Electronic Warfare - The Early Years Part 1

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In the Beginning

Early wireless pioneers soon recognized the need to obtain the strongest possible signal upon reception of due to the insensitive nature of the receiving equipment of the time. This was very true for sea-borne operations where the radio initially made its greatest impact. The large navies of the world also realized that they could potentially intercept communication transmissions which would lead them to the enemy task force if they could home in on the direction of the signal. As a result, early progress in Electronic Warfare closely tracked the developments and improvements of wireless radio and ultimately radar.

The earliest DF systems took advantage of the bi-directional properties of loop antennas to determine the azimuth of received signals. These early systems worked at low and medium frequencies, and eventually into the HF range as vacuum tube technology improved. One of the most famous of these DF systems was the Bellini-Tosi system used during both World Wars. These loop-based systems were particularly applicable for low frequency operation. In 1907 Bellini and Tosi discovered the DF principle that was named after them: a combination of two crossed directional antennas (i.e. loop antennas) with a rotating coil goniometer for determining the direction.

This technique would be used extensively in World Wars I & II. In 1910, Guglielmo Marconi had the foresight to purchase the patent rights for the Bellini-Tosi design. He utilized the technique, and improved receiving equipment to help overcome background static noise in his worldwide wireless receiving stations; including the Belmar Station, situated at what was to become Camp Evans.
Another advancement made around this time, was improvement in receiver design. Prior to WWI, a young engineering professor from Columbia University by the name of Edwin Armstrong, traveled down to the Marconi Belmar Station to help conduct the first full-scale test of his regenerative circuit, which revolutionized the wireless world, and dramatically affect the future of communications and Electronic Warfare. One of the key Marconi participants in this test was David Sarnoff, the future founder of the RCA Corporation. On a bitterly cold New Jersey night in January, 1914, Armstrong and Sarnoff sat through the night in a building at the edge of the Shark River copying messages from Clifden, Ireland, Poldhu, Cornwall, Nauen, Germany, numerous stations on the West Coast and even signals from Honolulu, coming in with incredible strength in the early morning hours. This was unheard of! All the messages were checked with the originating stations, confirming the fact that this new circuit, still undisclosed, provided incredible amplification of signals so weak that they rarely, if ever, had been received from such distances before. The combination of directionality and improved sensitivity set the stage for future wireless communications, and the development of sensitive intercept receivers for Electronic Warfare activities.

After Marconi had improved the overall capabilities of his world-wide wireless network, the Great War commenced in Europe. The Belmar station was used to receive important messages from across the Atlantic. However, when the United States entered the war, the U.S. Navy took over control of all of the East Coast stations.

**World War I**

It was during the First World War, that radio Direction Finding and Interception came into the fore. Previously, isolated incidents of interception, monitoring and primitive jamming were accomplished during the Russian Japanese war early in the twentieth century. In the European conflict, many fixed sites of the Marconi type were set up by both sides. These were used for a longer range interception and direction finding. The Royal Navy erected a chain of Direction Finding Stations along the east coast of England, in order to obtain bearing information on aircraft and ships using
radios in the North Sea area. The stations employed the Marconi Bellini–Tosi antenna system augmented by Armstrong’s circuitry for increased sensitivity.

Closer to the front lines, listening posts using induction equipment were set up to monitor short range trench communications, and portable direction finding equipment developed at Camp Vail New Jersey were also used.

Sergeant Ernest H. Hinrichs was one of the German-speaking Doughboys trained at Camp Vail who risked his life by crawling through “no-mans” land to plant his induction listening equipment near the enemy trenches. He was an early member of the Army Signal Corps Radio Intercept Section, operating one of the listening stations. The listening stations had three distinct functions: to intercept and decode German ground telegraphed messages; to intercept German trench telephone conversations; and to monitor U.S. telephone communications in the front lines.
The evaluation of Allied wireless and radio equipment, as well as the exploitation of captured German communications components were the tasks of Edwin Armstrong; who had enlisted in the Signal Corps and was immediately given the rank of Captain. Soon after his enlistment Armstrong was shipped overseas to Paris, France, where he became a member of the Radio Intelligence Division of the Signal Corps. The Signal Corps had set up a development laboratory in a rambling, once elegant old mansion.

At 140 Boulevard Montparnasse plush quarters for the slogging trench war of 1917 and Armstrong was assigned to an intercept section. He learned that one of the problems occupying the best Allied technical brains at that time was the detection and amplification of what were then very high frequency signals. The Germans were suspected of using higher frequencies to keep their field communications out of Allied hearing. Armstrong successfully “reverse engineered” a captured German radio and determined its detailed operating characteristics, greatly helping the allied cause, and receiving a promotion to Major.

After the War, Armstrong returned home and continued to accomplish incredible feats. He demonstrated his newest invention, FM, in the early thirties, by putting a transmitting system at his friend’s house just down the road from the Belmar Station in Mantoloking. The Signal Corps soon contracted with Armstrong to develop FM radios for the Army, and he later spent World War II stationed at Camp Evans designing and perfecting FM-CW radar for the Army.

Between the Wars

Following the end of World War I, the Services continued to conduct experiments to improve high frequency communications between ground stations. Preliminary tests were conducted to modify existing transmitters to sweep across a band of frequencies in order to cause interference to enemy systems. This was the beginning of a concerted effort to implement electronic attack techniques.
Introduction and Organizational History
The era of modern meteorology was ushered in 50 years ago with the launch of TIROS I on April 1, 1960. Before TIROS, weather forecasters gathered data from a loose assemblage of reporting stations whose data consisted of little more than cloud types, wind speed and direction, and barometric pressure. Aircraft and ship reports filled in some of the gaps, but these were spotty and poorly integrated into the forecasting process. As a result, the forecasts were little more than barely educated guesses and valid for a few days at best. Improving the accuracy of forecasts demanded visualizing weather patterns on a larger, synoptic level, something that was impossible when relying on simple ground station reports.

TIROS gave meteorologists the ability to see weather patterns on a larger scale. Specifically designed to observe weather conditions, TIROS was equipped with two television cameras and several infrared sensors. The photographs of the cloud structure and their temperature profiles revealed structures and complexities that were unknown at the time.
Although the images are of poor quality by today’s standards, it is impossible to overstate the impact of the data TIROS provided to meteorologists. For the very first time, it was possible to witness the genesis of a weather system and follow it until its death. Both the mundane passage of wind, rain and sun, to the evolution of hurricanes were visualized from a perspective that gave forecasters critical new tools to improve their reports.

TIROS I and its follow-on, TIROS II were the first US satellites designed to carry a television camera onboard. Its name, Television and Infrared Observation Satellite, derives from the two video bands used to observe the Earth. The visible light television camera could only photograph clouds during daylight. Infrared observations complemented the photographs by showing the temperature of the cloud tops, the Earth’s surface and clues to the moisture content of the clouds. Combined with the visible light photographs, infrared data provides critical insights on cloud height and the intensity of imbedded storms. Unlike visible light photographs, infrared observations of the Earth are possible on both the daylight and nighttime side of the Earth, providing essential data despite the clouds being in darkness. Although both TIROS I and TIROS II were originally designed as research satellites, the quality of the photographs were high enough to provide valuable data on clouds, ice cover and monitoring the life cycle of storm systems.

The TIROS project began several years before the Soviet Union launched Sputnik. In 1951, the Air Force contracted the RAND Corporation to study the problem of viewing the Earth using a television system. In turn, RAND came to the RCA Corporation for their expertise in camera technology. The objective was to use video to evaluate its potential as a general reconnaissance tool. From this study, small research projects began to develop hardware for use in spaceflight. In turn, this research led to the Army Ballistic Missile Agency (ABMA) contracting RCA to develop a prototype satellite to be launched using the Army’s Jupiter C missile. As a result of Cold War requirements, the Department of Defense later focused the project to a more specific mission, to identify the location of potential wartime targets. The design of a satellite with such advanced capabilities would be larger and heavier, requiring the more powerful Juno II ballistic missile to take it into orbit.

The contract was then divided into two main areas of responsibility, each reflecting the expertise of each division. The ABMA continued its role in managing the launch vehicle and related support equipment. Responsibility for the satellite and the ground tracking and data processing stations became the domain of the Army Signal Corps. By 1958, overall project management transferred to the Advanced Research Projects Agency (ARPA), which felt that a meteorological satellite demanded a high priority. This change to a strictly civilian mission was coupled with ARPA’s parallel, but highly classified spy satellite named Corona. Further changes in the national space program, notably the creation of NASA, forced several more changes in the TIROS design. The growing list requirements and capabilities of TIROS resulted in changing the launch vehicle yet again, to the Air Forces’ Thor missile.

**Design of the TIROS system.**

The TIROS satellites were drum shaped, 42 inches across and 19 inches high and weighed approximately 270 pounds. Three-axis stabilization, now universal in satellites today was not possible with the technology available in the late 1950s. The only practical option was to spin TIROS like a top to maintain its attitude in space. The spinning spacecraft was very stable, owing to the principle of gyroscopic rigidity which maintained its orientation relative to the stars.
TIROS observed the Earth using two imaging systems. Each provided their own perspective to the overall weather picture. Two video cameras produced black-and-white pictures of the Earth and its cloud patterns. A wide-angle camera, capable of a 104 degree field of view presented the “big picture” of weather patterns. A second imaging system showed a smaller area of the surface, providing much more detail of the cloud structure. The limitations of the video, storage and communications systems prevented taking truly high resolution images. Although the grainy, ghost-like images returned from the spacecraft were not especially detailed, skilled observers could resolve essential features. Complementing the visible light imaging were scanners that viewed the earth in the infrared. TIROS imaged in five separate infrared bands, each which was dedicated to revealing a particular characteristic of the Earth’s weather. Unlike the vidicon tubes used for the visual light photographs, the technology for creating infrared imaging tubes was still immature. The infrared sensors used to image the earth did not take pictures in the conventional sense, but rather “scanned” a narrow view of the Earth as the spacecraft moved along in its orbit. Coupled with the 12 RPM spin of the satellite, the infrared sensors produced a continuous, overlapping observation of the Earth. Although their data was much lower resolution compared with the visual light photographs, the data produced was a huge advance over previous measurements. The five IR bands used on TIROS were:

- 0.2 to 5.0 microns; Measuring the Earth’s reflected energy from the sun.
- 7.0 to 30 microns; Measuring the total radiated energy of the Earth and its atmosphere.
- 8.0 to 11 microns; Measuring the temperature of the earth’s surface.
- 5.9 to 7.0 microns; Measuring water vapor absorption.
- 0.55 to 0.74 microns (the visible spectrum); Provides a reference for the preceding four measurements, and for comparison with the TV pictures.

A second infrared system was mounted parallel to the cameras, using a viewing angle similar to the wide angle camera. The IR bands used by these sensors were the same as two of the IR scanners, 0.2 to 5.0 microns, and 7.0 to 30 microns. The data from these two sets of sensors, when combined with the visual photographs gave scientists their first accurate estimates of the energy flow into and away from the Earth. Calculations for the Earth’s “energy budget” are fundamental for the understanding of the dynamics of the atmosphere and its interaction with the oceans.

A third infrared sensor used on TIROS was not intended for weather observations at all. Because the satellite was spun for stability, it was necessary to know its orientation in space so that photography and IR scanning could be properly scheduled. Ideally, the spacecraft should maintain its attitude, but small perturbing forces can combine to alter the spacecraft’s attitude. This third IR sensor scanned the earth as the spacecraft rotated by recognizing the transition from the cold background of space to the warm planet below. Called a horizon scanner, this simple device allowed controllers on the ground determine the spacecraft’s attitude.
Orbit and photographic coverage areas.
The current generation of weather satellites are in geostationary orbits, constantly hovering over the same location on Earth. This allows continuous observation of a specific area, such as the east coast of North and South America. However, maintaining a satellite in geostationary orbit is not easy to achieve. Large rockets are necessary to reach the 22,300 mile altitude necessary for geostationary orbits, and powerful transmitters and receivers are required for communication. To resolve the details in the weather systems from such a height requires high-performance cameras, coupled with precision optics. None of these capabilities were available during the time TIROS was developed, resulting in a satellite with more modest capabilities.
Launched by one of the workhorse rockets of the era, the Thor-Able-II, TIROS I was placed in a nearly circular 407 by 430 mile orbit. At that altitude, TIROS required 98 minutes to circle the Earth once, all the while traveling at 16,300 miles per hour. The orbit was inclined at 48.40 degrees from the equator, allowing coverage of the entire continental United States and almost the entire South American continent. All of Africa and Australia and the southern half of Europe and Asia were also under the path of TIROS. Holding the spacecraft in a steady attitude with spin stabilization was straightforward, but it also imposed limitations on the areas that TIROS could photograph. The attitude TIROS assumed when spinning was fixed relative to the stars, not the surface of the Earth. With the television cameras mounted parallel to the spin axis, the geometry between the spacecraft attitude, the Earth’s surface and the sunlight dictated the possible times when it was possible to take photographs. During the time the spacecraft made one orbit, the cameras pointed towards the Earth less than half of the time. This was not a serious impediment, as the spin orientation was designed so that the cameras were pointed towards the Earth while the spacecraft was passing over the daylight half of the planet. However, about half of the pictures that did have the Earth in its field were towards the horizon, and were unusable because of the highly oblique viewing angle. Ultimately, only about 20 percent of the orbital period would yield usable photographs.
Tracking and commanding
the TIROS spacecraft

The technological state of the art in 1960 allowed little automation onboard the spacecraft, making the job of controlling the satellite a highly labor intensive task. TIROS did not have an onboard computer for determining the optimal lighting conditions and spacecraft geometry, and so was completely dependent on mission controllers to plan the photographic passes. Photographs and infrared data obtained while beyond the range of the tracking stations were stored on tape onboard the spacecraft. When passing over the ground stations, TIROS would rewind the tape and transmit the photographs to controllers. Controllers then radioed up freshly calculated parameters for the next set of photographs to the spacecraft, usually for times when the spacecraft was out of contract with the Earth. For those times when TIROS was within range of the ground station, pictures were broadcast directly to the ground station if spacecraft attitude and lighting allowed. The physical laws of motion that governed the path of TIROS around the Earth were often frustrating to work around. With only two ground stations in operation, there were days where the spacecraft was not within range of either station for several orbital passes. On many other occasions TIROS was visible to the tracking station, but for such a short time that picture transmissions and command uplinks were impossible. TIROS was visible to the ground stations for no more than 14 minutes, and a pass of at least 6 minutes was necessary to downlink the data stored onboard the satellite, and uplink new instructions.

The operational effort in the ground control station necessarily dovetailed with the actions in the satellite itself. Two primary Command and Data-Acquisition (CDA) stations supported TIROS. The Army Signal Corps operated its station at Camp Evans, Wall, NJ, and the Lockheed Missiles and Space Division maintained the station at Kaena Point on the Hawaiian island of Oahu. Minitrack receiving stations located in North and South America supplemented the tracking data derived from the primary tracking stations. Overall responsibility for daily operations was through NASA’s Space Operations Control Center, located at NASA’s Goddard Space Flight Center in Greenbelt, Maryland. The daily operations plan for TIROS was created at Goddard, which was then relayed to the staff...
in the two tracking facilities. In addition to the NASA center and the tracking stations, the Weather Bureau Meteorology Satellite Center provided considerable input for mission planning.

The two tracking stations were essentially alike. Both were equipped with a Harris Corporation 60-foot diameter, self-tracking parabolic dish antenna for receiving data and telemetry signals. The dish antenna was for reception only and commands sent up to TIROS used a separate antenna system mounted on the side of the dish. Both manual and automatic control over the satellite was available for controllers. The types of commands sent to the satellite included setting the clock for upcoming photographic passes, initiating the transmission of photographs and IR data from the onboard tape recorders and performing satellite housekeeping operations. The programming capability used within the tracking complex allowed significant flexibility in scheduling satellite operations. Pre-programmed sequences were the normal mode for commanding TIROS operations, as opposed to a manually entered sequence. Commanding the satellite using manual sequences were available when non-standard operations were necessary, such as direct readout of the TV cameras as the satellite passes over the tracking station.

**Receiving and processing TIROS data**

Teams of meteorologists were stationed at both Camp Evans and Kaena Point facilities. These teams included representatives from the Weather Bureau, Air Force Cambridge Research Center, Air Weather Service, Navy Research Weather facility, and the U.S. Army Signal Corps Research and Development Laboratory. The staff's role was to perform a real-time analysis of the pictures and the infrared data, which was sent along with the pictures to the Meteorology Satellite Center in Washington DC. As TIROS was the first attempt at observing the Earth's weather from space, it was important to calibrate its observations with the “ground truth” from meteorological station reports. In essence, the ground stations were “looking up” all the while TIROS was “looking down”.
Within the tracking facility were independent systems for recording and processing the television photographs and infrared data. Both television and IR data were recorded onto two multi-track tape recorders, along with reference data such as sun angle, synchronization pulses, indexing references, and the time. While recording the data on tape, a video monitor displayed the incoming television pictures. To capture the pictures, a special low persistence, high ultraviolet cathode ray tube was used, and were photographed by a 35mm camera mounted on the monitor. Automatically advancing the film as each picture was received, the camera continued recording until the playback from TIROS was complete. A reference number was recorded alongside each photograph, indicating the position of the satellite with respect to the sun, and the orientation of the satellite with respect to North. If additional copies of the 35mm films were desired, they could be created by playing back the previously recorded ground station tapes on the monitor. Finally, TIROS also radioed important engineering data, such as temperatures, voltages and other essential parameters describing the overall health of the satellite.

After the data was recorded at the ground stations on film and tape, it was shipped to the Naval Photo Interpretation Center for precision development and photogrammetric processing. The IR data sent by TIROS was multiplexed onto a single signal, and was passed unmodified to NASA’s TIROS control center at Goddard, where it was stored and available for analysis. Unfortunately, the spin stabilization used to maintain the spacecraft attitude creates a large number of oblique photos which are difficult to interpret. To improve the usability of the photographs for the user community, technicians rectified the images to reduce the perspective error and improve their readability. Originally performed by hand, this process was time consuming but produced many more useful images for researchers and meteorologists. Several pictures were then combined to create a large scale map of cloud cover called a nephanalysis, which was faxed to regional weather offices and researchers around the world.

Tropical Storm Photographed by TIROS
Significant accomplishments of TIROS

TIROS I did not have a particularly long lifetime, lasting only 78 days. Despite this short existence, its contributions to Earth observations are unparalleled. Never before had meteorologists been able to study weather patterns on a synoptic scale in such detail. Even its first photographs were useful to scientists, showing the changing state of the ice pack in the Gulf of St. Lawrence and St. Lawrence River. Only 10 days after launch, TIROS I observed a tropical storm in the south Pacific, north of New Zealand. From this observation, the era of continuous monitoring of tropical storms and hurricanes began. For the first time in history, dangerous storms were now visible days away from landfall, allowing coastal areas essential time to make preparations. A later photograph, taken on May 19, produced another ground-breaking image. A high, bright cloud system was observed moving northward over Iowa in the afternoon. Ground observers reported that this weather system not only was generating significant hail, but also contained a tornado!

TIROS I took 22,952 photographs of the Earth, of which 60 percent contained useful information for meteorologists. This bounty of images overwhelmed the staff responsible for analyzing and cataloging the data, and the Weather Bureau responded by asking for an emergency appropriation to manage the cataloging work. After 78 days and 1,300 orbits of the Earth, engineers retired the spacecraft due to multiple system failures. The TIROS program resumed with the successful launch of TIROS II on November 23, 1960, which operated until January 22, 1961. Camp Evans again acted as the primary tracking and receiving station. Over then next five years, eight more TIROS satellites would be launched before giving way to more sophisticated satellite systems.

INTERNATIONAL MARCONI DAY 2010

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International Marconi Day is an amateur radio event sponsored by the Cornish Amateur Radio Club from Cornwall, England. This yearly event commemorates the birthday of Guglielmo Marconi, who is considered by many to be the father of radio. Marconi, born April 25, 1874, would have been 136 years old this year. The Ocean Monmouth Amateur Club (OMARC) will once again participate in the event as an official Marconi Day station and will be using its call letters, N2MO.

Our sites involvement with Marconi dates back to 1912 when he established the Marconi Wireless Telegraphy Company of America on Marconi Road in Wall, NJ. It was one of 8 commercial telegraph links in America and was known as the Belmar station. It received wireless telegraph messages from Carnavan, Wales as part of the New York to London route. Its counterpart transmitting station was located in New Brunswick, New Jersey. The Belmar station stayed in operation until 1917 when the U.S. became involved in World War 1. At that time the Navy took control of the station.

OMARC is one of approximately 62 other official stations located world wide who may participate in the event by giving out radio contacts to amateurs who wish to earn credit toward obtaining a certificate from the Cornish Amateur Radio Club. For more information on this event, google International Marconi Day 2010.

OMARC will be operating this event on Saturday, April 24 and will be open to the public from the hours of 10am until 4pm. We are located on Marconi Road at the Diana site of the InfoAge Science/History Learning Center. Enter through the gate where the large radar dish is located. We are in the building to the far right. There is no charge to the public and OMARC operators will be glad to answer any questions regarding amateur radio or the event.
Learning The Code

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“Learning the code is considered by many to be an art form like learning to play a musical instrument or learning to type.”

The secret language of amateur radio operators is the code. I call it a secret because to me it sounds like a mysterious and intriguing way of communicating that only a few might be able to master. In reality, it’s a fun mode to use and once you learn it, you may never go back to using a microphone. The code, more precisely the International Morse Code, up until recently, was necessary to know in order to obtain an amateur radio license and operate on the amateur bands below thirty megahertz. Now however, it is no longer a requirement as the FCC abolished it back in 2007. At that time, it was a very controversial issue and it seemed that the amateur fraternity was split as to whether or not the FCC should keep it as a license requirement. Where as before it was mandatory to learn, it had now become optional and since it had become optional, many thought it would surely die out. In spite of the FCC’s ruling, it seems to me that this mode of operating has gained a resurgence in popularity. With the pressure of learning it being removed, more people have gravitated back to it. As humans, we all seem to do better in our endeavors when no constraints are put upon us.

We use code for communicating because by its very nature and narrow bandwidth, it is easier to copy than voice under interfering conditions. It’s a simple combination of dots and dashes that are used to form letters, numbers, and punctuation. However, a lot of hams shy away from it saying it’s too hard to learn. But it’s my opinion that almost anyone can learn it if they try hard enough and don’t give up. Learning the code is considered by many to be an art form like learning to play a musical instrument or learning to type. It requires patience and practice, practice, practice. I have been involved in instructing a number of code classes to beginners. The biggest stumbling block I’ve found with these beginners is their lack of daily practice. We usually recommend 2 fifteen or twenty minute practice sessions per day. Anything longer than that seems to be counterproductive as ones concentration seems to tire.

The method we use to instruct our students is the Ludwig Koch method. Ludwig Koch was a German psychologist who first developed it back in 1936. It begins by having the students learn to recognize two letters and after a 90% pass rate is accomplished, another letter is added until a pass rate of 90% can again be achieved. This continues on throughout the whole alphabet, punctuation and number system. Sounds simple enough, doesn’t it? We tell our students to practice word games in their heads by picking out various objects and then mentally try to decode them. We also tell them to concentrate on the sound of the pattern of each character, not on each individual dot and dash.

Once the code is learned, it is only a matter of time before ones speed in copying it will increase. Writing down on paper the code characters can usually be achieved up to about 20 words per minute. A word is counted as being 5 characters long, so at a speed of 5 words per minute, 25 characters are written and at 20 words per minute, 100 characters are written. After copying by hand at a speed of over 20 words per minute, the hand starts to tire and one usually cannot keep up with what is being heard. To go at a faster speed, one must concentrate and start to copy mentally without writing it down. Of course if you are copying code with a typewriter you can go much faster.

Copying code mentally is just a matter of concentrating by forming syllables in ones head and putting words together. Eliminating the writing process increases ones speed dramatically. I’m probably over simplifying the process as I have been primarily a code operator for over fifty years. Sitting by my radio and conversing in code without writing it down is a real pleasure and I try to pass along my enthusiasm for it to all who practice the art form.

Of course, copying code is just one half of the equation. Sending with a straight key or an electronic key also takes a lot of practice. At our class we primarily concentrate on the copying aspect but we also cover the aspects of good sending and the proper protocol to use when making a contact.

Our code class at OMARC usually runs for about 8 weeks, one evening a week and usually lasts for about an hour. We try to conduct a class when there are 4 or 5 students who are interested in learning it. The code is something you can’t really teach as much as you can help one to practice. Our students are encouraged to practice on their own and each week we review the previous lesson and continue on with the new assignment.

We have just recently completed a code class and hope to start another one in the fall of this year. If interested, contact me at wa2hzt@aol.com and I’ll put you on the list.

The Ocean Monmouth Amateur Radio Club (OMARC) is a support organization of the InfoAge Science/History Learning Center located on Marconi Road in Wall, New Jersey. If in the area and the gate is open, stop by to say hello. We’re in the building to the far right of where the large radar dish is located.
The New Jersey Historical Divers Association, Inc. presents our eighth

New Jersey Shipwreck Symposium

Saturday, April 24, 2010 – 2 PM to 6 PM
at the InfoAge Science/History Learning Center in Wall, New Jersey

Admission is $20 per person ($15 for NJHDA Subscriber Members). Reservations are required - seating is limited (payment in advance guarantees seating).

The symposium will be hosted by

Dean W. Fessler, Jr. – Shark Research Institute

The speakers and scheduled events are as follows:

Identifying the Vivian Wreck
Dan Lieb – Shipwreck Researcher

Horseshoe Crabs - Ancient Creatures In The New Millennium
Dave Barbara – Marine Photographer

New Jersey Shipwrecks
Gary Szabo – Wreck Diver/Photographer

(Intermission - light refreshments)

Admiralty Arrest – the Andrea Doria and the SS Carolina
Hon. Joseph Rodriguez, USDJ

The Stolt Anchor Recovery
a video presentation by Steve and Maureen Langevin, and Bjoern Kils

For reservations and directions, please call 732-776-6261, e-mail info@njhda.org, or visit www.njhda.org/eventspage.html
Send checks payable to NJHDA, Inc., 2201 Marconi Rd, Wall, NJ 07719

Alterations and substitutions to the schedule may occur without notice.
NJHDA, Inc. is a nonprofit charitable historical research organization. All donations are tax deductible.
The Newsletter of InfoAge
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2010 Calendar of Events

April 9
TIROS First Hurricane Discovery 50th Anniversary

April 11
TIROS 50th Anniversary Celebration

April 15
Wall Chamber Of Commerce Scholarship Fundraiser

April 17
OMARC Tailgate Hamfest

April 24
OMARC International Marconi Day

April 24
NJHDA’s Eighth NJ Shipwreck Symposium

May 2
Membership Drive Event

May 14
Family Film Screening “October Sky”

May 15
Rocket Building Clinic

May 16
Symposium & Apollo/Lunar Exhibit Dedication
Rocket Launch & Retrieval

June 19
InfoAge Fourth Annual Antique, Classic & Historic Car Show

June 26-27
OMARC ARRL Field Day

For more information about these events, such as admission costs and times, call 732-280-3000 or visit us online at www.infoage.org.