HANDBOOK FOR

MUSEUM HISTORIANS

Prepared by the Staff
of the
Antique Wireless Museum

Bloomfield, NY 14469
Revision A

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The AWA Vision

To preserve and share the history of technology used to communicate and entertain from the first telegram to today's wireless text messaging.

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Introduction

This guide is intended to assist Museum volunteers in gaining the knowledge and history of the Museum displays, in order to confidently lead tour groups and share the extensive history of electronic communications with Museum visitors.

The guide is comprised of three sections, containing a general overview of responsibilities and procedures; an in-depth description of many of the Museum artifacts and related background information; and procedures for opening/closing the Museum, and related matters.

Responsibilities of a Historian

The primary responsibility of a Historian is to represent the Antique Wireless Museum and to make sure a guest's visit is as pleasant and informative as possible. This section of the Handbook for Museum Historians is intended to provide general information on topics other than historical information.

> **NOTE:** Any Historian who is scheduled to work a shift at the Museum and who is experiencing cold, stomach, intestinal distress or flu-like symptoms should remain at home if possible, until symptoms have disappeared. If unable to miss the shift, a mask should be worn to respect and protect the health of others at the Museum. Masks are available at the front desk.

Historian Identification

Please wear you personalized Historian identification badge to show guests that you are not just another curious guest. It separates you from the crowd and makes them feel more comfortable by reminding them of your name. They are guests in our house and they would like to know their host's name; it makes them feel more at home. We want their visit to be as personal an experience as possible.

Greeting Visitors

When someone enters the AWA Museum, make a point of saying hello and acknowledge their presence as soon as possible. If you are with a group of people on tour, ask them if they would care to join the tour in progress. If the group with you is already large enough, suggest to the newcomers that you will be with them in a few minutes and to browse until then.

Guests wishing to take photographs or video recordings of the Museum exhibits should be encouraged to do so.

Identifying Interests

As soon as you have a chance, introduce yourself to the visitors and ask:

- The name of their home town
- What brought them to the Museum
- Do they have any special interests in communications or history

- How did they hear of the Museum

Armed with this information, you know "where they are coming from" and can direct the tour or conversation to topics of their interest. If they have been involved in some aspect of communications in the past, encourage them to tell a few stories from their personal experience. You would be surprised how interesting it can get for you and they are delighted to find someone to reminisce with. A secondary reason is to identify possible interest in becoming a member of the AWA, or they may be able to provide further information for collectors or the Curator. If you find someone of special interest, jot down their name and address and pass it on to the Curator or other interested officers of the AWA.

Sequence of Items or Areas in a Tour

There is no specific formula for conducting a tour of the Museum. In general, try and identify any common interests in a group you may be leading about the Museum. Give the tour in any way that YOU feel comfortable with. There is no formula that will work for everyone. Keep with topics and materials that you feel comfortable discussing.

Always encourage guests to ask questions, and never be afraid to tell them you don't know the answer. There is a lot to know about the history of wireless communications with experts abounding. If you come across a knowledgeable person, acknowledge their own expertise and start asking them a few questions. The purpose of the Museum is to provide a forum for education for visitors and staff alike.

Visitor's Register

Encourage as many people as possible to sign the guest book. This can be a good memory jogger of interesting people, in addition to good reading. It is surprising how many different types of people come to the Museum and from all parts of the world. In addition, it provides a basis for estimating attendance for the year.

Museum Activity Log Book

There is a simple log for the guides to fill in at the end of an opening of the Museum to the public. The log is intended to cover a few very critical items - an estimate of the number of visitors, and a list of problems or suggestions that came up during your shift. This information will aid us in keeping better track of the number of visitors and more importantly a convenient place to leave notes to the Curator and his assistants.

Membership Applications

Encourage guests to join the AWA if they appear to have more than a passing interest in the history of radio communications, broadcasting, amateur radio or the electronics industry. Do not "push" membership, but be "encouraging" if they look like they would truly enjoy the AWA’s activities. One of the primary reasons people join is to receive the AWA Journal

published quarterly. There are applications on the stand with the guest register. Sign the line for membership referral.

Items for Sale by the AWA

Visitors who purchase items for sale by the AWA must be charged New York State sales tax. The AWA will take care of the paperwork for taxes. Transactions will take place at the front desk, with a bill of sale showing all items purchased to be completed by the Historian on duty. Place any money received for sales in the cash box in the register. Note that all electronic items are sold as-is with no warranty.

Equipment Repair

On occasion, people stop by to inquire whether they can have electronic equipment repaired at the Museum. The answer should be a firm but tactful NO; this is an electronics Museum, and while many of the staff members could provide guidance and suggestions it is not within our charter to do so.

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The Museum Tour

This is a tour outline and not a script. It is not intended to be a speech or presentation; it is intended to give important historical information to allow the Historian to have a conversation (not a lecture) with guests. The tour will vary with each Historian but should follow this general flow. Each Historian is expected to give accurate historical facts, and this guide has been prepared to document factual information and stories for each exhibit.

Note that our visitors are guests, not tourists. Always see what level of knowledge they have. Determine their level of understanding at first: non-technical, ham, engineer. As our guests may have additional plans for the day, ask how much time they have to visit and adjust the tour accordingly.

Before starting a tour, or letting guests proceed on their own, be sure to call their attention to the locations of the emergency exits and restrooms.

Use discretion with time spent at each exhibit. Discipline yourself to give 6 main points at most. Guests often tire if the tour drags on. The tour should go about 60 to 75 minutes with a goal of 4 to 5 minutes on each section. Be alert for signs of disinterest, and spend more time on exhibits where guest interest is higher.

It is helpful to develop a segue, or method of transitioning the conversation from one exhibit to the next to show how technology developed.

Maintain an objective, professional attitude and keep personal ideology out of the discussion; focus on history and technology. If a guest mentions a hot button issue, politely divert the conversation back to the core message - history and technology.

Suggested opening statement:

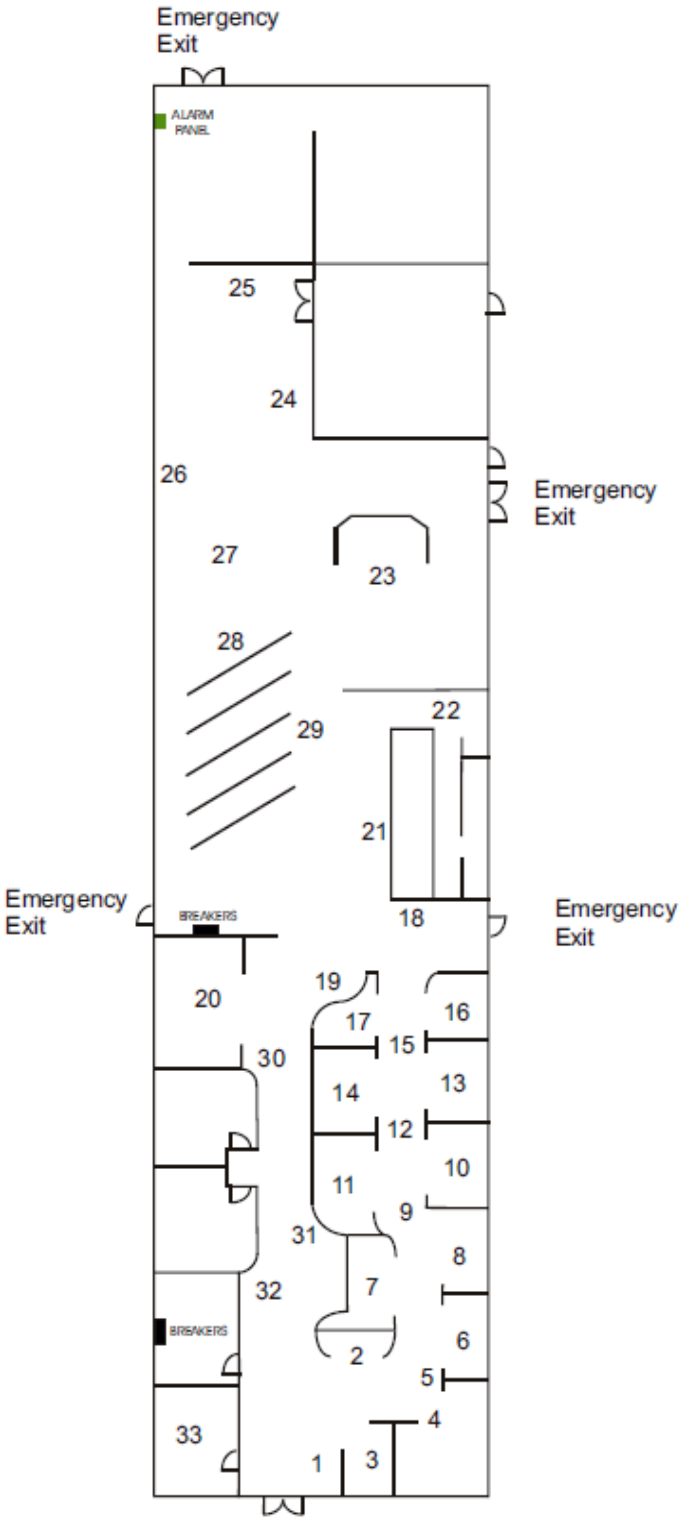
> What would your world be like without television, telephone, the internet, texting? We are an international society interwoven with communications for business and people. The Museum is dedicated to the preservation and sharing of the history of technology used to communicate and entertain, from the first telegram to today's wireless text messaging – a span of about 200 years. The Museum has a large number of "one of a kind" items that trace the development of communication technology.
>
> The Museum was started in North Chili, NY in 1952 and later moved to East Bloomfield. In 2013 the Museum moved to its current location. Today there are four buildings on the AWA campus – Museum, Conference Center, Media Center and Technical Center. It is the largest Museum in New York State run entirely by volunteers.

This Guide is organized by exhibit, starting at the front desk and following a generally counter-clockwise path across the Museum floor. Each section lists the exhibit name; the information listed on the plaque posted next to the exhibit; general background information to enhance the

Historian's understanding of the exhibit; and item-specific descriptions, information and related stories.

The exhibits are numbered by physical location in the museum, as shown on the map on the following page, to allow the Historian to become oriented with the locations. The numbers do not necessarily imply a firm tour sequence to be followed.

Exhibit Map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BREAKERS
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Exhibits

1 - Telegraph Office and Museum Admissions Desk

Exhibit plaque

> It is very appropriate that our visitors begin their Museum tour at a 1900 telegraph office. The telegraph, a device first proposed in 1753 and first built in 1774, was an impractical machine until Samuel Morse unveiled his first telegraph device in 1837 using a one-wire system. In 1838, Morse had developed an improved system and created a dot-dash coding system we call Morse Code which would become the standard throughout the world. By 1854 there were 23,000 miles of telegraph wire in operation.
>
> In 1851, one of the companies that would become Western Union was formed in Rochester, New York by Hiram Sibley. By 1900, Western Union operated a million miles of telegraph lines and two international undersea cables.
>
> Although Samuel Morse did not invent the telegraph and did not single-handedly create Morse Code, he may have been telegraph's greatest promoter, and undoubtedly contributed to its rapid development and adoption throughout the world. The era of electronic communication was born.

Background

Telegraphy pre-dates radio communication by sixty years. Landline telegraphy started in 1844 in the US and was used by Western Union, railroad stations, stock brokers and newspaper press.

Morse did not invent the telegraph but simplified and commercialized it. The Morse system for telegraphy, which was first used in about 1844, was designed to make indentations on a paper tape when electric currents were received. Morse's original telegraph receiver used a mechanical clockwork to move a paper tape. In his earliest code, Morse had planned to transmit only numerals and to use a codebook to look up each word according to the number which had been sent. However, the code was soon expanded by Alfred Vail in 1840 to use dots and dashes for letters, numbers and special characters so it could be used more generally.

Morse code has been in use for more than 160 years—longer than any other electrical coding system. What is called Morse code today is actually International Morse Code, which is somewhat different from American Morse Code, originally developed by Vail and Morse.

Items of Interest

- Desk shows a representation of a 1900s telegraph set at a train station. Typewriter is called a "mill" and has only sans-serif capital letters and numbers with a slash through the zero character. Operators were very skilled and could listen to the sounder and type the message at the same time. The sounder uses a tobacco can to distinguish it from

other sounders in the room - how you set lid distinguishes one sounder from another. Also mention can or no can for east and westbound direction at small RR stations.

- Photo of Albany train station, ask what is unusual about the photo. Picture shows telegraphers, both men and women; there was no glass ceiling, women telegraphers were paid the same as their male counterparts. Telegraphers were very skilled and could copy words and phrases in their heads at up to 40 words per minute.
- Western Union –The Western Union Company was formed in 1851 by Hiram Sibley of Rochester and Ezra Cornell (Founder of Cornell University). By 1900, Western Union operated a million miles of telegraph lines and two international undersea cables. Some of the equipment on display came from the Western Union office in Rochester, NY at the Reynold's Arcade. This was the first Western Union office in the U.S.A.

2 - Mobile Telephone

Exhibit plaque

The cellular telephone and mobile devices have become ubiquitous over the last decades. This display shows typical units used as mobile telephones since 1947, which have provided the basis for development of today's phones that you now carry in your pocket.

A "Mobile Telephone" is a radio designed to operate in motion and that communicates directly with a base station connected to (and often owned by) a land-line telephone company.

AT&T and the Bell System first offered a Manual Telephone Service (MTS) for vehicles, in 25 US cities in 1946. However, AT&T realized that the number of channels available would not come close to supporting the large volume of mobile telephone customers that they envisioned. In 1948, Bell Laboratories, the research arm of AT&T, proposed a method of dividing up a mobile telephone coverage area into hexagonal cells and reusing channels to greatly increase the capacity of the system.

It was not until the 1970s that the technology and number of channels available made a cellular system practical. In 1978, a test of the Cellular Service (then called HCMTS or High Capacity Mobile Telephone Service, and then AMPS – Advanced Mobile Telephone Service) was carried out by AT&T with 100 mobile units in Chicago IL. A mobile unit from this test, with serial number # 001, is part of this display. This unit is the first cellular phone.

Although tested in 1978, it was not until 1982 that the FCC approved the first cellular systems, and commercial cellular service began in Chicago in 1983.

Background

Early mobile telephones consisted of trunk-mounted receivers and transmitters utilizing special control heads equipped with telephone handsets and dials. They transmitted on a small number of VHF/UHF frequencies (150/450 MHz). A telephone operator at the radio base station placed the calls. The number of channels available was limited, for instance Chicago only had 16 channels.

Modern cell phones have many functions but the transmitter and receiver is still there inside, and radio waves are used to send the signals back and forth.

Items of Interest

- Early mobile radio using dynamotor to generate high voltages; these operated in the 35-47 MHz range and were made by Link
- Mobile radios with telephone handsets
- Duplexer allows simultaneous transmit and receive on one antenna
- Mobile unit from the cellular system test in Chicago. This unit is the first cellular phone serial number 001, built for AT&T by Oki Electronics in Japan. It was donated to the Museum by Jim Troe, who worked for Bell Labs. Note the HF button, it means “hands free”. Young people frequently ask where the screen is, and how one could text with it.
- The "brick" 1984 built by Motorola. It cost $4,000 when new. A status symbol. Marty Cooper led the team.

3 - Discovery Center

Exhibit plaque

Visitors of all ages are invited to enjoy our “hands-on” exhibits including a working shortwave radio, a teletype machine, a PC for looking at videos and our artifact data base.

Also be amazed by the sight of a Jacob’s ladder and two Tesla coils that will be demonstrated by a Museum Historian.

Background

Inventor Nikola Tesla learned of Heinrich Hertz's 1886–88 experiments that proved the existence of electromagnetic radiation, including radio waves. Tesla found this new discovery "refreshing" and decided to explore it more fully. The Tesla Coil was a means of transmitting AC voltage without wires. However it puts electricity where you do not want it – it electrifies everything in its vicinity and could cause shocks when touching nearby metal objects. Also, a wireless means of transmitting AC voltage could not be controlled as to who received it, either subscriber or non-subscriber.

Question: Can you feel radio waves? Radio waves have two components, an electric field and a magnetic field.

Items of Interest

- Jacob's Ladder: Heat makes arc rise. When the Jacob's Ladder is turned on, high voltage is fed into one of the wires. This voltage arcs to the other wire, which is connected to the ground, and creates a bright spark in the air. The spark then climbs up the ladder as it heats the air around it. Remember that hot air rises, and in this case takes the spark with it. Throw switch on front to demonstrate. Great for kids.
- Plasma globe ("Eye of the Storm"): This device demonstrates electrostatic discharge. It is a clear glass container filled with a mixture of various noble gases with a high-voltage electrode in the center of the container. When the machine is turned on a discharge occurs between the inner electrode and the outer glass; placing your hand on the glass draws the discharge but does not create a shock. It was invented by Nikola Tesla, during his experimentation with high-frequency currents in an evacuated glass tube for the purpose of studying high voltage phenomena.
- Tesla Coil: The vacuum tube oscillator uses two tubes in push-pull as signal source operating around 14 MHz. Unit may be operated by turning on the filament switch first and then the plate switch. The fluorescent light bulbs stored nearby may be held in one hand and raised towards the coil. The tube will light up as it approaches the top of the Tesla coil.
  CAUTION: Do not hold the bulb with any metal parts in contact with your skin. It is possible to receive a SEVERE RF burn if the bulb gets too close and you are touching the bulb's pins.
- Microphone display: You can see your voice on the oscilloscope display when speaking into the microphone.
- Teletype machine – kids call it a "big typewriter" – operating instructions are as follows:
  - Turn on the two switches under the table beneath the tape reader
  - Place "start" end of tape in tape reader, then turn reader on (switch in front). The teletype will print.

- The teletype will stop when the tape finished. Turn reader off, and re-thread tape if possible for the next use.
- Turn off the two switches under the table.

- Components used in telegraph systems – Morse register, Morse sounder, bug, spark key, Omnigraph.

4 - Pioneers and Inventors

Exhibit plaque

This exhibit is dedicated to those Inventors and Pioneers whose intellect, dreams and perseverance formed the foundation of the technologies we use today in communication and entertainment.

Items of Interest

Telegraph Case

- Morse's notebook containing the design details of the first commercial telegraph line from Baltimore to Washington, DC. From 1842. Samuel Morse and Alfred Vail worked out the details contained in the notebook. A copy is on top of the case for review. (Caution – we do not own the book and have to be careful as to what we say about it. It is NOT Morse's personal book; it has Morse's name on it but the drawings are believed to be done by Vail. To say anything else about ownership is to impinge on the value of the book, which is not ours and is on long term loan from the Wolf Family Trust.) The first message sent in 1844 was "What hath God wrought" chosen by Annie Ellsworth, daughter of a man who helped Morse secure Federal funding for the development of the telegraph. (An interesting side note: Because of the fact early Morse was recorded on moving tape, we have the actual 1844 message as received in Baltimore. It resides in the Library of Congress and can be seen on a YouTube video.)
- On the left is Morse's own telegraph register, made by Vail, which used paper tape to mark dots and dashes. It was difficult to maintain. Went to sounders since it was faster than reading the tape. Problem was if you did not hear it, the message was lost.
- On the right side is a replica of a Morse-designed telegraph repeater. Two replicas were made by Western Union, this one and the other is at the Smithsonian Institution.
- Compass belonged to Alfred Vail and was used to point to Baltimore. They had no idea how to build as telegraph line. Their biggest problem was no wire was being manufactured and they had no right of way. Plain wire on insulators (not buried as was the first failing effort) and using train track rights of way overcame these issues.
- "Lever correspondent" was the name coined by Vail for the first telegraph key.

Wall of Fame

This section recognizes those people responsible for the discovery and eventual implementation of communications using 200 years of technology starting with the electrical telegraph. It takes some knowledge communications history on the part of the visitor to fully appreciate this room, but select a few names to explain the purpose.

- Lee de Forest – self-described "Father of Radio" known for early advances in "wireless telegraphy"; invention of the Grid Audion tube – the first tube that could oscillate and amplify; and sound on film – talking movies
- Edwin Howard Armstrong – significant advances in radio including the regenerative, super regenerative and superheterodyne radio circuits; and Frequency Modulation radio (FM)
- Hedy Lamar was a famous actress of the 1940s. She was married to a munitions manufacturer in Germany. She was co-inventor of system of frequency hopping for the radio controlled US torpedoes to overcome radio jamming by the Germans in WW II. This frequency hopping technique is called "spread spectrum" which forms the background for cellular telephone, WiFi and secure military radio communications.
- Mary Loomis was an expert telegrapher and ham radio operator, and in 1920 founded the Loomis Radio College
- James Maxwell – electromagnetic theory
- Bruce Kelley, W2ICE, George Batterson, W2GB, and Linc Cundall, W2QY/W2LC – AWA founders

Armstrong Display

Background

Edwin H. Armstrong was a pioneer who may have been the most prolific and influential inventor in radio history. He is known for his early work on regenerative and superregenerative receivers. He developed the superheterodyne receiver and frequency modulation, or FM. The superheterodyne process is still extensively used in radio receivers. Eighty years after its invention, FM technology has started to be replaced by more efficient digital technologies. The introduction of digital television eliminated the FM audio channel that had been used by analog television; HD Radio has added digital sub-channels to FM band stations. However, FM broadcasting is still used and remains the dominant system employed for audio broadcasting services.

Armstrong's original FM equipment operated in the 42-50 MHz band. One reason for going to FM was to avoid interference to AM reception by trolley cars in the larger cities. The sliding contact on the trolley catenary wires would generate interference that blocked AM reception. RCA persuaded the FCC to change the FM band to 88-108 MHz to eliminate interference (skip)

issues. The FCC decided to change in 1945 and by 1949 the transition was completed, making Armstrong's equipment useless.

Items of Interest

- Painting on wall next to the display case shows the regenerative receiver model. The painting includes Edwin Armstrong and his long time lab assistant Harry Houck. Houck saved a number of prototype radio circuits built by Armstrong himself including the ones displayed here. Harry Houck would later become an AWA member, supporter and historical resource.
- Replica of Armstrong's First Regenerative Receiver. Regenerative reception was invented by Edwin Armstrong in 1912 using an Audion tube. This item was built by Armstrong as one of two models of his first regenerative receiver and was used in patent litigation with Lee de Forest, the inventor of the triode vacuum tube. de Forest claimed he also invented regeneration. The model on display is from Armstrong's estate; the other is in The Smithsonian Institution.
- This is the RF amplifier of the first FM transmitter made by the hand of Edwin Armstrong in 1934. In October 1935 Armstrong conducted field tests of his FM technology from an RCA laboratory located on the 85th floor of the Empire State Building in New York City. An antenna attached to the building's spire transmitted signals for distances up to 80 miles (130 km). These tests helped demonstrate FM's static-reduction and high-fidelity capabilities.
- IF strip from an early prototype of a superheterodyne receiver receiver built by Armstrong. Note use of RC coupling, no IF transformers, and total lack of selectivity, but better fidelity.

5 – Hallway – Scott Receiver

E. H. Scott unit built in 1935. E.H. Scott was founded in 1925 by Ernest H. Scott. The company was known for its elaborate, high quality radio receivers. It had no connection to a later manufacturer H. H. Scott.

This example has no top half cabinet but has a splendid Art-Deco design in front. Scott wanted to show off the 23 tubes and custom made chrome covers. The set has 17 radio tubes plus 6 for the power supply and audio amplifier in the wooden cabinet. Shock hazards were not considered back in this era. The 1935 Scott receiver is a transition piece with mid-length legs. It is a very rare set. Collectors like this set because it lacks a "top" and exposes the receiver's chassis. It never had a top cover, but a plastic dust cover was available. This model is more rare than the larger 34 tube version because few were made, and the extensive use of chrome.

Back in the day, people held "radio parties" where one could show off their new set. Akin to having the biggest screen TV set and showing it off to friends. This was the beginning of Short

Wave broadcasting where next-day water cooler talks brought bragging rights of what countries you heard the night before.

McMurdo-Silver also made a radio with an all-chrome chassis.

6 - The Beginning: 1850 to 1900

Exhibit plaque

> This room represents the earliest forms of electrical communication using the electro-magnetic telegraph.
>
> Included are rare examples of early telegraph keys and archaic test equipment, galvanometers and unusual voltmeters.
>
> The development of telegraphy was swift, thousands of miles of telegraph lines were strung in the first decade after its commercialization in 1845 and telegraphy proved invaluable during the Civil War and beyond.
>
> Primitive telephones and a stock ticker are displayed. They also played an important role in the transmission of messages and in the development of wireless telegraphy.
>
> The earliest form of wireless apparatus is represented, by a very rare Max Kohl Hertzian Parabolic Transmitter and Coherer Receiver dating from about 1900.

Background

Heinrich Hertz was a German physicist who first conclusively proved the existence of the electromagnetic waves predicted by James Maxwell's equations of electromagnetism. The unit of frequency, cycle per second, was named the "Hertz" in his honor.

Heinrich Hertz theorized you can send electricity (energy) across the room. The Hertz resonator was used (1886-1889) in the first experiments by Hertz as the "receiver" to detect the presence of radio frequency energy and thus prove Maxwell’s theories. Hertz did not realize the practical importance of his radio wave experiments. He stated that "It's of no use whatsoever[...] this is just an experiment that proves Maestro Maxwell was right—we just have these mysterious electromagnetic waves that we cannot see with the naked eye. But they are there." Asked about the applications of his discoveries, Hertz replied, "Nothing, I guess." (Wiki)

In 1894, Guglielmo Marconi sent wireless signals across the room to make a bell ring. He succeeded in making an engineering and commercial success of radio by innovating and building on the work of previous experimenters and physicists. Marconi had a monopoly business model. He leased shipboard equipment (would not sell it); only trained Marconi operators could use it. Also, Marconi had a policy of refusing to communicate, except in the case of emergency, with stations operated by other companies such as Telefunken and United Wireless.

The word wireless originally referred to code sent without wires. “Radio” term originated at the first International Radiotelegraphic Convention held in Berlin in 1906. This convention reviewed

radio communication (then known as "wireless telegraphy") issues, and was the first major convention to set international standards for ship-to-shore communication. One notable provision was the adoption of Germany's "SOS" distress signal as an international standard. It also sought to end the Marconi restriction on communication with other non-Marconi stations.

The coherer was an early radio wave detector consisting of a gapped conductor inside a tube filled with iron filings. In the presence of a strong radio wave (spark emission or lightning) the filings line up and complete the circuit. Tapping the tube manually or by means of a timed relay breaks the circuit (decoheres). This was an early form of radio wave detection which could not be used on a ship because of vibration. It was a sensitive but slow method.

Light galvanometers were used at the receiving end of the undersea telegraph cable in order to compensate for the weak current through the cable. A light galvanometer is really a microampere meter with a small mirror in place of a more common needle. A light source would be aimed at the meter and its reflection observed on the wall across the room. The spot of light would travel a considerable distance to either side of center. Movements in one direction were read as dashes and movements in the other were dots. The light galvanometer is a brass cylindrical unit mounted on a tripod. It has a window on the side to pass the light beams and to keep air currents and dust away from the delicate mechanism.

Question: where is a situation where you cannot connect wires for communication? Shipboard use.

Items of Interest

- Mariners' lodestone used to calibrate compasses and carried on board ship. This example is from 1750, the oldest item on display in the museum. Example of raw lodestone on the left.
- Benjamin Pike Jr. electrostatic machine 1843-1864 – generated high voltage for demonstration and experimental purposes.
- Humpback telegraph key 1850 – from the Princeton University collection and is the oldest key in the museum.
- Henley needle telegraph receiver and electro-magnetic telegraph transmitter 1853. Matches the electromagnetic telegraph transmitter.
- Chubbock Co. (Utica NY) weight driven telegraph register 1860 – with original string (AWA 1237)
- George Phelps round telegraph sounder 1860. This style was popular during the Civil War.
- Front page of New York Herald dated August 7, 1865 celebrating the laying of the second Atlantic telegraph cable. The first one laid in 1858 failed after three weeks, the

second was much more reliable and its telegraph speed (8 wpm) was 80 times faster than the first cable.

- 1865 kerosene lantern used on board the Great Eastern, the ship that laid the Transatlantic cable. Provided a light source for the early cable galvanometer.
- Walter Phillips style step lever telegraph key (1870) used by George Barlow at the Lehigh Valley RR yards in Rochester NY circa 1900 (AWA 1262)
- Moving magnet (tangent) reflecting galvanometer built by Elliott Brothers, 1875.
- Bell System butter stamp style telephone receiver 1880 – one of the first commercial receivers on the market.
- Blake style telephone transmitter box 1880 – also known as microphone; may have been built by Thomas Edison Co.
- Replica of Hertz Resonator
- Light galvanometer 1895 – built by Elliott Brothers, London. Used at General Electric plant in Schenectady NY.
- Max Kohl 1898 parabolic spark transmitter and matching coherer receiver - operates in 450 MHz range. Max Kohl was located in Chemnitz, Germany and was a well-known maker of scientific instruments. Became one of the first manufacturers of wireless apparatus. This transmitter/receiver set is the earliest known wireless equipment on public display in the US.
- Oldest known broadside (1898) describing Marconi's wireless activities.
- Morris E. Leeds variometer, 1902 – variable inductor.
- 1903 Lodge and Muirhead wireless telegraph component – a mercury interrupter that controlled the spark coil output of a transmitter. Believed to be one of two samples of equipment submitted to the US Navy in 1902 for evaluation of wireless equipment. In 1903 Navy chose Telefunken, a German company; a choice that proved unfortunate when WW 1 broke out and all Navy ships were equipped with German wireless equipment. This example was found at Mare Island Navy Yard in the 1960s.
- Fragment of original antenna from Marconi's Garden, Bologna Italy – this fragment was presented by Marconi to his lifelong friend Ettore Bellini of Bellini and Tosi, inventors of the direction finder.
- Western Union telegraph galvanometer owned by J. B. Stearns, who invented the duplex telegraph system.

7 -

Ralph Williams Estate items moving here

8 - Radio: 1900-1910

Exhibit plaque

> The development of wireless telegraphy during this period is represented here using primitive forms of receiving apparatus, including the coherer, magnetic detector, Fleming Valve, de Forest Audion and the crystal detector.
>
> Many top inventors from all over the world developed various instruments for communication during this decade. Included in the display is apparatus designed and built by (American) Lee de Forest, (Canadian) Reginald Fessenden, (Italian) Guglielmo Marconi and (British) John Ambrose Fleming, (Danish) Valdemar Poulsen.
>
> To the left is a duplicate of the early equipment used in 1909 by the United Wireless Company station at the Buffalo Evening News as pictured in a surviving newspaper article.

Backgound

Question: Have you heard of the term "scoop" with regard to newspapers? The word scoop is of American origin, first documented in 1874. As a verb, meaning to beat someone in reporting first, its first use was recorded in 1884. Many newspapers set up a wireless station so they could get news sooner and thus sell more papers.

United Wireless Telegraph Company was formed in 1906 and one of its best customers was the United Fruit Company, whose “Great White Fleet” of cargo ships were equipped with shipboard radios. Radio communications greatly enhanced the banana trade market in the 1907-1909 time frame. The UFC cargo-liners are known today as the “banana boats” and were instrumental in helping to establish what is popularly known today as the Banana Republics. Today the United Fruit Co. is known as Chiquita Brands.

Items of Interest

- To the left is a replica of the 1908-09 United Wireless ship-to-shore station used at the Buffalo Evening News, as pictured and described in the surviving newspaper article. This is the only known complete station of this type. The United Wireless Company was founded by Lee de Forest and absorbed by American Marconi Company in 1912. Of special interest is the very rare Type D tuner (mahogany box with two sliders), a large black 5,000 watt spark coil/transformer (on the floor), on the shelf above is the open frame resonating coil with an enclosed spark gap nested in the coil, and large rack of 12

Leyden jar condensers. The Buffalo station was probably the second commercial station established in the Great Lakes for business communications. Its purpose was to provide communications for Great Lake's ships to shore.

- When other forms of business communications were needed, the company would use landline telephone or telegraph, never radio. This was the case until after the First World War.
- Fleming Valve (diode) and de Forest Audion (triode).
- Tape recorder preceded by wire recorder in 1906.
- 1907 Telegraphone wire recorder. This was (either the first telephone voice mail system or used to make announcements?) invented in 1898 by Danish engineer Valdemar Poulsen, of the Poulsen arc converter fame. He franchised an American company to manufacture the Telegraphone. It was intended to compete with the Dictaphone, voice transcribing set, invented by Edison. The Telegraphone was not a commercial success.
- The man who licensed the patent rights to manufacture the Telegraphone was also a major shareholder in the competing Edison Company. In order to protect his own significant interest in the Edison Company, he did not promote the Telegraphone. As a result, the manufacturer of the Telegraphone went bankrupt. AWA #595 (BK/CB)
- Loose coupler – was used as the primary tuning device in radios between 1910 and 1920. The primary coil was stationary and attached to antenna and ground. The secondary coil slid in and out of the primary coil to vary the coupling, and was connected to the detector. Loose couplers fell out of favor in the early 1920s.

9 – Hallway – Atwater Kent

Background

Atwater Kent was the largest manufacturer of radios in the country from 1920 through 1929. Originally founded as a manufacturer of automotive components, in 1929 they were producing a million radio receivers a year. The plant located in Philadelphia covered 15 acres on one side of the street, and 32 enclosed acres on the other side. Following a decline in the demand for high-end radios during the Depression, and faced with other business issues, Kent closed the company in 1936. The company's products were of the highest quality and it employed thousands of workers.

- Photograph: Arthur Atwater Kent on the production floor.
- Photograph: Storefront with Atwater Kent radios, circa 1910-1920

Hallway – Left side

Background

The *Nagato* was the only Japanese battleship to have survived World War II. It was the flagship for Admiral Isoroku Yamamoto during the 7 December 1941 attack on Pearl Harbor. In mid-1946, the ship was a target for nuclear weapon tests during Operation Crossroads at the Bikini Atoll. She survived the first test with little damage, but was sunk by the second. (wiki) Other artifacts from the *Nagato* are shown elsewhere in the Museum.

- Large variable capacitor was used in the transmitter aboard the Japanese battleship *Nagato*, the flag ship of Admiral Isoroku Yamamoto who issued the code phrase "Niitaka yama nobore" (Climb Mount Niitaka) on 2 December 1941 from *Nagato* at anchor at Hashirajima. The signal was for the 1st Air Fleet in the North Pacific to proceed with its attack on Pearl Harbor and may have been transmitted through this capacitor.

10 - Radio: 1910-1920

Exhibit Plaque

Many large companies entered the wireless telegraph trade between 1910-1920, inspiring the invention & discovery of various circuits and apparatus. Wireless telephony developers heralded in the radio age with the invention of the vacuum tube detector.

Notable inventors of the period include Edwin Howard Armstrong, David Sarnoff, Paul Godley, Alfred Grebe, and Louis Hazeltine.

During this decade Armstrong invented and developed the Regenerative and Superheterodyne circuits and Hazeltine perfected the Neutrodyne circuit, all necessary to bring radio reception into the home.

World War I contracts were awarded quickly to a many of the brightest companies who designed equipment to serve our armed forces in the air, over the ocean and on the battlefield, providing a new method of reporting enemy positions. Many of the sets displayed in this exhibit were originally installed on Navy battleships and cruisers.

This time period set the stage for the 1920s, an era of radio which was to change the world, bringing families together to hear news & serial radio programs at home.

Background

In this time period radios began to look like radios with “funny things” on the front of them – tubes, dials and controls.

Items of Interest

- Model of Curtis Jenny observation plane that was built in Hammondsport, NY. Officially designated the JN-4, it first appeared in 1916 and was the test plane used for the world's first air-to-ground and air-to-air radio communications systems.
- de Forest Panel Receiver, circa 1920. Extremely rare modular receiver. The assemblies in this panel were sold separately so that the purchaser could build as large and sophisticated a radio as he could afford. There are 15 sections in the receiver panel with a minimum of two required - an antenna coil and detector. (BK/CB)
- Preservation of RCA/GE 1920 prototype receiver – was a "mouse hotel" and scrap wood when received. Was preserved by AWA member Robert Lozier, KD4HSH as a display example but not restored.

11 - Military – B17 Radio Room

Exhibit Plaque

In military conflict, information is often the key to victory. During World War I, radio rapidly evolved and was deployed to provide vital, real-time information. Today, radio technology has evolved to the point where we can actually watch "smart bombs" hit their targets.

As happens in many technologies during war time, the driving need for the military to have "the latest and the best" to gain an advantage over the enemy pushed the radio technology envelope forward in quantum leaps.

This exhibit shows military radio artifacts and technology from World War I to some of today's latest units. A very special display is a complete, working radio room from a B-17 bomber.

Background

WW 1 era -Radios begin to look like radios now with tuning dials for frequency. Military realized radio could be an advantage by getting news to and from the battlefield very quickly. The military pushed radio technology improvements after every conflict. The first military use of radio was spark transmitter aboard a plane, with a BC-14 crystal receiver on the ground. WW 1 transmitters display exceptional craftsmanship.

During WW II three US B-29 bombers made emergency landings near Vladivostok, Russia after attacking Japanese targets in Manchuria in 1944. Unable or unwilling to fly back to their bases on the Chinese mainland, the crews chose to land in the Soviet Union, reasoning that Stalin was an ally. One of the planes was completely dismantled into its 105,000 component parts, and each one was copied by engineers working for the aviation pioneer Andrei Tupolev. The resulting "Bear Bomber" was an important addition to the Russian air fleet but Russians could not duplicate the curved clear glass.

The Gibson Girl radios were originally conceived and developed by the Germans. Allied troops captured a German life raft in the North Sea and "reverse engineered" the distress transmitter and put it on all our life rafts. The nickname comes from the curved shape that is similar to the idealized "Gibson Girls" popular at the turn of the century.

(Anecdote: AWA Director Emeritus Tom Peterson obtained one of these while living in Cleveland, OH. He tried it out, cranking the handle repeatedly and playing with it. The next day, the Coast Guard showed up; they had triangulated his position because of his transmissions on the shipboard distress frequency! The conversation went like this: “What are you doing? Why are you doing that? Don’t do that!”)

Items of Interest

- German military receiver or “morale radio”. Uses only one type of vacuum tube with the exception of the voltage regulators.
- World War II British RAF T1154 military aircraft transmitter commonly used in bombers. RAF planes had no radio operators, therefore the unit has colored dials to easily identify the correct sequence for tuning the transmitter sections by untrained crew members. The aircraft operated at high altitudes and was not heated, requiring the crew to wear heavy clothing. Thus, the large toothed knobs are designed to be operated with gloved hands. Companion R1155 receiver is on shelf behind.
- BC-778A "Gibson Girl" Distress Transmitter. This self-contained transmitter operates on the international 500 kHz distress/emergency frequency. It was standard equipment in life rafts. The operator's first task was to deploy the antenna system which would have consisted of a balloon or kite lifted wire. The unit is designed to be placed between the legs and operated by a hand crank that is connected to an internal magneto-generator that produces the transmitter's operating voltages. The set's standard configuration will also produce an SOS in Morse Code as the crank is turned. The operator needed only deploy the antenna and operate the crank to meet the minimum requirements to broadcast a distress signal. The set could also be switched to the manual position and a second person could send Morse code by hand.
- On the other side of the room see the radio direction finding (RDF) aircraft antenna that would pinpoint the location of the downed airmen and send a landing craft to pick them up. RDF antennas were used aboard Navy PBY search planes to locate Gibson Girl distress transmitters. The PBY Catalina is an American flying boat or amphibious aircraft of the 1930s and 1940s produced by Consolidated Aircraft. It was one of the most widely used seaplanes of World War II and served with every branch of the United States Armed Forces.
- Show radio equipment from Curtis Jenny. How was power generated? Generator had a prop on the wheel strut.

- Japanese Zero radio on top shelf. Rare. Occupation was told to dispose of all Japanese radio gear and very few surviving examples exist.
- Picture of Japanese communications center in the Phillipines, with example of same transmitter as in the picture.
- Point out differences between the American B-29 radio and the Russian clone.
- B-17 radios were often sold as surplus to hams and modified. Hard to find one unmodified. Show how speedometer cable linkages allowed remote control of aircraft command radio sets by pilots. The transmission equipment was located in the fuselage behind the pilot. A radio specialist would set up the plane's radio prior to taking off on a mission.

12 - Hallway – Display Case

The display case contains a variety of early electrical and telegraphy items.

Items of Interest

- World War 2 Dutch "underground" receiver in a small box camera.
- The very first "portable" television camera developed around 1936-37. Prior to this time television cameras required many large pieces of equipment, particularly the power supply. Dr. Otto Schade developed this camera to prove to RCA President David Sarnoff that a camera could be carried. The key problem to development of the "portable" camera was the power supply. Initially, the only way to develop the high voltage required for the pickup tube was through a conventional two step isolated transformer. To operate the original camera at a remote location, a truck was required to carry the motor/generator set to run the power supply. Dr. Schade designed the high frequency flyback transformer to provide the high voltage to run the camera. The flyback transformer was used not only in the TV camera, but also was one of the key elements to the development of a practical TV receiver. This original camera was donated by Dr. Schade before his death.
- Hitler's key was used on Hitler's yacht to communicate with the German U-boat fleet during World War II.
- Large tube was taken from the 500 watt main transmitter of the Japanese ship *Nagato*, same transmitter that the tuning capacitor was from. The *Nagato* was the flag ship of Admiral Isoroku Yamamoto during the 7 December 1941 attack on Pearl Harbor.
- Crystal detector from the Maj. Edwin Armstrong estate, donated to AWA by Harry Houck in August 1970.
- Adjustable spark gap also taken from the *Nagato*.

- 1863 Confederate Battlefield telegraph key – Marked “Dixie 1863” on the bottom, it was constructed using Minie balls for the binding posts used to connect to the circuit.

13 - Marconi Gallery and Titanic Wireless Room

Exhibit plaque

Guglielmo Marconi was the first inventor to realize and develop the commercial potential of wireless telegraphy. With his breakthrough ideas, utilizing a ground and overhead antenna, he was able to extend the effective range of his wireless to many miles. By surrounding himself with the greatest wireless inventors and engineers of the day, he developed many wireless instruments that would expand the usefulness of his wireless system. Many of his rare original pieces of apparatus are on display in this room.

To your left is a recreation of Titanic’s Marconi wireless room using authentic era devices. The rest of the exhibit includes rare original pieces of Marconi Wireless Company apparatus discovered in attics and collections around the world.

Without Marconi’s wireless aboard the Titanic, all lives would have been lost. This one event influenced the development of ship to shore communications more than any other. Marconi and his wireless proved instrumental in providing increased safety for all future ship travel.

Background

The RMS *Titanic* sank on 15 April 1912 after striking an iceberg. The closest ship (SS *Californian*) turned off their radio at 11:00 PM and did not hear a distress signal after 11:40 PM when *Titanic* hit an iceberg. RMS *Carpathia* arrived on scene about 4 AM in response to the *Titanic’s* distress calls. What was the role of the wireless operator? Who did they work for? They worked for Marconi. Their role was to send commercial traffic, mainly personal messages for passengers, for a fee. When their shifts were over they turned off their wireless sets and went to bed.

The *Titanic* did not initially use “SOS”, rather it used the old distress call “CQD” which had been replaced by “SOS” a few years earlier; however most Marconi operators still used CQD. According to radio logs Titanic began using SOS about 30 minutes after the initial distress call.

SOS became the official International distress call at the International Radiotelegraph Convention on 1 July 1908 and was first used by ships in distress in 1909. It was sent as a prosign (like SK, KN, AR) in that the signal should be sent as ...---..., not as individual letters. It was only referred to as "SOS" because it was made up of those letters; it does not stand for "Save our ship" or "Save our souls". The first ships that have been reported to have transmitted an SOS distress call were the Cunard liner RMS *Slavonia* on 10 June 1909 while sailing the Azores and the steamer SS *Arapahoe* on 11 August 1909 while off the North Carolina coast. The

signal of the *Arapahoe* was received by the United Wireless Telegraph Company station at Hatteras, North Carolina, and forwarded to the steamer company's offices.

After the *Titanic* sinking, all shipboard radio operators were required to maintain a radio watch around the clock.

Items of Interest

- Replica of *Titanic's* wireless room based on computer-generated images derived from actual undersea video of the *Titanic* wreck. There was only one picture taken of the *Titanic* wireless room, but it was a double exposure and everybody thought the *Titanic* room was like that of its sister ship. An AWA member looked at the underwater video and all wood was gone, however the metal parts were still there. Their rooms were completely different. This is authentic gear from the time. Power panels were on the other side of the wall with transmitter. Power was on in the *Titanic* when it went down in that the meters are stuck in the ON position. (Note - Because of Eric Wenaas' work using the *Titanic* underwater video, the Museum's exhibit is based on the computer generated "photo" published in the AWA Review.)
- The transmitter room was located next door to the wireless room and was called the *Quiet Room*. The main transmitter was a 1.5 kW spark transmitter. There is an emergency 50 watt battery-powered transmitter on the desk. Rods are spark gap.

14 - Amateur "Ham" Radio

Exhibit plaque

Amateur radio, also known as ham radio, is a hobby enjoyed by several hundred thousand people in the United States and by over a million people worldwide. Amateur radio operators call themselves "radio hams" or simply "hams." Amateurs need to demonstrate skills in the radio art and have been licensed by the federal government since 1912. Amateur radio operation is fun, and that is one of the main reasons hams participate in it. But ham radio can provide communication during states of emergency. Ham radio works when many other services fail. After Hurricane Andrew struck South Florida in 1992, the utility grid was destroyed over hundreds of square miles. All cell phone towers and antennas were blown down. Only amateur radio and a few isolated pay phones with underground lines provided communication between the outside world and the public in the affected area. Amateur radio operators are known as technical innovators, and have been responsible for important discoveries. For example, in the early part of the 20th century, government officials believed that all the frequencies having wavelengths shorter than 200 meters (1.5 MHz) were useless for radio communications, so they restricted radio amateurs to these frequencies. It was not long before ham radio operators discovered how to communicate on a worldwide scale using simple Amateur transmitters. Thus the short wave radio era began.

In this display you will see the very earliest of spark type transmitters from 1914, (ask for a demo) and then the transition into vacuum tube equipment in 1923, when most equipment was home made. Commercial equipment became more readily available in the 1930s and post-war, and equipment by famous manufacturers such as Collins, Hallicrafters, National, Hammarlund and the like are shown. The modern era brings SSB transceivers from Japan; ICOM, Yaesu and Kenwood and Drake from the USA. Also displayed are numerous accessory items such as Morse code keyers, measuring equipment and operating aids. The AWA Museum has a ham call, too: W2AN. Enjoy.

Background

Amateur radio – group of hobbyists who enjoy talking on the air, constructing, experimenting, etc. Early amateur radio operators were unlicensed hobbyists who were not always liked because their signals often interfered with commercial wireless services. In 1912, after much lobbying to get rid of these hobbyists the government began licensing amateur operators and they had to move to other frequencies. A radio inspector would examine a prospective operator on radio theory, Morse code and verify that his/her equipment operated on the proper frequencies ("short waves").

The American Radio Relay League (ARRL) is the national association for Amateur Radio in the US. Founded in 1914 by Hiram Percy Maxim of Hartford, Connecticut. He was a prominent businessman, engineer, and inventor (notably of the Maxim Silencer). He was also an active radio amateur, with one of the best-equipped stations in the Hartford area. One night in April he attempted to send a message to another ham in Springfield, Massachusetts but was unable to make contact. Remembering that he knew another ham in Windsor Locks, about halfway, he asked him to relay the message. At that time, the maximum reliable range of a station was a few hundred miles, and so Maxim realized that a formally organized relay system would be of tremendous use to amateurs.

In the early days of amateur radio almost all equipment was built by the operators themselves, giving rise to the term "home brew." A lot of advances in radio come from the amateur community as many radio operators pursued radio communications as a career. Experimentation with new technologies on the ham bands led to further advances in the art.

The rotary gap spark transmitter was invented by Nikolai Tesla in 1896 and applied to radio transmitters by Reginald Fessenden and others. The quenched spark gap was developed by German physicist Max Wien in 1906. Spark transmitters were very wide bandwidth emissions and thus limited the number of channels available. Spark was outlawed to licensed users in 1925 however some emergency spark transmitters existed in maritime installations until 1960. Amateurs subsequently found that a 30 watt CW (continuous wave) transmitter was as effective as a 1,000 watt spark transmitter.

Spark transmitter operators suffered two conditions – hearing loss and "glass arm" which we know today as carpal tunnel syndrome.

CAUTION: Before demonstrating spark transmitters, ask about Pacemakers; if a guest has one, ask him/her to please step over to the Pioneers and Inventors area while the demonstration takes place. Assure them that they will hear the transmitters.

Items of Interest

- Small spark unit is Rexford and Matlock commercial unit, very low power output that just covers the neighborhood. Young hobbyists could talk back and forth
- Medium unit: 250 watts, goes 500 miles. ARRL used these to relay across country.
- 1000 Watt synchronous rotary gap spark transmitter: Range 1000 miles more or less. Mention when describing and demonstrating the 1 kW rotary sparker that this transmitter was built around 1914 by George Batterson, then 8TC, one of four founders of the AWA. George's interest in wireless started when he listened to the *Titanic* wireless telegraph traffic in 1912. He owned a trucking company and many of the early artifacts acquired by the AWA Museum were moved by him.
- (On shelf) Home brew 50 watt transmitter from 1921-22 using a mechanical modulator to produce modulated CW transmissions. The motor/spark gap mechanism produces a tone that modulates the transmitter. Small unit demonstrates the principle. Tone modulated CW was an interim method of communications as it could be easily demodulated by crystal sets. (Lynn's video on line)
- Early radiotelephone transmitter unit built by Paragon, 1921. 10 watts on phone and CW using two UV 202 tubes.
- 1933 National SW-3 had preamp and plug-in coils, very sensitive but no selectivity.
- National FB-7 – first superhet designed for amateurs, also used plug-in coils. Optional matching preselector also on display.
- 1935 National HRO, also plug-in coils and external power supply. Had an "R" meter for "readability"
- Homebrew Novice transmitter built using plans from "How to Become A Radio Amateur" book. In 1952 the number of amateur operators almost tripled due to the introduction of the Novice license class. Made it easy for people to get licensed. The owner built the station, operated as a Novice for a year, then never upgraded his license class and left the hobby until 1960 when the FCC allowed Novices to renew their licenses. He became active again and operated as a Novice for twenty more years until he passed away.
- Hoover Cup presented to Don Wallace, 9ZT (later W6AM) in 1923. Future president Herbert Hoover was Secretary of Commerce in 1921, and he wanted to encourage the development of radio. He offered to give a silver cup to the best of American amateur radio operators who built and operated their own stations. The Hoover Cup was awarded annually based on such factors as: transmitter efficiency and range; extent to

which station was home made; ingenuity of design; and neatness of station log. In the early and mid-1920s, Hoover's activities as Secretary played a key role in the organization, development, and regulation of radio broadcasting. Hoover also helped pass the Radio Act of 1927, which allowed the government to intervene and abolish radio stations that were deemed "non-useful" to the public.

- Heathkit was a large supplier of amateur radio equipment and most every ham has at one time built and operated a Heathkit radio.
- “Japanese invasion” was a big change in radio equipment; manufacturers such as Kenwood, Yaesu, ICOM etc. forced many US manufacturers out of the market – Drake, Hallicrafters, Swan, Tempo, Atlas, Dentron et al. Today’s state-of-the-art software defined radios and high spec equipment, however, are built by US manufacturers.
- Due to the complexity of today’s radios and the regulatory requirements of the FCC amateurs generally no longer build their own equipment. Despite this the hobby continues to flourish today with digital communications, software defined radios and relaxed licensing requirements.
- Carbon microphones – first invented around 1878, they consist of two thin metal plates separated by carbon granules, with a small DC voltage across the plates. When plate vibrates it changes the resistance of the granules, thus varying the voltage across the plates. Widely used in telephones up until the 1980s. Found use in ham radio applications because they were cheap and readily available, and voice quality was adequate.
- QSL cards – “QSL” means “I acknowledge” in the standard Q code used by telegraphers. Although they are associated with ham radio, many commercial broadcast stations sent QSL cards to listeners who reported hearing the station at great distances. The card reports date, time, frequency and signal report received and given plus any notes about the contact. A “QSO” is a contact between amateur stations.

15 – Hallway – Tube Display

This case contains a selection of unusual vacuum tubes, including some of the very first ones to the "modern" Nuvistor tubes. A loose-leaf notebook is kept near the case with descriptions of the contents of the display case.

The contents of this display case are of extremely rare tubes from America on the left and foreign tubes on the right.

- Item 56 in the case is the first transmitting tube made in the USA by General Electric Company in 1913.
- Item 46 was used by the Navy in the first voice Trans-Atlantic Transmissions in 1915; 200 of these were wired in parallel.

- Item 43 is a Loewe (rhymes with “oww”) tube having four different tube sections in one glass envelope. In the U.S. radio was paid for by advertising. In the United Kingdom you paid for a license for each radio you owned. In Germany radios were taxed on the number of tubes the set had; a radio could be built with only a single Loewe tube to minimize taxes.
- The tube in the center, item 103, is an early water cooled tube. The plate consists of a coil of pipe that was connected to the amplifier circuits and a water supply.

16 - Television

Exhibit Plaque

> “Pictures by wireless” was theorized in the early 1900s, but it took until the 1920s before Charles Jenkins invented a mechanical scanning disk television.
>
> With the invention of all-electronic television by Philo Farnsworth in 1927, television was on the path to its incredible success story. Having purchased Farnsworth patents, RCA commercialized all-electronic television publicly demonstrating TV at the 1939 World’s Fair in New York.
>
> Scanning TV was used in commercial television broadcasting from 1925 to 1939 when all-electronic television rendered scanning television obsolete. “And the rest of the story is…”

Background

Some of the early inventors who contributed to the development of television include:

- Paul Nipkow, who invented the idea of using a spiral-perforated disk (Nipkow disk), to divide a picture into a linear sequence of points.
- John Logie Baird of Scotland, widely considered to be "The Father of Television" who pioneered television technology before anyone in the USA
- Charles Jenkins of Washington, DC who pioneered the development of early television in America
- Philo Farnsworth, who invented the image dissector and the first all-electronic television system.
- Vladimir Zworykin, an RCA scientist who invented the iconoscope and kinescope.

Baird (UK) and Jenkins (US) worked on television concurrently. They discovered and solved similar problems using similar solutions, independently – they never knew each other.

The early television sets used mechanical scanning with a revolving Nipkow disk containing many staggered small holes. The number of holes determines the number of "scan lines" in the picture. One rotation of the disk will create one complete picture. The transmitting station must

have the same number of holes in the disk, and rotate at a constant speed. The receiver's disk must rotate at the same speed as the transmitter. In order to do this there is a "fine tuning" adjustment to vary the receiver's disk motor speed to exactly match the transmitters. The system was "in synchronization" when the received picture was clear and stable.

The transmitter would send a control signal to turn the neon type lamp behind the receiver's disk on and off. This would create the colors of only black (off) and orange (on) used in the picture.

In 1928 Baird, the recognized leader in television development, made history when he transmitted the first TV signal across the Atlantic. Baird and his associates transmitted the historic signal from England to W2CVJ in Hartsdale, NY. The equipment of the time was an all mechanical TV consisting of a spinning disk with 30 offset holes around the perimeter. With the disk spinning rapidly in front of a flat neon gas panel, a 30 line raster would be created. Now, turn that neon light source on and off in sync with an identical spinning disk in front of a photocell at the transmitter, and you had a crude but functional 30 line TV.

By 1935, RCA engineer Vladimir Zworykin developed electronic scanning used with cathode ray tubes. That same year David Sarnoff, President of RCA, devoted millions of dollars to the development of television. By 1936, they had developed an experimental television set. As deflection techniques were very primitive, it used a cathode ray tube with such a long neck that it was mounted vertically in the cabinet. The image was reflected off a mirror for the viewers to see. It had 343 lines of resolution and allowed for shades of gray. The result was better definition and displays of moving objects. The next step was 441 lines, before we went to 525 lines.

A raster scan, or raster scanning, is the rectangular pattern of image capture and reconstruction in television. The word *raster* comes from the Latin word rastrum (a rake), which is derived from radere (to scrape). The pattern of parallel lines of an image displayed on a CRT resembles lines left by the lines of a rake, when drawn straight; this line-by-line scanning is what creates a raster. Scanning is a systematic process of covering the area of the CRT face progressively, one line at a time.

Iconoscope – an image is projected onto a mosaic which is scanned by an electron beam to create an analog video signal.

Kinescope was the initial name for a picture tube, a CRT whose fluorescent screen is scanned by an electronic beam controlled by the analog video signal. Persistence of the phosphor used in the screen material allows alternate frame scanning (interlaced scan). In later usage the term kinescope film or kinescope recording referred to a motion picture made by filming the image displayed on a picture tube.

Historical Note: In 2003, to celebrate the 75th Anniversary of this event the very active Narrowband Television Association (NBTV), made up mostly of Radio Amateurs in Great Britain, decided to re-create the event and created a replica using the technology Baird used. Searching

for a NY station to be the USA side, the NBTV group located the AWA Museum in Bloomfield, NY, and a very willing and enthusiastic Museum Curator, Ed Gable, K2MP. Ed received parts from England from which to build the mechanical televisor and as well modified a Kenwood R-1000 to have an AM receiver with a flat response to 12 kHz. On the British side a special TV transmitter, running wideband AM with a power of 400 watts and crystal controlled in 21.310, was specially built for the task. Test transmissions began in January and took several weeks of trying before signals were finally received on February 6, 2003, with good results. The actual 75th anniversary date was the 8th of February with the NBTV group celebrating with events at UK's Amberley Museum. Those in attendance, included Baird family members, former Baird employees and interested on lookers. The equipment was capable of producing very useable pictures but needed very good signals, something difficult to achieve on the crowded 15 meter band with a required 12 kHz bandwidth. SSB signals in the passband were numerous and intolerable. None-the-less, many good pictures were received with the absolute best picture received when three things occurred simultaneously; all three SSB signals stropped, the selective fading disappeared and the signal peaked to over S-9. There it was, a perfect picture of the video transmitter identification, GB2KZ. The operators at GB2KZ, Ted G3GMZ, Peter, G4JNU and Vic G3SDQ, as well as all in attendance were very pleased.

Items of Interest

- One of the earliest mechanical televisors in the Rochester area, 1927. Note it is turned around, screen faces wall. Below the receiver is a photograph of the builder, Gordon P. Brown, a local broadcast engineer and founder of radio station WSAY. The rotating disk has 24 holes which gave a 1 inch square picture of only 24 lines. The receiver could receive signals from the General Electric Company in Schenectady, New York as well as the Jenkins system. The lamp in the display unit is not correct or original. The original bulb was a neon type that allowed the light source to turn on an off very quickly. An incandescent bulb has been put in the place of the neon one due to the scarcity of the original bulb.
- Jenkins 100 TV (on floor) – this is a very unique receiver was made in September 1926 and was given to Jack Poppele by Allen B. DuMont.
- Jenkins 400 Scanning Disk TV Receiver. Circa 1929/30. Light from lamp passes through the 60 glass lens to a mirror and on to a ground glass "screen". May be one of only several left in the USA. AWA #587. The Jenkins is similar to the Baird, except that it has glass lenses instead of pin holes in the disk.
- Baird television receiver, circa 1930/31. Manufactured by Hollis Baird of Boston. This unit uses a spinning disk with 60 holes. The matching Universal Short Wave receiver is on shelf and connected to the television. Both were available either in kit form or factory built. **NOTE:** Hollis S. Baird was born in Maine and was no relation to John L. Baird. Hollis

Baird was chief engineer at the Short Wave and Television Corporation of Boston and worked on the early development of mechanical TV in America.

- RCA “Portable” RR-359 TV Receiver, 1935 (Pre-WW2/343 scan lines). Field test prototype, extremely rare; one of two sets still in existence. (The term “portable” is used because technicians had to move the set from location to location in New York City for test and demonstration purposes. It takes four people to move it.) By 1937/38, RCA had produced several hundred of these sets. They were known as the "TRK" series, and the TRK-9, TRK-10, and TRK-12 were featured at the 1939 World's Fair in New York City. Test transmissions originated at the Empire State building.
- Meissner 5 inch Television Kit (late 1930s) – required 12 to 15 hours of assembly. It could receive images comparable in clarity to newspaper pictures.
- Pilot Radio Corporation, Model TV-37, Circa 1948. First television set produced by the Pilot Radio Corporation, manufacturer of the famous Pilot Wasp and Super Wasp broadcast radio receivers of the 1930's. This unit has a 3" screen and uses a common oscilloscope CRT. Sold for $99.95. Price was the result of a challenge given to the chief engineer to design a set that could be sold for under a hundred dollars. It is AC/DC powered without a filament transformer. The small screen was aided by an optional oil filled six inch magnifying lens that hung on to the grill of the receiver, thus solving an electronic problem with a mechanical solution. The magnifier is stored behind the receiver, but do not hang it on the grill as the grill has been broken and has been only cosmetically repaired.
- Westinghouse H619T12, 1949-50. 12 inch round picture tube, chassis possibly built by Philco.

17 - Entertainment

Exhibit plaque

The precursor of all electronic entertainment in the home began with Edison’s invention of the cylinder phonograph in 1877. Over time disc records slowly won the competition between cylinders and discs. This exhibit has working examples of both cylinder and disk phonographs. As radio developed, units incorporating both radio and phonographs were sold for home entertainment.

Background

The following general information on the phonograph was taken from “His Master’s Voice in America” published by General Electric in 1991.

“Nipper” was a fox terrier owned by English painter Francis Barraud, who also owned an Edison Commercial Phonograph that played wax cylinders. Barraud often noticed the dog listening to the phonograph, with an intelligent and rather puzzled expression, trying to make out where

the voice came from.He created the iconic painting of his dog and phonograph sometime between December 1898 and January 1899 and titled it “His Master’s Voice.”

Barraud showed his painting to several publishers in an attempt to sell it, but received only a few small offers. It was shown to Mr. William Barry Owen, the manager of the Gramophone Company Ltd. of London. He took an interest in Nipper and agreed to purchase the painting and copyright after the artist painted out the Edison cylinder phonograph and painted in a Berliner Disk Gramophone.

Gramophone Ltd. began using the Nipper portrait in its advertising literature in 1899. In May of that year Emile Berliner, inventor of the Disk Gramophone, traveled to London to visit the Gramophone Company and returned to the United States with a copy of the portrait’s trademark. He applied to the US Patent Office in Washington DC and the "Trademark for Gramophones" was issued on July 10, 1903, marking the official arrival of "His Master's Voice" in America.

Thomas Edison invented the Tinfoil Phonograph at his Menlo Park, NJ laboratory in August 1877. Voice was recorded by speaking into a flexible diaphragm attached to a metal pin, which indented the foil as the cylinder was rotated. The recording was then reproduced by playing it with a needle attached to a "sound box."

Edison patented his machine in February 1878, under the title Phonograph or Speaking Machine. This marked the official birth of recorded sound and its subsequent massive industry. That same year, the Edison Speaking Phonograph Company was organized to exploit the instrument's novelty appeal. Edison, however, turned his attention to another project by late 1878 which he considered far more important: perfection of the incandescent or electric light.

While Edison's attention shifted away from the phonograph, his 1877 tinfoil machine sparked intense rivalry. Chichester Bell and Charles Tainter patented an improved recording process utilizing wax instead of tinfoil cylinders in May 1886. It was called the "Graphophone" and it became direct competition to Edison's "Phonograph." Edison countered with a perfected wax cylinder version of his own Phonograph.

Emile Berliner, a telephone expert from Washington, DC introduced a machine which featured the world's first commercially available flat disk. He was issued a US patent for a disk-playing "Gramophone." Berliner's system included a manufacturing technique which provided a master record from which duplicate copies could be made, which could not be accomplished with cylinders. The flat disk had a groove that not only vibrated the phonograph needle to reproduce sound, but piloted the sound box and horn across the record. The record vibrated the needle laterally by means of modulations in the walls of the grooves, as opposed to the "hill and dale" method used by his rivals.

In 1893, Berliner formed the US Gramophone Company in Washington, DC to which he assigned his patents for his original hand-powered Gramophone. By 1896, Berliner's Gramophone was considered a milestone achievement, but the machine required improvements.

Eldridge Reeves Johnson, a young machinist in Camden, NJ became fascinated with Berliner's machine that talked. He immediately began experimenting with his own designs and within a few months built both an acceptable spring motor and an improved sound box.

In 1896, Johnson began experimenting with an improved process of recording which involved improved recordings on flat wax-like disks; a very fine electrotyped matrix of the recording, and multiple "stampers" made from a master matrix.

In 1900 Johnson formed the Consolidated Talking Machine Company. He received permission from Berliner to use the Nipper trademark ("His Master's Voice") on his gramophones and records. In mid-1901 a decision was reached to combine Berliner's patents, Johnson's patents and Johnson's manufacturing activity into a new company, the Victor Talking Machine Company of Camden, NJ.

Several stories have surfaced regarding the origin of the word "Victor" and its use in the company's name. One story claims that Johnson considered his first improved Gramophone to be both a scientific and business "victory." A second account is that Johnson emerged as the "Victor" from lengthy and costly patent litigations involving Berliner and others. There are other stories that attempt an explanation but these two are the most generally accepted.

In the fall of 1901, Victor won its first gold medal over all competitors at the Pan American Exposition in Buffalo, NY. Before the year was complete an organization of 10,000 dealers was established, including the noted Chicago musical firm of Lyon & Healy. Acceptance by the world's largest musical house greatly enhanced the prestige and commercial appeal of Victor's products. The process of stamping duplicate records from electroplated master disks was further developed and record quality was improved substantially.

By 1905, Johnson's firm had already sold over 200,000 "Victor" talking machines. In August 1906 the "Victrola" was introduced. The ornate product was an immediate success. Selling for $200, the "Victor Victrola" soon became a standard fixture in homes of the elite.

By 1929, the Camden plant totaled 2.5 million square feet of floor space, housed in 31 buildings, equivalent to ten city blocks. The plant consumed nearly 200 tons of coal per day, which was enough to last an average homeowner more than a quarter of a century. The company had its own private railroad system, a 17 million-gallon-per-day water works, a hospital, a restaurant, a printing plant, a coal wharf and the largest lumber yard in the world handling African mahogany and other cabinet woods. Nearly 10,000 people were employed by Victor at the time.

Victor records were being produced in over forty languages by 1929. The Victor trademark of "His Master's Voice" had been brought from Camden, NJ to all corners of the globe. Nipper had become the world's most famous dog, and the Victor "Red Seal" label was recognized as the standard in high quality musical recordings.

The rights to "His Master's Voice" transferred to RCA when it acquired Victor in 1929.

Items of Interest

- Brunswick-Balke Radiola Superheterodyne radio/phonograph made by RCA. Early transition machine. The first radio/phonograph combination ever made to Bruce's

recollection. It has a battery radio set, with a wind-up phonograph. Able to play Edison (Vertical cut) and conventional (Lateral) by rotating the pickup head. Both radio and phonograph used the same horn speaker. Circa 1923.

- Edison machine with what looks like a 78 record that could only be played on an Edison machine. The arm does not travel across the record by means of the groove; it is led by a lead screw in the rear that directs the arm's movement. Thick record on which the needle moved vertically using the diamond disk, or "hill and dale" method. Two sided records were rare and actually spun at 80 RPM. Demonstrate the volume control on the unit. The phrase "put a sock in it" may have come from using a sock in the horn of a gramophone to reduce the volume.
- Edison cylinder machine, circa 1900. Works using a spring that is set using a crank on the side of the machine. It uses a diamond stylus and a hard wax record. Strictly mechanical, no electronics at all. Cylinders were hard to produce. So a flat record was developed. Edison was deaf and bit into cabinet to hear the audio.
- Carola child's phonograph from the late 1920s
- Brunswick Automatic Panatrope phonograph with radio circa 1929. A machine that could play a stack of records. The arm used a sharp point instead of a diamond stylus and moved across and down the record. It cost $480 without the tubes, which were extra. Due to the Depression and its expense few machines were sold.
- Victor Talking Machine Co. "Victrola" was ultimate before electronics were added. They used a very large and convoluted horn, designed to take advantage of the new records cut with the vacuum tube cutter built by Columbia. This vastly improved sound quality. Volume controlled by door opening. Purely mechanical.
- The Nipper mascot was the trademark of Victor Talking Machine Company. It became the trademark of RCA after RCA bought the rights to Victor in 1929.

18 - Hallway

Philco started as a battery company, founded as Helios Electric Company, then renamed Philadelphia Storage Battery Company. They were making storage batteries in the early 1920s. In 1928 Philco decided to enter the booming radio business. By 1930 they were selling more radios than any other maker, a position they held for more than 20 years. In 1961 Ford Motor Co. bought Philco.

- Philco Model 541 Radio, 1928 – example of a radio designed to appeal to women, and could be found in the bedroom.
- RCA Radiola 62, 1928
- Midwest Radio, circa 1937

- Crosley AC-7B radio, 1927 – one of the first AC line powered radios.

19 – Hallway – TV Cameras

- RCA TK30 image orthicon camera - first TV camera in Rochester 1949. One of the AWA Museum's first artifacts. The lens in the wooden box showed up on the steps of the museum 30 years after the camera was acquired. There is a picture showing the first remote broadcast by WHAM-TV on May 11, 1949.
- Ikegami Beta cam, from WHEC-TV Rochester NY. Circa 1990; compare size with 1948 camera. Weight between camera and belt-worn battery pack was significant. The lead cameraman at Channel 13 remarked that "you could always tell a TV cameraman, his right shoulder was three inches lower than his left."
- RCA TM-6 Master Monitor, 1950s – with camera control panel. This was used as part of a camera "chain" of equipment linking studio camera to control room. The monitor displays both picture and video waveform to ensure the camera was adjusted properly. Fine adjustments could be made via the local control panel.

20 - 1925 Gernsbeck Radio Store

Exhibit plaque

This exhibit represents what a radio store may have looked like in 1925. The first scheduled commercial radio broadcast was made by KDKA in Pittsburgh on November 2, 1920 to promote the sale of radios. That first broadcast was heard by a meager audience of mostly amateur radio operators.

Radio was an instant phenomenon. By 1925, the era depicted in this radio store exhibit, there were over 6 million radios in homes. Fully half of those radios were made at home from parts purchased at a Radio Store based on radio magazine articles published by Hugo Gernsback.

Suddenly, the world was at people's fingertips and "the rest is history".

Background

Hugo Gernsback (oil painting on wall) was an inventor, writer, editor, and magazine publisher, best known for publications including the first science fiction magazine. Gernsback was an entrepreneur in the electronics industry, importing radio parts from Europe to the United States and helping to popularize amateur "wireless". In April 1908 he founded Modern Electrics, the world's first magazine about both electronics and radio, called "wireless" at the time. The magazine published articles on how to build radios, including parts lists, construction details and wiring diagrams. In 1913, he founded a similar magazine, The Electrical Experimenter, which became Science and Invention in 1920. It was in these magazines that he began including scientific fiction stories alongside science journalism. His contributions to the genre as

publisher—although not as a writer—were so significant that, along with the novelists H. G. Wells and Jules Verne, he is sometimes called "The Father of Science Fiction". In his honor, annual awards presented at the World Science Fiction Convention are named the "Hugos".

Many towns and cities had a Gernsback Store, or an equivalent. The showcases contain individual parts and assemblies that the home builder would buy in a radio store to make up a radio commonly described in magazines of many varieties. On the shelves are many commercial Tuned Radio Frequency (TRF) receivers commonly known as "three dialers" that were preferred by people not willing to make their own set. When purchasing a three-dialer the owner would provide a tuning log showing what dial settings were needed for a particular station in your area. After 1941 or so this type of store disappeared due to the shortage of parts; catalog stores such as Allied allowed you to buy parts via mail order.

In 1920 there were approximately 5,000 radios in the USA, and only two licensed broadcast stations. In 1925 there were over 6 million radios. By 1930 there were 100 million sets, many of them were replacements for the older, now outdated radios.

Items of Interest

- King Am-Pli-Tone horn speaker - With the early crystal radios, only one person could listen at a time because the set required the use of headphones. To allow all in the room to hear the radio program, the headphones could be mounted onto a special horn device that “amplified” the sound.
- Two examples of crystal sets available are the Federal and the special Mothers’ Oats box with built in wires. For $0.25 you could send away for parts to build a radio using the box. Very popular with youngsters.
- Selection of early Atwater Kent "bread boards". Circa 1922-1924. There was never a cabinet or front panel on the early AK sets. Some were available in kit form so you could build them at home. AK sets are highly valued by the collector and range in price from $350 to $500 at auctions. The rarest in the showcase is the Model 5 receiver. It and similar models appeal to many collectors due to their unique construction. The Model 5 commands a high price at actions as few number that were made; that was because of their poor performance.
- Leutz Model L was the first commercial superheterodyne receiver offered to the public. This eight foot receiver was offered in kit form from Leutz for a brief period of time. The detector and first local oscillator section is contained in the left-hand three foot section. The right-hand unit contains the first IF section, "second detector", and the third units contains the audio amplifiers. You needed to be a real radio aficionado to be able to tune this radio. Leutz (pronounced “loots”) was a manufacturer in Altoona, PA.
- The use of headphones limited listening to radio to one person. Megaphones were used to amplify voices. Horn speakers were developed which are basically a megaphone

attached to a megaphone. As tube amplification developed and improved, disc speakers and the speakers as we know them to day were developed.

- The glass encased receiver represents what was once a fad in home construction. You could see the internal components and the tubes when they lit up. The glass did nothing to improve the performance of the set and was difficult to make, since it was hard to drill holes in glass. Radio cabinets could attract a buyer to prefer one model over another. Some early receivers had tubes mounted so they protruded from the cabinet and gave off a soft glow.
- Promotional materials included GE and RCA dolls, which would hold vacuum tubes in their arms. “Johnny” represented Philip Morris cigarettes. Also lighted window signs, etc.
- Loewe radio has one multi-element tube that combined the functions of several tubes into one envelope.
- With the advent of radio, a new business opportunity developed: the radio repair shop. The radio service bench has period tools, components, reference books and test speaker. Also a non-electric soldering iron that had to be heated on the kitchen stove, furnace or using a blowtorch.
- Tube testers allowed you to make repairs to your radio equipment. These were found not only in radio shops, but in drug stores, five-and-dime stores, etc. If a tube tested bad you could go to the cashier and purchase a replacement tube, and take it back home with you.
- Heathkit Model O-1 - first Heathkit oscilloscope made from kit. There are only 3 O-1 scopes known to have survived.

21 – Telegraph Office

Background

Western Union had a corporate museum until 1960. When it was closed, half (mostly paper) went to Smithsonian, half to Stu Davis in New Jersey. He operated the National Telegraph Museum in his basement for several years until his health declined. He sold it to Sherman Wolf in Boston, who had ample room for storage of the equipment. When Sherman died his family donated most of his collection to the AWA. One 26 foot truck and one 16 foot truck were required to move the collection. Some of this equipment is on display in the Telegraph Office.

This office represents a typical 1920s telegraph office. On the right desk the typewriter is called a “mill” and has a red front, with only capital letters and numbers, with a slash through the zero. The term mill may come from Henry Mill, and Englishman who patented a device for transcribing letters in 1714.

The left desk is set up as a four wire desk, meaning four outside telegraph wires come into the station and terminate at the desk. Two wires are operational at present, connected to the internet. One is Reuters News headlines at 20 wpm, the other is reporting live train traffic from the former Santa Fe Railroad Middle Division in Kansas. The other two may someday be connected to other areas of the Museum.

Calling sounders along wall are directly connected to incoming wires; each telegraph office had its own call. Museum's is DW after Davis-Wolf. Canandaigua was CA, Holcomb "EF" and so on.

Placing the cordless plug into a wire jack connected that wire to a more sensitive sounder and the key. Telegraph key could be then be used to call other stations on the wire and send traffic. The sounder typically had a tobacco can that was used to amplify the sound of the ticker.

Telegraph was widely used on the railroads, each station had a telegrapher to report train traffic by the station. Report was called an "OS" (for on sheet, possibly) which was recorded by the dispatcher ("DS") on a large spread sheet on his desk. The dispatcher could issue train orders via telegraph to stations, which would deliver the typed orders to train crews. Orders typically modified scheduled meeting points to keep traffic flowing and prevent collisions. Last known train order issued via telegraph was in 1982 on the Burlington Northern RR in Montana.

Commercial messages were also received and sent at the office. Messengers would deliver the telegrams or they could be picked up at the office. Often telegrams were received when something bad had happened. Otherwise it was used for business. Then WU promoted telegraph greetings of a friendly nature ("Candy-gram").

Telegraph was the first job that accepted women in an office environment; long before there were women secretaries there were women telegraph operators, who were paid the same as their male counterparts. Telegraph allowed operators on a line to interact with one another sight unseen during lulls in traffic. This was essentially the first "chat room" as ladies and men could talk freely; this gave rise to "telegraph romance" novels and a few are still available on line. There are also biographies of women operators.

In the 1930s President Ronald Reagan was a sports announcer before he became an actor then politician; when he worked at station WHO in Des Moines, IA he would sit in the studio and recreate Chicago Cubs baseball games from telegraph messages received from the stadium. (During one game between the Cubs and Cardinals, the wire went dead with the teams tied going into the 9th inning. Reagan smoothly created a fictional play-by-play with a lot of foul balls, until the wire was restored.)

On the Jay Leno show of May 13, 2005 a competition was held between two teens texting and two skilled amateur radio operators sending CW. They were to send the same message to their counterparts and read the message when done. The telegraphers (K7JA and K6CTW) won. They used Yaesu transceivers and a Bencher paddle with an approximate rate of 29 wpm. The texter was a world text-messaging champion.

The acronym “POTUS” (President of the United States) was originally Phillips Code. Telegraph ops were paid well. Morse KOB is a free downloadable program.

In the United States the final commercial Morse code transmission was sent from the Globe Wireless master station near San Francisco. The final message on July 12, 1999 was Samuel Morse's original 1844 message, "What hath God wrought", and the prosign "SK" (Maritime Radio Historical Society).

American Morse code was used in land line telegraphy and by the railroad exclusively, while International Morse is used by amateur radio and commercial radio operators worldwide.

Horace Martin invented the Vibroplex in Norcross GA. around 1909.

22 - Telegraph and Teletypewriter

Exhibit plaque

> The invention and development of the Telegraph in the 1830s by Shilling & Morse introduced instantaneous, long distance, two-way communication to the world. Although initially communication over wires, the Telegraph set the stage for wireless communications.
>
> Almost as soon as the Telegraph came into general use, ways to make it print messages directly (instead of relying on highly trained operators) were investigated. Early versions of the “Printing Telegraph” were built and patented in the 1850s. But they did not become practical until the early 1900s.

Background - Early History of Digital Communications

Printing telegraphs were invented to send and receive messages, which meant that operators did not need to know Morse code. Skilled women telegraph operators were the equal of men in pay and responsibility while telegraphy was used, but lost this equality when the teletype took over because the job paid less.

Emile Baudot was the inventor of the first means of digital communication in the 1870s. He was looking for an alternative to the telegraph, which required highly trained people. He devised a 5 digit code for each character in the alphabet. His printing telegraph had only 5 keys, requiring the operator to memorize the 5 digit code for each character. The best speed of operation was 50 words per minute with a skilled operator. On the receiving end the message was printed on a paper strip.

Baudot also invented time division multiplex where four messages could be sent simultaneously on a single wire. Commutators (multiplexers) at each end connected to the individual typewriters; this allowed only one typewriter at a time to send a code over the wire. At any given time the commutators connected the corresponding units at each end. Commutator motors were synchronized using a tuning fork

The Murray system allowed the operator to punch a paper tape, which would be fed into tape transmitter for sending. At the other end, the receiver was connected to a printing mechanism that would print on a paper tape. It introduced control characters – CR (carriage return), LF (line feed) etc. Punch tape for replicating messages was much faster than typing.

In 1930 AT&T bought Teletype in an attempt to create a teletypewriter exchange system (TWX) similar to the telephone exchange system. In Europe a similar system was called Telex. A message was typed and punched onto a paper tape; a special tape reader sent the message over telephone lines or a radio link to the desired recipient. At the receiving end the teletypewriter would type the message, then shut off. This was essentially the first electronic mail system, first used in 1930.

Teletypes are quite complex but very problem free. Dependable, but heavy.

Items of Interest

- Printing telegraph - first piece of digital communications equipment built in 1900 after patent of Emil Baudot.
- Kleinschmidt Electric Co. Model 20A typewriter made in the 1920s, designed for Western Union
- Morkrum model 12 printer – Morkrum was using “teletype” as a brand name by 1924, when they merged with Kleinschmidt. Western Union gave them a large order for 10,000 units.
- Western Union 2B printer printed on gummed paper
- In 1928 Morkrum-Kleinschmidt renamed the company to Teletype Corp.
- Teletype Corp. Model 15 – a Signal Corps version of the TG-7-B manufactured in 1943; prior to this the military did not use teletype due to its expense. The TG-7-B teletype was manufactured between 1930-1950 and used by businesses and news stations up until the 1960s.
- Western Union model 103 teletypewriter, built by a typewriter firm for about half the cost but was not as reliable.
- TT-4/TG built for the Signal Corps by Kleinschmidt – Signal Corps wanted a smaller, lightweight unit for tactical applications. Built from 1950 to 1985.
- Teletype Corp Model 28 page printer, 1950-1981 – the Navy needed more stable paper platform than was possible on the Model 15 so this model was developed. It could do up to 100 wpm.
- Teletype in the wooden case is an East German teletype with both Cyrillic and English characters on the keys. First printer to print in two different languages. This model was used on the first Moscow - Washington hot line. Built by Siemens Corp. whose plant was

in Berlin during WW II. They relocated the plant to a different part of Germany which later became East Germany. Siemens had to build another plant in West Germany.

- Teletype news coming out over the internet set-up here. This uses “internet teletype” (ITTY) from on-line sources. The two-tone signal is demodulated to form electronic pulses that control the model 28.
- Teletype Corp. AN/UGR-10 Model 28 “Waterfall” printer – four printers in one to monitor four different circuits, used by Navy in shipboard and shore stations. Up to 100 wpm.
- TT-76 Reperforator sends and receives messages on tape. The operator could prepare messages for later transmission. Operates at 60 or 100 wpm. Note special mechanism that indicated “carriage return”.

23 - Voice of America

Exhibit plaque

The Jack R. Poppele Transmitting Station
Director – Voice of America 1953-1956
A visionary and pioneering radio engineer committed to excellence in broadcasting.
A man with a heart and voice for all the people

Background

What is the Voice of America? That is a question that cannot be answered in a few words given the gigantic scope of VOA operations. In essence, the VOA is you speaking your thoughts, words, and suggestions of freedom to the peoples of the world. President Dwight Eisenhower said the purpose of the VOA “is to submit evidence to the peoples of other nations…that the objectives and policies of the United States are in harmony with and will advance their legitimate aspirations for freedom, progress, and peace.”

Many people may not have heard of the Voice of America and what a major long-term impact it has had in the struggle for freedom since 1942. They do not know that people risked their very lives to listen to VOA. In the U.S. we assume freedom of news and public information. But that has not been, nor does it continue to be, the case in many countries around the world. Freedom is not free.

In mid-1941, President Roosevelt established the U.S. Foreign Information Service (FIS) and named speechwriter Robert Sherwood as its first director. Driven by his belief in the power of ideas and the need to communicate America's views abroad, Sherwood rented space for his headquarters in New York City, recruited a staff of journalists and began producing material for broadcast to Europe by the privately-owned American shortwave stations. Sherwood also spoke with officials in London about the prospect of relaying FIS material over the facilities of the British Broadcasting Corporation (BBC).

In December 1941, FIS made its first direct broadcasts to Asia from a studio in San Francisco. On February 1, 1942— less than two months after the United States entered World War II--FIS beamed its first broadcast to Europe via BBC medium- and long-wave transmitters. Announcer William Harlan Hale opened the German-language program with the words: “We bring you Voices from America. Today, and daily from now on, we shall speak to you about America and the war. The news may be good for us. The news may be bad. But we shall tell you the truth.”

Basically, the initial role of the VOA was to overcome propaganda from Germany and Japan (Tokyo Rose), and to share who and what America and freedom was all about. The programming included news, music and commentary.

By June 1942, VOA was growing rapidly and had a new organizational home--the Office of War Information (OWI). Twenty-three transmitters had been constructed and 27 language services were on the air when the Allied summit took place in Casablanca. By the end of the war there were 39 transmitters broadcasting in 40 languages. At its peak VOA broadcast in 55 languages including Special English, which was limited to 1500 words and spoken at a slow rate so listeners could translate and so learn English. By law the VOA was not allowed to broadcast to US citizens so as not to propagandize them.

Three VOA transmission facilities in the US were built during WW II at Bethany, OH; and Dixon and Delano, CA. Bethany was built by the Crosley Corporation; Delano was built by CBS; and Dixon was built by NBC. In the 1980's, a modern transmitter complex was built in Greenville, NC. Today, all but the Greenville facilities have been closed. Towers and buildings remain at Delano, and a VOA museum has been established at the Bethany site.

Insight: Before the Polish revolution, Polish musicians were fascinated by the jazz music they heard on VOA. Jazz was such an American unique art – ultimate freedom for a musician: time signature, key signature, and have fun. Communist Poland directed the style of music to be played, and banned the playing of American jazz. Musicians could relate to what freedom felt like, musically, and helped overthrow Communism.

Items of Interest

- AWA requested and received the Delano Station control room and one of the 250,000 watt Collins 821A-1 auto-tune transmitters from the VOA and the General Services Administration. The Collins transmitter was one of three located at the Delano Station which is 130 miles north of Los Angeles. The facility was built in 1944 and served all of Central and South America and the Pacific Rim countries. It served as a relay station, as all programming came from either Washington DC or New York City, and measures were taken to ensure that no local program content was possible. It was closed in November 2007. In 2013, the station was to be sold for scrap. In an effort to save one of the Collins transmitters, AWA and the Collins Collectors Association applied to the GSA and VOA for a transfer of the control room and one transmitter to the Museum for a display. In 2014, GSA approved the application with the stipulation that AWA had two weeks to pick up

the equipment. A team of nine went to the site, dismantled, packed and shipped over 15 tons on two trucks to Bloomfield. It was an amazing effort by that team. Then the staff in Bloomfield had 12 months to put the display together to meet GSA requirements. Physically putting the control room and transmitter back together in the Museum became the project nicknamed "the Heathkit from hell" or the "Erector set from hell".

- Some facts about the 821A-1 transmitter: Built in 1965, 250,000 watts unmodulated carrier, 21 tons, 4CV100000C vapor-phase cooled finals and modulators, each weighing 95 pounds. Frequency range 3.95 to 26.5 MHz, designed to frequency change in 20 seconds thanks to water-cooled capacitors. Power input 4160 VAC three phase, 682 kW at 100% modulation.
- Show modulator and final output tubes, coaxial line section and harmonic filter.

24 - Military radio exhibit – Radioteletype Shelter

Exhibit Plaque

Radio Set, Teletypewriter AN/GRC-46B

U.S. Army 1958-c1990

HF Radio teletypewriter shelter typically mounted on M-37 ¾ ton, 4x4 truck. Used to provide secure, wireless, text messaging between tactical military elements. TT-98 and TT-76 teletypewriters provide page printer and punched tape functions at rates of 60 to 100 words per minute (0.045 to 0.075 Kbps).

T-195 and R-392 provide radio communications in the 1.5 to 20 MHz range at 100 watts output. CV-278 and MD-203 comprise a modem to convert between the radio signal and the teletypewriter DC pulses. The AN/GRC-46 operates on 28 VDC from the vehicle battery or an external generator. Internal motor-generators convert 28 VDC to 115 VAC for the teletypewriter and crypto equipment.

25 – Zenith Radio Collection

Collection of Zenith cabinet and portable “Transoceanic” receivers.

Also models of Harris AN/PRC-150(C) HF and AN/PRC-117F VHF-UHF manpack radios

26 – East wall – Signs and Advertisements

Along the east wall – lots of signage, articles and advertising shown.

27 – Temporary Exhibit and Display cases

Temporary exhibits will be set up from time to time in this area.

There are five glass top display cases in this area.

- Three contain documents and artifacts from the 1934 expedition to Antarctica led by Admiral Richard Byrd. Amory “Bud” Waite (W2ZK) was a radio and electrical engineer who participated in eleven expeditions to the Antarctic and twelve expeditions to the Arctic regions between 1933 and 1965. As a radio operator during the Second Byrd Antarctic Expedition, Waite gained national recognition as one of the three men who rescued Admiral Richard E. Byrd from the Bolling Advanced Base during the Antarctic winter of 1934. His most notable achievement in polar exploration and research was the development during the 1950s and 1960s of a system to measure the depth of ice using radio waves. Waite patented this system, known as radio ice depth sounding.
- Two contain telegraph keys of various types, along with a Clearfield Deluxe TRF broadcast radio receiver in a glass cabinet. Radio was manufactured by Sherman Radio Manufacturing Corp. of New York City.

28 – Max Bodmer Collection

Background

Dr. Max Bodmer was a Swiss scientist who worked for Bell Labs. He led the team that developed a traveling wave tube (TWT) amplifier small enough to fit inside the Telstar 1 satellite. He was a long time AWA member who in later years lived in Zurich, Switzerland. After his death his family donated 127 pieces of his extensive radio collection to the AWA. They paid to have the items crated and shipped from Switzerland to Newark, NJ where a truck picked them up and brought them to the Museum.

The AWA Media Center is named in honor of Dr. Bodmer. An example of the TWT he designed is located in the Media Center.

Items of Interest

- A number of items from his collection are displayed here including the Zenith Stratosphere radio, one of 350 total made, which in 1935 sold for $750. This was the biggest radio Zenith ever made for the home market. In 1935 a number of cars sold for less than this fine radio.
- Another item is the National 500 receiver that he bought but never turned on. It is located in the National section of the display shelves.
- Other items are European radios which are quite different than those sold in the US. One Latvian radio has a display rather than a frequency dial; turning the knob lights up cities where transmitters are located. Display is limited to Europe.

29 – Display Shelves

The shelves contain a wide selection of radio equipment – entertainment radios, commercial and home-brew Amateur Radio equipment, and other examples from manufacturers like National, Heathkit, Hammarlund, etc.

30 - The First Transistor Radio

Exhibit plaque 1

In the period just after the invention of the transistor at Bell Laboratories, several radio receivers, of varying design and complexity, were built to demonstrate the feasibility of using transistors in place of vacuum tubes in radio sets. This is believed to be the last surviving example of those sets and it is the design which most closely demonstrates that eventually put into production by various manufacturers. This set is a superheterodyne type and uses five junction type transistors in the RF and IF stages and four point contact transistors as oscillator, detector and audio amplifiers. No attempt was made at miniaturization. All other components, including cabinet, were typical of those used in tube type portables of the time. It used four batteries weighing approximately 8 pounds with an expected 200 hour operating life at a speaker output of 0.1 watt.

This receiver was a gift of James Troe, a Bell Labs Manager, in November 2001

Exhibit plaque 2

Bell Labs was a great place for innovations, but mother company AT&T often fell short in capitalizing on their inventions. As a monopoly they were not hungry for new products or markets. In the case of the transistor, they sold the rights to others for a mere $25,000 and even offered seminars explaining how to manufacture them.

But one company had trouble obtaining the manufacturing rights. An oil-exploration company in Dallas, Texas had re-invented itself as an electronics company called Texas Instruments. Its leader, Pat Haggerty, wanted to get into the transistor business. Haggerty recalls that Bell Labs was “visibly amused at the effrontery of our conviction that we could develop the competence to compete in the field.” Initially, Bell resisted selling TI a license.

But in 1952, TI did get a license from Bell Labs and also hired one of Bell’s chemists who had worked on the development of the germanium and silicon transistors.

In 1954, transistors were being sold to military contractors for about $16 each. Haggerty knew he had to get the price down to be feasible for the commercial market and thus insisted that his engineers develop a way to sell them for under $3 each, which they did. In looking for a market for his transistors, Haggerty came up with the idea of a pocket-sized radio. He tried to interest RCA and other radio manufacturers to produce such a

radio, but no one was interested. They all said that their customers were happy with the present floor and table models.

Haggerty knew that he needed a new market to produce the sales required for TI's transistors. He convinced a small Indianapolis company that produced TV boosters, Regency Electronics, to join forces and produce a consumer pocket radio. The deal was reached in June 1954, with Haggerty's insistence that the radio be on the market by November in time for Christmas. The Regency TR-1 went on sale for $49.95 that October, and within one year they sold over 100,000 units, one of the most popular new products in history. Thomas Watson, head of IBM, bought 100 of the new Regency radios and gave them to all of his top executives, telling them to start finding ways to use transistors in computers.

Background

The invention of the transistor was done for the telephone industry. Telephone systems had hundreds of repeater amplifiers that used vacuum tubes, and created a huge maintenance issue. After transistorized amplifiers replaced the tube units, Bell engineers wondered what was next. Answer – a transistorized radio – and this led to the development of the first commercially sold portable transistor radio in 1954 by the Regency Division of Industrial Development Engineering Associates (I.D.E.A.) of Indianapolis, Indiana. As transistors gradually replaced the vacuum tube in the electronics market, the term "solid state" became commonplace. It was used to describe an electronic product having no vacuum tubes, and based entirely on semiconductors.

Items of Interest

- The cabinet radio on display was discovered during a clean-up at Bell Labs and was thrown into the dumpster. Brand new employee James Troe took it out and kept it for 30 years and upon his retirement gave it to the museum – along with its schematic documentation. Later in his career Mr. Troe saved the first mobile cellular telephone prototype for donation to the museum.
- Regency TR-1 – the first commercial transistor radio - was the beginning of the world of personal electronics, including radios, digital cameras and computers. The person who donated the Regency TR-1 stipulated that it be shown alongside the Bell Labs prototype.

31 – Hallway – Made in Rochester

- An exhibit of radio products made by Rochester-area companies including Stromberg-Carlson, RF Communications/Harris, Scientific Radio and Microwave Data Systems.
    - Stromberg-Carlson made their own speakers that had red cones. Stromberg was big into hi fi in 1950s but never very popular outside of Rochester. They invented the acoustic labyrinth speaker enclosure which is still used today in Bose

speakers. Biaxial and red cone speakers show development of speaker technology. 1925 Stromberg Carlson neutrodyne AM broadcast band receiver was a prototype portable radio designed for use with batteries. A S-C “Stereo 8” similar to the one on display was installed in the White House in the early 1960s.

32 – Hallway - Miscellaneous

- Philco radio with remote control 1939 – unusable today because the frequencies used then would be interfered with today because of light dimmers, etc.
- Capehart console radio/phono made of rosewood – post WW II - open it up, received the old FM band, has log scale as well as frequency scale, it was rendered obsolete when FM band changed. Has record player that would play a stack of records: Push the white button, would play one, then physically flip it and play the other side, then plays the next. Hasn’t worked in years account it breaks records; unknown if acting up or the records are too old and brittle.
- Very rare Edison console radio just outside the office. Thomas Edison went on vacation for several months, and while he was gone his son decided to get into the radio business. After the elder Edison’s return the radio business was shut down (Edison had a very low opinion radio and believed it would fail). Only a few of these were made. This example came from Olean NY.
- Dow Jones stock ticker tape machine, circa 1940 – used to communicate stock quotations, telegrams, and such. Pocket on right side held scissors.
- Sparton radio made for children, not believed to be a sample. Open back would not be an option today.

33 - Museum Store

The AWA materials located in the Museum Store include books, clothing articles, electronic equipment and small items of interest to the collector. Electronic equipment should be labeled whether or not it has been checked for operation; regardless, it should be clarified that the equipment is not under any type of warranty unless so noted. The Store provides the AWA with some income.

General Security Procedures

Senior Historians are responsible for opening and closing of the museum when assigned by the Museum curator. They have been chosen because of their experience and unique abilities to be a Senior Historian. One very significant responsibility given to a Senior Historian is that of Museum security.

The value of the materials in the Museum is incalculable, and most of it is not replaceable. Even with that in mind, the uniqueness of our collection and the closeness of the radio collecting community make the likelihood of a loss from theft low. What would be disastrous is the consequences of vandalism or fire. And so, focus your efforts in that area.

Make sure there are always two Historians in the building when the Museum is open to the public.

Careful touching of equipment is allowed by visitors, in fact some of the displays are intended to be manipulated by the visitors.

Opening the Museum

1. Entry to the Museum will be made via the rear door using the key fob.
2. Turn on overhead lights at back door.
3. Alarm system - hit "OFF", enter pass code and listen for long beep that ensures alarm is deactivated.
4. Teletype shelter – turn on power strip under shelf.
5. Turn on wall switches (10 unlocked switches total) except the 2-way for rear lights.
6. Turn on shelving lights - a single wall switch to the right of the panels in the Mae West area. (Mae West table radio, on the first display shelf, can't miss it.)
7. VOA transmitter – turn on switch on upper right of audio rack, which is on west side of control console.
8. Turn on temporary display equipment, if present.
9. Turn on power strip in Teletype area, above the 103 machine.
10. Telegraph room:
    a. Turn on plug strip, monitor.
    b. Push power button on computer.
    c. Turn on two lamps.
    d. Turn on display case lights with remote control (behind the jack board).
11. 1925 Radio Store area:
    a. Turn on tube tester, on/off switch is a rotary type in the under side of the top light box (**NOTE**: Leave only one tube out at a time to be tested. If anyone puts in more than one tube at a time, the tester will be damaged.)
    b. Turn on lamp on top of the workbench

c. Turn on two wall switches – one to the left of the workbench, the other on the far wall behind the publications, under the shelf.

12. Philco cathedral radio near bathrooms - use knob to turn on.
13. Turn on the TV display gear – power strips for TV/DVD player and the 1927 spinning disk receiver. Start DVD player.
14. Power to Spark gap transmitters will be turned on/off by Historians giving a tour, using safety key**
15. Discovery Area:
    a. Turn on laptop, wait to boot, then click “Automatic” icon to begin slideshow.
    b. Turn on power strip behind Collins amplifier.
    c. Turn on power to Tesla Coil area using safety key ** (ONLY when giving tour in area)
16. Office:
    a. East wall – turn on AM transmitter and CD player (power strip below). Make sure CD player is set to “repeat ALL.”
    b. West wall – turn on all soffit lights (11 switches total) except those marked/taped.
    c. Turn on breakers marked with yellow or white tape (list is posted on outside of panel door).
17. Turn on DVD player outside Titanic display (on/off controlled by breaker).
18. Gift Shop:
    a. Turn on “OPEN” sign in window.
    b. Turn on wall switch.
    c. Turn on display radio in corner.
19. Retrieve Historian badge from the front desk.
20. Turn on cash register (see Appendix B).
21. Unlock front doors using "skate key" for each side and test to ensure they are unlocked. Replace key in proper location.

** - Safety keys are kept in the top drawer of the front desk.

Closing the Museum

1. Lock front doors using "skate key" for each side and test to ensure they are locked. Replace key in proper location.
2. Make sure everyone is out of the Museum building – check all exhibit areas and the restrooms.
3. Place Historian badges in the top drawer of the front desk.
4. Turn off cash register.
5. Gift Shop:

a. Turn off “OPEN” sign in window.
b. Turn off display radio in corner.
c. Turn off wall switch.

6. Office:
    a. Turn off breakers marked with yellow or white tape.
    b. East wall – turn off AM transmitter and CD player (power strip below).
    c. West wall – turn off all soffit lights except those marked (11 switches total).
    d. Camera monitor stays on.
7. Discovery Area:
    a. Turn off outlet strip behind Collins amplifier
    b. Turn off outlet strip running laptop computer
    c. Verify safety switch on wall is OFF.
    d. Light inside Morse display cabinet remains on.
8. Verify DVD player and monitor outside Titanic display are off.
9. Turn off TV display power strips, and check to see that all other TV sets are also off.
10. Check to see the electrically powered Victrola is off as it generates heat.
11. Verify that safety switch for Spark gap transmitters is off.
12. Turn off Philco cathedral radio near bathrooms.
13. 1925 Radio Store area - Turn off tube tester, lamp on the workbench, and wall switches
14. VOA transmitter – turn off switch behind audio rack.
15. Turn off special/temporary exhibit equipment.
16. Turn off shelving lights - a single wall switch to the right of the panels in the Mae West area.
17. Turn off wall switches (10) except the 2-way for rear lights.
18. Admiral Byrd display cases - no action needed (Note: the TV and DVD will go off with the shelving lights).
19. Teletype shelter – turn off power strip under shelf.
20. Check to see that lights and any equipment are off in Auditorium.
21. Turn off remaining lights with switch to the right of the back door.
22. Alarm panel – with door closed, hit "away" button (three beeps will be heard), leave by rear door within 45 seconds.
23. Make sure door is securely closed and latched.

Appendix A – Teletype Display Instructions

Turn on Power Strip under shelf and above Western Union 103 printer. (Look for "V Power SW V" label on edge of shelf.) This strip controls all the other strips. If some equipment does not turn on, check that their strips are on. The switch above the WU 103 is the only one that needs to be turned off at end of day. Others should remain on.

Make sure the power switch is turned off when closing the Museum.

Receiving Teletypewriter Signals from the Internet

A. Heavy Metal (Internet text reader) Canandaigua Weather to TG-7-B (WW II Model 15) printer.

1. Turn on power strip. Two neon lamps on gray KLI loop supply on floor (under Model 26 unit) should come on. Turn on lap-top computer.
2. On computer LOG ON, click on "OK" (does not need a password). On Desktop, check that Wi-Fi has connected, then double click on "Heavy Metal TTY" icon. (May take a minute to come up if computer is still booting up.)
3. Check that red plug "COMPUTER" from Lap-top serial port is plugged into right side of jackfield.
4. Check that the black plug "TG-7-B" from TG-7-B (Model 15) printer is plugged into any jack on the right hand side of the jackfield.
5. Turn on M15 printer (power switch on front right), it should run closed. On TG-7-B, press [CAR RET], [LINE FEED], & [LTRS] keys to get it ready to copy.
6. Wait for "Heavy Metal TTY Program, v2.5" screen to open. The milliameter plugged into right-hand side of jack field ("COMPUTER - KLI LOOP") should read about 60 ma. From the top menu, select "AWA Museum"; then "Canandaigua Weather".
7. Program goes out onto the Internet and collects the Canandaigua Weather Report from the National Weather Service. Then converts it from ASCII to Baudot and sends it at the desired speed (normally 60WPM = 45 bps) to the "COMPUTER - KLI LOOP".
8. The Canandaigua Weather will be printed and then stop when finished. To stop the printing before it has finished; select "Cancel" in top menu, then select "Cancel I/O & action"
9. Once Heavy Metal has finished, invite visitors to type on TG-7-B keyboard. Then turn TG-7-B power off when finished.
10. When opening Museum, print out a copy of the Canandaigua Weather and post on the clipboard next to the crank wall phone and also a copy for the front desk.

B. ITTY (Internet Teletype - 170hz shift AFSK) through RaspberryPi box to Model 28 printer.

1. When power strip is turned on, RasPi should power up and connect to Internet automatically.
2. Check that Dovetron Terminal Unit is on. Important Dovetron settings are:
    a. LEVEL: 12 o'clock
    b. SIGNAL: 45
    c. MULTIPATH: OFF
    d. NORMAL/REVERSE: NORMAL
    e. MARK: 2125
    f. SPACE: 2295
    g. MODE: MS
    h. THRESHOLD: 12 o'clock
    i. AUTOSTART – MARK/FSK: MARK
    j. AUTOSTART/OFF/MOTOR ON: ON
    k. REC/SEND: SEND
3. After master power is turned on, within 20-30 seconds ITTY AFSK tones should be heard from RasPi box and cross pattern should be seen on Dovetron display. Audio tone level to speaker can be adjusted with control on external speaker (it is independent of audio to Dovetron). Blue LED on RasPi box should be blinking about once every few seconds, showing it is on channel 1 = ITTY.
4. Check that the red M28KSR printer plug is plugged into any jack on the left-hand side of jack field ("FSK CONVERTER"). Turn power switch of M28 on (right-hand side); it should run closed. Press [CAR RET], [LINE FEED], & [LTRS] keys to get it ready to copy.
5. On Dovetron, "MARK" should be set to about 2125 - peak control for max horizontal trace on scope. "SPACE" should be set for about 2295 - peak control for max vertical trace on scope (these may drift some during warm-up). Turn "REC/SEND" switch to "REC". M28 should now be printing.
6. To stop printing ITTY, put the Dovetron "REC/SEND" switch in in "SEND" position. Invite visitors to type on the M28 keyboard and show them the typebox (print head) stored under the keyboard.
7. When finished, turn off the M28 power. Dovetron can remain on for effect.
8. RasPi is turned on and off by master power switch and can remain on while Museum is open. RasPi automatically connects, through Museum's WiFi, to Internet to bring in streaming audio AFSK tones from W2TTY in Arvada, CO. This service was specifically set up to provide content for people to print on their old teletypewriters. For details, see RTTY.com.

C. ITTY AUTOSTART (Internet Teletype - 170hz shift AFSK) to TT-4C/TG printer.

1. In AUTOSTART mode, presence of an AFSK signal at the HAL ST-6 Terminal Unit will turn on the TT-4C printer's motor. When the AFSK tones cease, the motor will be shut off after a few seconds. This provides unattended reception of messages. Since the ST-6 controls the TT-4's power, the TT-4 power switch should be left on.
2. When laptop boots up, it will automatically open a browser window and connect to the ITTY AUTOSTART channel (HTTP://INTERNET-TTY.NET:8030/AUTOSTART).
3. Audio from the laptop is connected to the HAL ST-6; the only way to tell that there is audio being sent to the ST-6 is that, in TUNE position, its meter will read about half scale with audio input.
4. The ST-6 controls should be set as follows:
    a. SHIFT: 170
    b. LIMITER: ON
    c. NORMAL/REVERSE: NORMAL
    d. SLOW/FAST: SLOW
    e. AUTO/AUTO OFF: AUTO
    f. AUTO/MOTOR: AUTO
    g. AUTO/STAND-BY: AUTO
    h. TUNING/LOOP: TUNING
5. Turn on the power to the ST-6. The TT-4B motor will also come on, but then shut down after about 20 seconds.
6. When AUTOSTART browser window opens, within a few seconds, the TT-4 may turn on and start printing. But probably there will be no activity on the channel at the time, no indication on ST-6 meter and the TT-4 will stay off. The ST-6 SPACE and STBY lamps will be on. Just let it stay in standby all day. Eventually, there will be some activity: the TT-4 will turn on, print a message, and then turn off and return to standby mode.
7. When an AFSK signal comes on, the ST-6 will detect it and turn on the printer. When the message finishes and the AFSK signal goes off, the printer will turn off in about 20 seconds. This demonstrates the unattended operation mode. This was a system used commercially and by radio amateurs over HF & VHF radio circuits from the 1950s through the 1980s as an early form of wireless text messaging.
8. The AUTOSTART channel will print any messages sent to the Greenkeys email list. Also, occasional jokes and pictures show up. You can send an email to autostart.itty@gmail.com and it will be printed out on the TT-4.
9. To test the system, double click on the "ITTY" icon on the laptop. A browser window will open and in a few seconds the ST-6 meter should show about a half scale indication. The TT-4 motor should start and the TT-4 should start printing ITTY text. This shows that

everything is set up properly. Close the ITTY browser window. The TT-4 should shut down in about 20 seconds. This step can be skipped when you have a good feeling on how the system should work. Reset the HAL ST-6/TT-4 to Autostart by clicking the AUTOSTART icon on the laptop.

Off-Line Teletypewriter Demos

D. Sending a message from tape. TT-76 Reperforator to TG-7-B printer.

1. Early in the history of teletypewriter message handling, it was found that it was most efficient to prepare a message on perforated paper tape first, and then have a machine send it out at maximum speed. The TT-76/TG was one of the standard units (1957-c1990) in the US Army & Air Force for preparing a tape message. When the message got to its destination, it would be printed out on a page printer. Printers like the TG-7-B (M15) and the TT-4 did not have automatic Carriage Return & Line Feed (aka "word wrap") So the TT-76 keeps track of the number of characters entered for a line and signals the operator when it is time to enter the Carriage Return and Line Feed commands.
2. Set lever on TT-76 tape reader to lowest position, "FEED RETRACT". Insert tape and close cover. Move lever to mid position "STOP" and pull tape slightly until tape feed pins engage. "SELECTOR" switch on right side of TT-76 should be set to position 2 (TD SEND/LOCAL REPUNCH). Turn ON all three switches on left side of TT-76.
3. Ensure that TG-7-B is turned on and TT-76 plug is in same area of jackfield as TG-7-B plug. Move tape lever up to "START" position. Message should print out on TG-7-B. Tell guests that the TT-76 and TG-7-B could be thousands of miles apart. Note that a bell signal can be sent to wake up operator at TG-7-B that an important message has come in.
4. Remove tape and queue it up for next time as described in para. 2, above.
5. Turn off TT-76 and TG-7-B.

E. Model 28 Multiple Printer Monitor Set. Aka "Waterfall"

1. This is one of the largest machines made by Teletype Corp. It is designed to monitor up to four circuits and was used in many large US Navy communications centers, ashore and afloat. It was also used by the US Army and Western Union.
2. In high security areas where Top Secret classification messages were received, extra shielding was used on teleprinters. This unit has been modified to meet the high security "TEMPEST" requirements.
3. In normal operation, this unit would be set up to monitor four separate circuits. For this demo, we have a test set sending a test message to all four printers at 100 words per minute (75 bits per second).

4. Open the bottom door and turn on the two power toggle switches. A test message is sent to all four printers simultaneously. An individual printer can be observed by moving silver buttons on door toward center and pulling door down. The printer can then be pulled out. Note the selector magnet on the right side, which converts the electrical signals to mechanical motions, is in a shielded box to prevent unwanted radiation of classified material.
5. Turn off the two toggle switches when finished. The test box can be left on.

Teletypewriter Exhibit Notes

1. All jacks on left side of jackfield ("FSK CONVERTER") are tied together and fed by the output of the Dovetron Terminal Unit, which includes loop supply;
2. All jacks on right side of jackfield ("COMPUTER - KLI LOOP") are tied together and powered from the gray KLI loop supply on floor below and keyed from the lap-top's serial port through the computer's red plug.
3. Some jacks are a little intermittent. If something doesn't work when you have changed a plug, make sure the plug is in all the way or try another jack.
4. TG-7-B and M28 can be plugged in any jack on either side.
5. Heavy Metal and ITTY can be run simultaneously.
6. If a teletypewriter is running and making noise, but not printing anything, it is said to be "running open". This is generally due to loss of current in the loop. Check loop power supply and connections. If teletypewriter motor is running, but machine is otherwise quiet and not trying to print anything (this is the normal standby mode), it is said to be "running closed."
7. RasPi box generally is OK with just having power shut off and then will start up again when power is reapplied. However, it might get confused. To reboot it, shut it down by pressing pushbutton switch until green LED inside box starts blinking. It will then shut down, blue LED will shut off, but red LED will stay on. Then cycle power on RasPi box and it should reboot and operate normally. When it powers on, there is nothing that needs to be done. It automatically goes out onto the Internet and in about 20-30 seconds, ITTY AFSK tones should be heard. If nothing is heard, check lap-top computer to see if it has WiFi connection. Both RasPi box and lap top computer connects to Museum's "BLDG1" WiFi router. Also check blue LED. It should only be blinking once every few seconds. If it is doing a double blink, it has switched over to channel 2 = Autostart. Give the button a quick press and it should switch back to channel 1 = ITTY.
8. Sometimes TT-76 tape reader sends "garble" (junk) when it hasn't run for a few days. (I think I have fixed it). If TG-7B prints garble from TT-76, let the tape finish, then try it again, until it prints correctly. Then it should be OK for the rest of the day.

9. Note that “Teletype”, like “Xerox”, is a brand name and should not be used generically. General terms used for these machines are: “printing telegraph”, “teleprinter” and “teletypewriter.”
10. ITTY Europe uses different tones, but can be tuned in with the Dovetron:

	ITTY Arvada	ITTY Europe
Mark	2125 cps	1275 cps
Space	2295 cps	1445 cps

Appendix B - Cash Handling Procedures

This section explains how cash transactions are to be handled at the front desk.

Entrance Admissions

1. The Historian handling the front entrance will ask visitors if they would like a tour and encourage same. Many people enter expecting this to be an antique shop and not a museum. Explain it is not an antique shop but the Museum store is open for them at no charge.

2. Explain to the guest that admission is $10.00 per person, $9.00 for active military, veterans and seniors. Kids and teens are free. AWA members are also free.

3. Have guests print (not sign) their name the log. Printing makes recording the entries much easier.

4. The Museum accepts cash, check or VISA via Pay Pal. The VISA/PayPal iPad is in the office and requires a separate training experience and is best explained in person. There are two passwords needed to access this system.

5. Place cash or checks received in the cash register. This allows any currency to be secure at all times. Refer to the Cash Register Transaction section for detailed information.

6. Type in the cost of the admission as a total or multiple entries into the register. Then hit CASH with the amount tendered. (I need to check this in person.) The register will provide the amount of change to be returned, if any. Remit any change.

If sale is via VISA/PayPal see separate card reader procedure and examples. There is no need to use cash register. Stan should be notified via email when the card reader is used.

Store Items

Store items are rung up on the cash register but for tax purposes special procedures must be used to properly document each sale.

1. There is a sales receipt book on the counter. Write up the sale with: date, cash/check/credit, name of purchaser if possible, name of product, quantity and price. The total for all purchases is taxed 7.5%. There is a calculator nearby to so the math.

2. If purchaser is an AWA member they get 10% off. The discounted price is taxed 7.5%.

3. Once the sales receipt is completed, annotate the tax log (sample attached) with date, sales book receipt number, price before tax and the tax amount collected. The yellow receipt goes to the customer.

4. Go to the cash register. Insert the item prices and the type of item (books, clothing, used items) when in doubt hit anything EXCEPT admission. Hit SUBTOTAL and then CASH. The register will print a receipt stub. Tear off the stub and annotate it with the sales receipt number and place it on the clipboard with the tax log.

The tax log, receipt book and register stub goes to Stan for safe keeping as they are the only way we can prove to the state we collected tax per their regulations.

6. Offer the buyer a plastic bag if multiple items have been purchased.

Information: Stan does all the opening, set-up and closing of the money to be reconciled. The tax is reported every 90 days on-line soon after the first day of December, March, June, September. Four (4) times a year. AWA has an account with the bank devoted only to tax withdrawals by the state via the state website.

Gift Certificates

The AWA offers gift certificates good for admission and the store. Sometimes a certificate could be only for a tour(s).

After Hours

For After Hours events people generally pay in cash and a pack of tickets for the event is behind the desk. People who pay that evening do not need receipts. The register is not used for these transactions, however storage of the cash should be via the register before and after the event.

Cash Register Transaction Examples

At Start of Museum Shift

1. Turn on power switch – just above drawer on right side of cash register.
2. Insert register key (it is in the desk drawer) and turn to "REG"; remove key and put back in desk drawer
3. Enter "1" then push "Clerk ID" key

NOTE: DO NOT USE THE DECIMAL POINT ON THE KEYBOARD

Transaction examples:

Example 1: Purchase of $10.00 Book and $15.00 CD:

1. Register Entry
    a. Enter "1 0 00" or "1 0 0 0" and push "Books" key
    b. Enter "1 5 00" or "1 5 0 0" and push "CDs" key
2. Payment:
    a. Push "Subtotal" key
    b. Enter cash received ($30.00) enter "3 0 00" or "3 0 0 0" and push "Cash" key
    c. Drawer opens and cash register indicates "$5.00 Change"

Example 2: Purchase of 3 of same items such as 3 adult admissions at $7 each:

1. Register Entry

a. Enter “3” and push “@/For” key
b. Enter “7 00” or “7 0 0” and push “Admissions” key – total shows $21.00

2. Payment:
    a. Push “Subtotal” key
    b. Enter cash received ($21.00) enter “2 1 00” or “ 2 1 0 0 “ and push “Cash” key
    c. Drawer opens and cash register indicates “$0.00 Change”

NOTE: If visitor gives you money and says keep the change, make the change and put change in the donations radio as a donation.

TO OPEN CASH DRAWER – push “#/NO SALE”

TO CORRECT ENTRY ERRORS OR TO TURN OFF ALARM SOUND – push ”CLEAR”

At End of Museum Shift:

1. Turn register key off with key from desk drawer and put the key back in DESK DRAWER (not cash Register)
2. Turn off power switch on right side of cash register

Sample Tax Collection Log

AWA

SALES TAX COLLECTION LOG

1. PLEASE ANNOTATE BELOW WHEN A TAXABLE ITEM IS SOLD: BOOKS, CLOTHING, MEDIA, SOUVENIRS etc.
2. RECORD SERIAL NUMBER FROM RECEIPT BOOK
3. ATTACH SALES SLIP FROM REGISTER TO CLIPBOARD

DATE OF SALE	RECEIPT BOOK SERIAL NUMBER	AMOUNT OF SALE	TAX COLLECTED

Appendix C – Donation Procedures

In case a visitor wishes to donate an item or items to the Museum, the following guidelines and information should help the Historian understand what to do and say when a donation is received, and what happens to it afterward.

1. The Museum does not accept radio consoles unless they are unusual or are approved by the Curator.
2. The Museum does not accept TV sets at all.
3. The Museum will accept small radio sets or other items.
4. If in doubt ask the Curator when possible.
5. If the donor has the item at home, ask him/her to give us a photo and written description first.
6. Inform the donor that:
    a. Any duplicate item is compared to other similar items in the collection
    b. We cannot give back the item once it is donated

The Registrar's Role

1. The donation is entered into the Past Perfect database, which generates a donation letter.
2. Donor must sign letter
3. The Museum cannot give a monetary value to any item, as Internal Revenue Service regulations do not accept our value estimate.
4. Donation is assigned a GUI number (pronounced gooey) which means the item is in "Gift Status." The Museum can keep, sell or discard at will any item in gift status.
5. If an item is unique and the Museum wishes to add it to the permanent collection, the item is accessioned. Criteria for accessioning are contained in rules of the Museum charter.
6. Accessioned items are under protection of the State and cannot be sold or otherwise dispositioned unless the reason for doing so meets one of ten reasons directed by New York State.
7. Accessioned items will have a bar code label with a RED DOT in an O
8. Books and random parts are not accessioned.

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Appendix D – Stories

Ed Gable and the 5,000 feet of wire:

”In the mid-1990’s, pioneer Swedish Alexanderson Alternator station SAQ wanted to do something special for the AWA and SAQ’s anniversary. They decided to send a special message to the AWA convention. Big Deal! Bruce Kelly wanted to make sure the AWA would be able to receive SAQ at the Annex building and appointed myself and Steve Sykes, KD2OM, to build the necessary antenna. As we found a 5,000 foot roll of army surplus field telephone wire in the backroom, we decided on a BOG (Beverage on Ground) antenna. We started at the annex building and went straight north to a hedge row, turned northeast and followed that until we ran out of wire! The appointed Saturday morning of the event Steve and I set up the equipment at the Annex and I walked out to the back to retrieve the antenna wire and it was gone! All 5,000 feet of it, just gone. It was stolen by a copper thief, I guess. A hurried effort to build a loop antenna failed but we did hear the message! One the attendees was from Sweden and he knew the telephone number at the SAQ site. We went to Bruce’s house called the TX site and the very loud transmitter could be heard clearly over the phone. And there you have it.”

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