as countries were caught up in the holocaust.

CHAPTER VI

WORLD WAR II

As the war broke in Europe, amateurs in nearly half the countries of the world suspended operations. By early 1941, more than fifty percent of the 3,380 Canadian amateurs were in uniform. United States operators were urged to observe strict neutrality and avoid government crackdowns. In August 1940, the Federal Communications Commission required all licensees, commercial and amateur, to file a photo, fingerprints, and proof of citizenship. Some one hundred amateurs quietly turned in their license rather than comply.[20]

A call went out in the September 1941 QST magazine for five hundred operators to man the expanding FCC monitoring facilities. The quota was quickly met. The armed services also stepped up their recruiting in the amateur ranks. With the bombing of Pearl Harbor, all activity was suspended. As a shortage of radio gear grew, due to the expanding wartime demand, the amateurs were asked to sell their equipment to the military. More than once, an amateur in the service found himself using his old receiver or transmitter for military communications. By the time the war was over twenty-five thousand amateurs had been in service, and an equal number had been in some phase of essential war industry.[21]

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[20] C. D. Tuska, Fifty Years of Amateur Radio (Newington, Connecticut: ARRL, 1965) p. 60.

[21] American Radio League "QST" West Hartford, Connecticut, September 1946, Vol. 31 No. 8 p. 40.

Many operators contributed time and equipment to Civilian Defense, which operated the War Emergency Radio Service. Fortunately the anticipated air raids did not develop, but the WERS performed important service in the 1944 Atlantic coast hurricane as well as in flood and blizzard emergencies.

The backbone of Army, Navy, and Air Force communications had again been the radio amateur.

THE AFTERMATH

Unlike the period following the first world wars, the group was well organized, and plans had been made to get operating privileges back immediately. Four days after V. J. day, a portion of the ban by the FCC was lifted, and under the prodding of the ARRL, most of the old frequencies were returned by the end of 1946. One casualty, however, was a low frequency band taken over by a wartime navigational system called Loran which had proved so valuable that it was retained as a permanent fixture.

The informal working relationship between the ARRL and FCC was permanently altered with the adoption by Congress of the Administrative Procedure Act in 1946. In the past, ARRL suggestions had been checked out with the FCC engineering and legal departments, and the suggestions were immediately adopted if no objection was raised. The law now clearly specified a much more detailed hearing procedure.

TELEVISION COMES OF AGE

One major problem facing the hobby was the growth of television. As more and more Americans made TV watching the national pastime, the amateurs faced much the same problem as reported earlier with the advent of radio. Interference with television was common, not only by amateurs but also by many commercial services. Poorly built

TV sets received not only the television signal but also any strong signal in the immediate vicinity. RCA lead the way toward designing more selective sets, and the industry followed. The ARRL lead the drive to cleanup the signals produced by amateurs, and the problem dwindled.

INTERNATIONAL COMMUNICATIONS

An important effect of the war was the increase of the world's amateur population outside the United States. Several factors contributed to this use. Thousands of United States servicemen in occupation forces were able to activate amateur stations from Europe and Asia. In Germany and Japan, as an example, a great deal of interest was generated among the countries population as the service personnel demonstrated the ease with which world wide communications were possible.

Mountains of surplus military radio equipment was scattered across the globe. Much of this found its way, either legally or illegally, into the hands of foreign nationals who converted it to amateur use. This opened a whole new concept to many who previously had used relatively crude homemade apparatus.

THE TECHNICAL REVOLUTION

Out of this war, just as in the first world war, technology made rapid strides. More selective receivers made possible a greater volume of communications in a given space. Improved antenna techniques, little used before the war, allowed the operator to beam his signal at a specific point. This increased its effectiveness while reducing interference to stations in other areas.

The biggest aid to the crowded amateur frequencies was the advent of a different form of voice transmission known as single sideband. This method was patented in the

early 1920's by Bell Telephone. Little practical use was made of the single sideband system in the beginning because it demanded extreme stability and selectivity. As the "state of the art" developed, these barriers were overcome. In many respects it was a breakthrough similar to that which took place when vacuum tubes and their continuous wave signals replaced the spark transmitter.

AMATEURS IN THE SPACE AGE

Two aspects of modern amateur radio were totally undreamed of a decade ago. Experiments showed the possibility of using the moon as a reflector for very high frequency signals. Stations beamed a signal to the moon, and it was reflected at an angle to return to a similarly equipped station across the continent or the world.

A more practical arrangement was that of a satellite repeater much like a small scale Telstar. The amateurs wangled space from the National Aeronautics and Space Administration aboard rockets and launched several of these orbiting repeater stations. Conversations of the amateurs are relayed through the satellite and returned. Contacts all over the world are made when the orbit of the repeater is correct. Satellites built by amateurs in other countries are currently waiting United States rocket space for trials.

RECIPROCAL LICENSING

In spite of international tensions, the United States began granting reciprocal licenses to the amateurs of other countries who would respond in similar fashion. A British amateur, for instance, can operate his station under United States regulations while visiting in the United States. These privileges have been worked out with eighteen countries at present. American hobbyists have taken advantage of this development and

many a tourist in foreign lands is equipped not only with assorted cameras but also with small, highly sophisticated single sideband transceivers capable of conversation "back home" from any point in the world.

POSTWAR INTERNATIONAL REGULATIONS

World War II prevented the International Telecommunication Union meeting which had been slated for Rome in 1942.

The meeting was finally held in Atlantic City in 1947. The changes that had taken place between the 1938 Cairo conference and the 1947 Atlantic City meeting were more drastic than any encountered before. International shortwave broadcasting had increased to a point that it threatened to swallow up most of the medium wavelength spectrum. These propaganda stations were operated by almost every country. The voice of America, The BBC, Radio Moscow, and a host of others were spewing millions of watts into the ether in the name of truth, justice, and national pride.

Commercial and military aviation had grown tremendously and used radio equipment in huge amounts. Television and FM broadcasting had grown from a laboratory demonstration to reality. Radar and various electronic navigation systems for both ship and plane occupied large spaces in the radio frequency spectrum. The amateur once again lost some space to commercial interests and national pride. The frequency assignments remained, for the large part, intact.

THE GENEVA CONFERENCE

The 1959, the ITU meeting took place on schedule in spite of United States and Canadian efforts for a postponment. United States representatives went to the conference with a determination to hold the line on all amateur frequency assignment below

thirty megacycles. For almost five months, the discussions continued. The results were mixed, from the amateur standpoint. The Western Hemisphere assignments remained the same, but cuts were made in the frequency assignments for amateurs of the rest of the world. In practice, interference from commercial and government stations was greatly increased, even for those amateurs in the Western Hemisphere. This has lead to interference in North Africa from Voice of America transmitters for United States amateurs in the seven megacycle band.

FURTHER REGULATIONS

The next full scale ITU conference will take place in Geneva in 1969 or 1970 if present plans are followed. Early evidence points to another struggle which will result in further reduction of the amateur frequency allocations. Fortunately technical progress has kept pace with this gradual reduction in operating privileges through the years so that today less frequency spectrum space is used by a much greater number of amateur radio operators.

DEMOGRAPHIC CHARACTERISTICS OF AMATEUR OPERATORS

A study of the characteristics of United States amateurs, compiled in 1966, by Stanford Research Institute points up the changes that have taken place since the youthful enthusiast of the early 1900's struggled to send signals a few miles.[22]

The median age of amateurs is forty-one and a half years as compared to a median age of twenty-seven and two-tenths years for the total population as shown in Figure 5.

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[22]Stanford Research Institute, Amateur Radio: An International Resource (SRI Project No. M-5436 Menlo Park: Stanford Research Institute, 1966) p. 29.

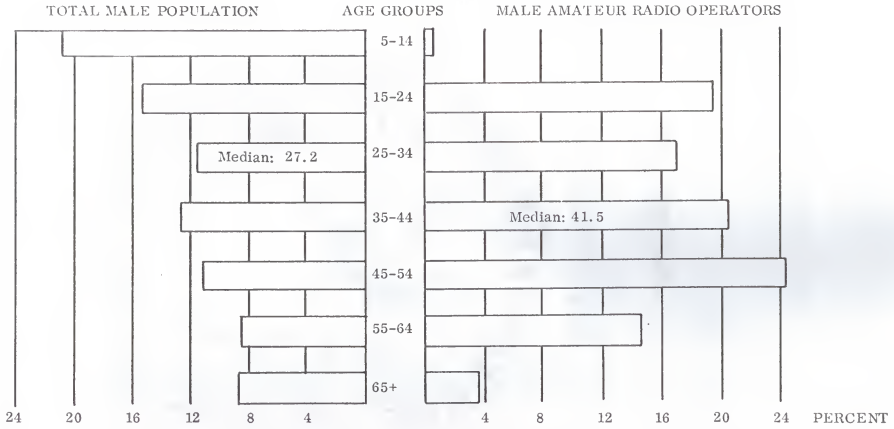

Figure 5. Age distribution: Total male population in the United States (1964) vs male amateur radio operators (1965)

Source: Stanford Research Institute 1966

The hobby apparently has little attraction for women since ninety-nine percent of those holding licenses are men. About forty-one percent of the presently licensed amateurs are in the thirty-five to fifty-four year old age group.

Comparisons of the educational level of male amateurs over twenty-five years of age with males over twenty-five in the general population provide some interesting facts as shown in Figure 6. More than ninety-six percent of these amateurs are high school graduates against thirty-six and eight-tenths percent for the general population. Those who have completed college in the general population is less than ten percent while in the amateur group forty-five percent have completed four or more years of college.

As would be expected from the educational level the amateurs also rank much higher in income than the total male population as seen in Figure 7.

Median income among male licensed amateurs was approximately $9,900 against $4,500 for the general male population. Higher income levels show sixty-four and eight-tenths percent of the amateurs with incomes of ten thousand dollars or higher. The general population had less than ten percent in this bracket.

These studies of United States amateurs probably represent a paradim for amateurs in other countries but data are lacking for definite conclusions.

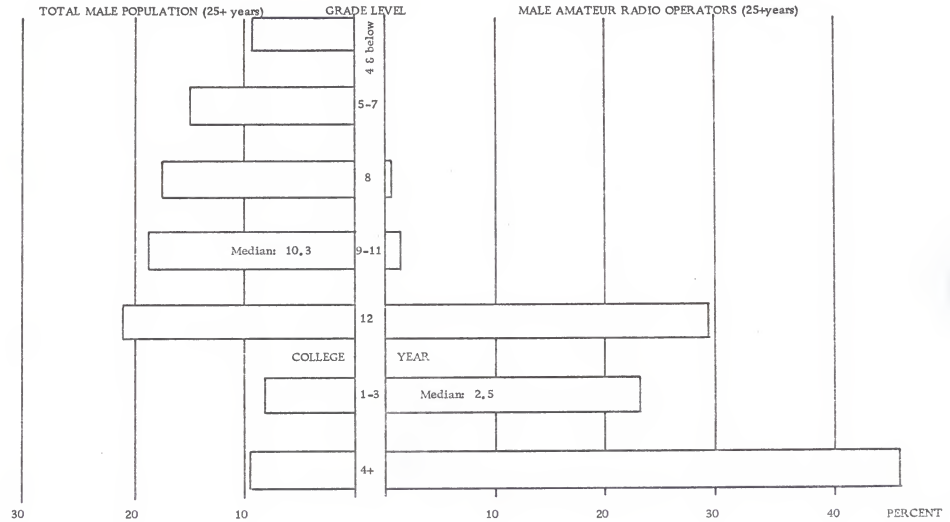

Figure 6. Education distribution for persons 25 years old and older: Total male population in the United States (1960) vs amateur radio operators (1965).

Source: Stanford Research Institute

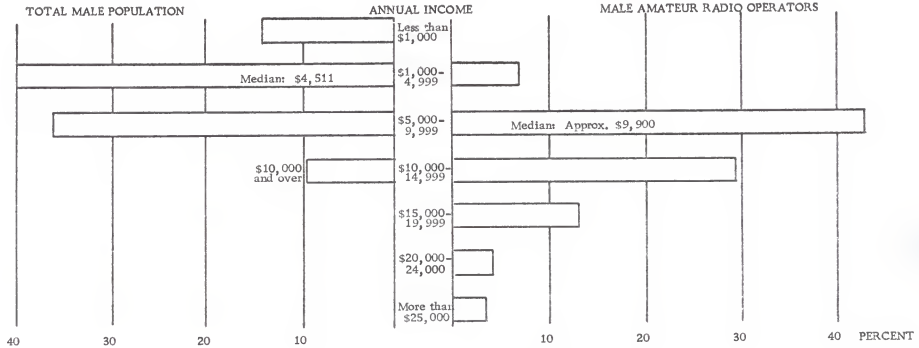

Figure 7. Income distribution: Total male population in the United States (1963) vs male amateur radio operators (1965).

Source: Stanford Research Institute

CHAPTER VII

THE ECONOMIC CONTRIBUTIONS OF AMATEUR RADIO

Current equipment sales to amateurs are estimated at between $35 million and $40 million per year.[23]

In a 1963 study the average amateur was estimated to spend three hundred and fifty dollars per year for the first two years and about two hundred dollars per year thereafter.[24]

On the basis of a median time in the hobby of thirteen and eight-tenths years, as shown by a survey conducted by Stanford Research Institute in 1965 each amateur invests about three thousand dollars in equipment, during the period in which he participates in the hobby.[25]

The magazine CQ, which is directed at the radio amateur audience, has done a readership survey of the value of equipment owned for several years. The most recent was conducted in January 1966 and showed the average value of amateur stations in use to be $1,200.00.[26] Considering obsolescence and trade-in this figure would appear to be in line with the estimates made of a life time investment of three thousand dollars.

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[23]Leon Tolopeko, "Ham Sales Signal a Big Business", Electronic News, May 2, 1966, p. 1.

[24]Stanford Research Institute, Mobile Communications (Long Range Planning Service Report 173 Menlo Park: 1963) p. 7.

[25]Stanford Research Institute, Amateur Radio: An International Resource op. cit.

[26]"How Much Do We Spend," CQ Magazine, (January 1966) p. 80.

INTERNATIONAL TRADE

The superiority of amateur radio equipment produced in the United States is recognized world wide. A survey was conducted by radio among foreign amateurs in an effort to determine the country in which their equipment was manufactured. The results are tabulated in Table I. The entire survey appears in the appendix to this thesis.

TABLE I

EQUIPMENT IN USE BY FOREIGN STATIONS, 1968

Of United States manufacture	58.0 percent
Of Japanese manufacture	20.0 percent
Of manufacture by all others	27.6 percent
Total*	105.6 percent

*Does not total 100 percent since some stations contained equipment from several different countries.

The interview period was June 1, 1968 through August 30, 1968. Of the seventy-nine people interviewed sixty-five of these produced usable results. The remaining fourteen were disregarded because the question was not answered or interference and poor propagation paths made the answers uncertain. The technique used was to ask questions about the station's equipment until specific indications of the type and make were obtained. Some interviews were completed in a few minutes while others took as long as forty-five minutes. Forty countries were represented in the sample.

This survey would seem to indicate that the hobby has resulted in an economic contribution to world trade, particularly beneficial to the United States.

CHAPTER VIII

SOCIOLOGICAL ASPECTS OF AMATEUR RADIO

INTERNATIONAL GOOD WILL

One of the major contributions of the hobby has been to further personal contact between the citizens of the different countries. These "face to face" conversations are the essence of what former President Eisenhower meant when he called for "people-to-people contact" and of what the Chinese Communists term "people's diplomacy."

While shortwave broadcasting has grown, it appears from equipment sales and response to programs that the listening audience is dwindling.[27] Part of this decline may be a lack of creditability. Certainly the creditability of individuals is higher than that of their governments. The conversations are personal, unrehearsed, and therefore more compelling. A measure of this vitality is evidenced by the exchange of verification cards between amateur operators after a conversation. An example of these cards is reproduced in black and white in Figure 8. Several million individual conversations between pairs of amateurs in different countries take place every year and the number is increasing steadily.

UNIVERSAL LANGUAGE

English speaking amateurs dominate the hobby in terms of numbers and technical contributions. In addition QST, the American publication, and publications of the Radio Society of Great Britian are the principal sources of technical information and operating news. These factors have worked together to cause amateurs in non-English speaking

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[27]Stanford Research Institute Amateur Radio: An International Resource Menlo Park: SRI, 1966) p. 60.

Figure 8. Verification cards, known to amateurs as QSL'S, are exchanged after a conversation takes place.

countries to learn English. Communications between South America and Japan, as an example, are almost universally in English. The same can be said for almost any area of the world. This has certainly contributed to increased personal conversation that otherwise would have been impossible.

WORLD WIDE MESSAGE TRAFFIC

Another major area of sociological effect has been the use of amateur radio for traffic concerning missionary endeavors. It was an amateur with a Quaker missionary group in the Congo who secured air lift aid and undoubtedly saved many lives during the uprisings in this country in 1964.

Catholic missionaries in South and Central America were the first to link both their missions and their centers in the United States together by amateur radio.

The United States hospital ship, Hope, has brought emergency treatment as well as advanced training for local doctors to many remote areas of the world. The Hope now operating off Ceylon is linked to the United States by amateur radio.

United States servicemen in many remote areas are able to talk to their families via amateur radio. American Telephone and Telegraph has always cooperated to let American amateurs connect these distant servicemen through telephone "patches", although their rules clearly specified that no foreign attachments could be made to their equipment.

TECHNICAL RESERVOIR

The contributions of amateurs to war efforts has been documented previously in this thesis. As technology advances this may be of less importance than in the past. Since voice, high speed teletype, and computer data transmission now dominate, the

use of manually sent Morse code has decreased. Many amateurs are more interested in the ability to communicate rather than in the technical aspects of their equipment. Current amateur literature refers to these members as appliance operators. They are the growing majority. Much of the apparatus now used is beyond the ability of its user to construct and is purchased "ready to operate."

The Federal Communications Commission has recently issued new regulations which set aside certain frequencies for use only by amateurs who have passed advanced technical examinations. This has been done in an effort to promote advanced study and a better understanding of electronics by the amateur fraternity as a group.

CAREER GUIDANCE

Many high school age youths are exposed to electronics for the first time by participation in amateur radio. In a survey among 364 gainfully employed amateurs there is a high correlation between amateur interest and career work as shown in Table II.

TABLE II

INFLUENCE OF HOBBY ON LIFE CAREER

Career Field	Employment in Field		Employment Influenced by Amateur Interests	
	Number	Percent of Total	Number	Percent of Total in Field
Radio communications	61	16.8%	54	89.5%
Other electronic engineering	76	20.9	64	84.2
Other electrical engineering	44	12.1	38	86.4
Other engineering	42	11.5	19	45.2
Physics	14	3.8	10	71.4
Chemistry	8	2.2	2	25.0
Other science	21	5.8	9	42.9
Subtotal	266		196	
Other or none	98	26.9	32	32.7
Total	364	100.0%	228	
Not Given	55			

SOURCE: STANFORD RESEARCH INSTITUTE, 1966.

CHAPTER IX

SUMMARY

The purpose of this thesis has been to examine the history of amateur radio and to draw some conclusions concerning the contributions of this hobby to the affairs of man.

From a primitive beginning with homebuilt equipment, the amateurs have progressed in step with the technology of radio. Today, world wide communication is a simple matter.

The amateurs pioneered in the development of many of the early day technical innovations in radio. As the science became more complicated, the hobbyists have contributed less. The use of shortwaves was proven to be practical by the amateurs. Its development would undoubtedly have taken place, but much later, without this demonstration. Today's use of satellites and moonbounce methods by the amateurs are but adaptations of already proven commercial and military techniques. Amateur radio can no longer justify its existence on the basis of what it can contribute to the science of electronics.

Amateur radio fulfills a different role in our present society from that when it began. The hobby is one facet of what Marshall McLuhan has called our "electric technology."

> "Societies have always been shaped more by the nature of the media by which men communicate than by the content of the communication. The alphabet, for instance, is a technology that is absorbed by the young child in a completely unconscious manner, by osmosis so to speak. Words and the meaning of words pose the child to think and act automatically in certain ways. The alphabet and

print technology fostered and encouraged a fragmenting process, a process of specialism and of detachment. Electric technology fosters and encourages unification and involvement."[27]

The hobby of amateur radio is, perhaps, man's effort, as a person, to be a part of this changing world. What amateur radio is contributing to our society is an ability to draw people and nations closer together. What seems to motivate the greatest number of these hobbyists is a sense of belonging and involvement. The individual Russian and American citizen, as an example, communicate in a way their governments seem unable to do.

Several logical questions remain unanswered. Will amateur radio survive as increased demands are made on the space that it occupies in radio frequency spectrum? Will the world governments of different ideologics, continue to allow this relatively free interchange among their peoples? Is there anyway that amateurs can increase their usefulness to society? Time will answer the first two, and perhaps the amateurs, as they continue to demonstrate their ability will answer the third.

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[28]Quentin Fiore and Marshall McLuhan, The Medium is the Massage (New York: Bantam Books, 1967) p. 8.

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APPENDIX

EQUIPMENT IN USE BY FOREIGN STATIONS

A survey was conducted by amateur radio, among amateur stations outside of the United States. Stations were contacted and asked in a tactful manner about the equipment they were using in order to establish the country of manufacture. Every effort was made to avoid alerting the contacted stations that they were a part of a survey. It was felt, that since national pride was involved, the most accurate information could be obtained in a casual manner. Between June 1, 1968 and August 30, 1968 seventy-nine stations were queried. These were chosen at random as dictated by propagation conditions. Ne effort was made to select specific areas of the world. The sample does not represent a cross section of the world's amateurs since contacts were more apt to be made with the higher powered better equipped stations.

From the seventy-nine people interviewed sixty-five usable replies were obtained. Several stations avoided answering when asked about their equipment. In some cases interference and poor reception made the answer uncertain.

The following raw data were tabulated and reported in Table I.

Station Call Letters	Country	Equipment in use manufactured in: U. S.	Japan	Others
1. LX1BW	Luxembourg	x		
2. F2KL	France			x
3. DJ2RE	Germany		x	
4. GM3VQJ	Scotland	x		
5. TG9AD	Guatamala	x		
6. ZL1TU	New Zealand	x		
7. 5Z4KK	Kenya			x
8. 9Q5DG	Congo	x		
9. LU1DAB	Argentina	x	x	
10. VU2DKZ	India			x
11. UA9FC	USSR			x
12. UD6BR	USSR			x
13. IS1SCB	Sarninia	x		
14. CR6LU	Angola	x		
15. 5H3KJ	Tanganyika			x
16. CX4AAQ	Uruguay	x		
17. DU1FH	Phillipines	x		
18. JA9JX	Japan		x	
19. FO8BS	French Oceania	x		
20. KX6GJ	Marshall Island	x		
21. JA1ZAA	Japan		x	
22. TF2WKP	Iceland	x		

Station Call Letters	Country	Equipment in use manufacturee in: U.S.	Japan	Others
23. 9Q5SE	Congo	x		
24. TF2WKS	Iceland	x		
25. HB9AGN	Switzerland			x
26. DK1NO	Germany	x	x	
27. YS1RCP	El Salvador	x		
28. HKØBKX	Columbia	x		
29. OX3DX	Greenland			x
30. SP5CJT	Poland			x
31. 9M2BD	Malaya			x
32. 9K2CB	Kuwait	x		
33. 6W8AL	Senegal	x		
34. V86DR	Singapore			x
35. EI8BB	Ireland	x		
36. GB3NEW	England			x
37. GM3JC	Scotland	x		
38. IT1JR	Sicily	x		
39. I1GMG	Italy	x		
40. 9M2PO	Malaya		x	
41. YV4AU	Venezula	x		
42. XE1LU	Mexico	x		
43. JA2CHJ	Japan		x	
44. JA9CNG	Japan		x	

Station Call Letters	Country	Equipment in use manufactured in: U. S.	Japan	Other
45. JA1GLE	Japan		x	
46. DU1AT	Phillipines	x		
47. TI2FU	Costa Rica	x		
48. UA1IG	USSR			x
49. DL2TL	Germany			x
50. DL8OH	Germany	x		
51. OZ2JA	Denmark			x
52. SM4ATF	Sweden			x
53. SM3AVQ	Sweden	x		
54. UA3KBO	Russia	x		
55. VU2DOI	India			x
56. PX1UP	Andorra	x		
57. JH1EYB	Japan		x	
58. JH1GMS	Japan	x	x	
59. DJ2VZ	Germany		x	
60. UR2AR	USSR			x
61. XEØRZW	Mexico	x		
62. CE3TR	Chile	x		
63. LU2QC	Argentina	x		
64. YV4AHE	Venezula	x		
65. CT1OF	Portugal	x	x	
Total		38	13	18

AMATEUR RADIO: AN EXAMINATION OF ITS HISTORY AND ITS CONTRIBUTIONS TO SOCIETY

by

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Amateur radio is a unique phenomenon brought about by man's desire to communicate and the development of radio. Its impact upon society has been much greater than most activities that are considered hobbies.

The concept of a youth tinkering away in an attic or cellar to send a message a few miles by Morse code is far from correct. The average age for United States amateur operators is forty-one and a half years. He has three thousand dollars invested in equipment for his station. In terms of education and income the amateur is far above the median for the total population.

His voice conversations are world wide. He may chat easily with a dozen different countries in a single day. His unrehearsed visits with foreign amateurs carry a creditability that the official programs and publications of his government may lack. These "face to face" conversations are the essence of what former President Eisenhower meant when he called for people-to-people contact and of what the Chinese Communists term peoples diplomacy. The 257,000 licensed amateurs in the United States provide a strong force for generating international good will.

The purpose of this thesis is two fold. First to examine the history and trace the progress of amateur radio. How was it able to survive and grow in a world political environment that negates against communications by private citizens across geographic and ideological boundaries? The second concern was to identify and evaluate what amateur radio has contributed to the affairs of man in terms of economics and sociology.

The history of the hobby is interwoven with the history of radio. The early discoveries that lead to making radio a practical communications instrument were made,

for the most part, by people who considered themselves as amateurs in the field. Guglielmo Marconi, the father of radio, referred to himself on many occasions as the first radio amateur. Marconi's public demonstrations of radio in 1895 caught the public fancy almost immediately. By the early 1900's, magazines in the United States and Europe were publishing articles on how to build simple apparatus for sending and receiving. Thousands of people, almost overnight, became interested in the new and exciting science of radio. As the hobby grew, the amateurs organized and fought off national and international attempts to ban them from the radio spectrum. A Pittsburgh, Pennsylvania, amateur began broadcasting music on November 2, 1920. People bought receivers to listen, and the broadcasting industry was born.

Amateurs in the United States spent thirty-five to forty million dollars last year on radio equipment. The amateurs have provided a reservoir of trained technical personnel for war time and other emergencies.

The hobby has provided a focus point for life career goals. Many high school age youth get their first exposure to electronics through amateur radio. Surveys show a high percentage go on to make some area of electronics their occupation.

Amateur radio is one facet of what Marshall McLuhan has called our "electric technology." This technology encourages unification and involvement. The hobby of amateur radio is making a major contribution by drawing people and nations closer together.