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Chapter 1

What is Amateur (Ham) Radio?

For more than a century, a growing group of federally licensed radio hobbyists known as Amateur Radio — or "ham radio" — operators has had a front-row seat as radio and electronics have broadened our horizons and touch virtually all of our lives. Hams pioneered personal communication, even in the days before the telephone and household electricity were commonplace and the Internet not yet conceived. The word "radio" — or "wireless" — still evokes awe.

Today we enjoy wireless amenities that range from the ubiquitous cell phone to diminutive "netbook" PCs than can go just about anywhere. Personal communication is the goal. Wireless radiocommunication lets us reach out via voice or text message or tells us — literally — how to navigate in strange surroundings. Printers and scanners now can communicate wirelessly with your PC. Radio signals can even automatically set your clock to the precise time. In this chapter, Rick Lindquist, WW3DE, provides a broad overview of Amateur Radio activities and licensing requirements.

1.1 Do-It-Yourself Wireless

Ever evolving, Amateur Radio has always been what its participants bring *to* it and what they make *of* it. "Make" is a key word in ham radio, since many enthusiasts still enjoy building their own radio communication equipment and electronics. It is in such "hands-on" activities that this *Handbook* often comes into play.

Hams also "make" contact with each other using equipment they've bought or built, or a combination of the two, over a wide range of the radio spectrum, without the need for any external infrastructure — such as the wired or cellular telephone network or the Internet.

The methods hams use to keep in touch range from the venerable Morse code — no longer a licensing requirement, by the way — to modern digital modes and television. The marriage between Amateur Radio and computer technology grows stronger by the day as hams invent ever more creative ways to make computers and the Internet essential station components. The wonder of software defined radio (SDR) techniques has even made it possible to create *virtual* radio communication gear. SDRs require a minimum of physical components; sophisticated computer software does the heavy lifting!

1.1.1 Something for Everyone

Amateur Radio offers such a wide range of activities that everyone can find a favorite niche. As one of the few truly *international hobbies*, ham radio offers the ability to communicate with other similarly licensed aficionados all over the world. The competition of "radiosport" — just to pick one activity many hams enjoy — helps operators to improve their skills and stations. Further, ham radio offers opportunities to serve the public by supporting communication in disasters and emergencies, and it's a platform for scientific experimentation.

Ham radio has extended its horizon into space. The International Space Station boasts a ham radio station, and most ISS crew members are Amateur Radio licensees. Thanks to the Amateur Radio on the International Space Station (ARISS) program, properly equipped hams can talk directly with NASA astronauts in space. Hams contact each other through Earth-orbiting satellites designed and built by other radio amateurs, and they even bounce radio signals off the Moon and to other hams back on Earth.

Hams talk with one another from cars, while hiking or biking in the mountains, from remote campsites or while boating. Through a plethora of activities, hams learn a lot, establish lifelong friendships and, perhaps most important, have a *lot* of fun. Along the way, radio amateurs often contribute some of the genius behind the latest technological innovations.

In all likelihood, you're already a ham or at least have experimented with radio and electronics yourself and are thinking about becoming one. This *Handbook* is an invaluable resource that reveals and explains the "mysteries" governing electronics in general and in radio — or wireless — communication in particular, especially as it pertains to Amateur Radio.

HAMS ARE EVERYWHERE!

Amateur Radio is open and accessible to everyone. Hams are mothers, fathers, sons and daughters of all ages, ethnic backgrounds and physical abilities who are part of a unique worldwide community of licensed radio hobbyists. These individuals come from all walks of life. Some are even well-known celebrities. They have one thing in common, however.

Fig 1.1 — Hams travel around the world, putting rare and unusual locations "on the air" to make thousands of contacts. The VP8ORK team traveled to Antarctica's South Orkney Islands by sea, operating from tents as shown here. Team members such as Nodir Tursoon-Zadeh, EY8MM, came from as far away as Tajikistan to participate. (*W7EW photo*)

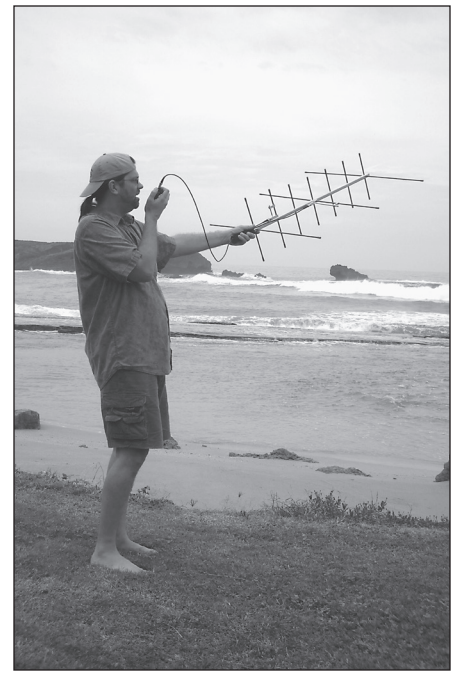

Fig 1.2 — Hams can use simple antennas and hand-held radios to contact amateur satellites, even the International Space Station. Sean Kutzko, KX9X, took his satellite gear along during a vacation to Puerto Rico, making contacts via the AO-27 orbiting "bird." (*N0AX photo*)

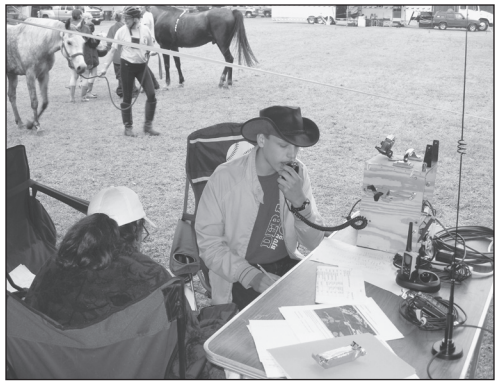

Fig 1.3 — Hams often provide communications for public events as training. In this photo, Philip Beach, KJ4MWM, is keeping track of riders at the Broxton Bridge Plantation Endurance Ride. (*NC8N photo*)

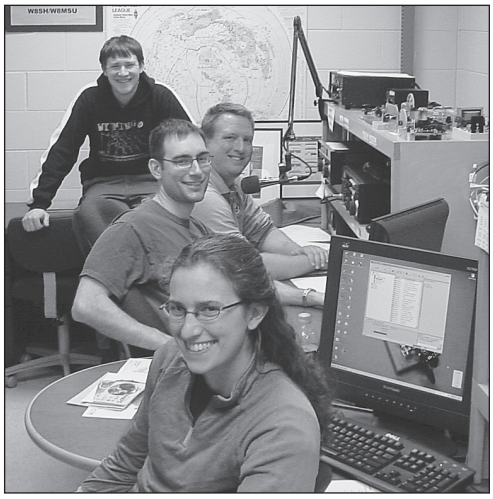

Fig 1.4 — Ham radio contesting or "radiosport" spans the globe, attracting thousands of participants. Taking time out from the fall semester, the Michigan State University Amateur Radio Club, W8SH, operated in the annual November Sweepstakes contest's School Club category. Stations participating in Sweepstakes try to contact all 83 ARRL and RAC sections for a "clean sweep." (*WB8LZG photo*)

Fig 1.5 — Amateur Radio is a social activity, too, as hams make friendships around the world. (Above) A recent International Amateur Radio Union meeting found IARU Region 2 President Reinaldo Leandro, YV5AM, from Venezuela conferring with Nobel Prize laureate Joe Taylor, K1JT. (Right) Nearby, longtime IARU volunteer from Senegal, Tafa Diop, 6W1KI, and ARRL Present Kay Craigie, N3KN, were reviewing their work between sessions. (*N3AO photos*)

All find joy and excitement by experiencing radio communication and electronics on a very personal level.

How can you spot a radio amateur? Sometimes it's easy. The driver of that car in front of you sporting an "odd-looking" antenna may be a ham who's equipped his vehicle for mobile operation. Your neighbor on the next block with the wires strung between trees or, perhaps, a tower supporting what looks like a very large television antenna probably is one too.

Modern technology continues to make ham radio more accessible to all, including those on a tight budget or confronting physical challenges. People who are not as mobile as they'd like to be find the world of Amateur Radio a rewarding place to make friends — on the next block or around the globe. It's possible for a ham to control a transmitting and receiving station via the Internet using a laptop computer, even if that station is thousands of miles distant.

For many radio amateurs, a relaxing evening at home is having a two-way radio conversation with a friend in Frankfort, Kentucky — or even Frankfurt, Germany. Unlike any other hobby, Amateur Radio recognizes no international or political boundaries, and it brings the world together as good friends.

Hams at the Forefront

Over the years, the military and the electronics industry have often drawn on the ingenuity of radio amateurs to improve designs or solve problems. Hams provided the keystone for the development of modern military communication equipment, for example. In the 1950s, the Air Force needed to convert its long-range communication from Morse code to voice, and jet bombers had no room for skilled radio operators. At the time, hams already were experimenting with and discovering the advantages of single sideband (SSB) voice equipment. With SSB, hams were greatly extending the distances they could transmit.

Air Force Generals Curtis LeMay and Francis "Butch" Griswold, both radio amateurs, hatched an experiment that used ham radio equipment at the Strategic Air Command headquarters. Using an SSB station in an aircraft flying around the world, LeMay and Griswold were able to stay in touch with Offutt Air Force Base in Nebraska from around the globe. The easy modification of this ham radio equipment to meet military requirements saved the government millions of dollars in research costs.

More recent technological experimentation has focused on such techniques as software defined radio (SDR). This amazing approach enables electronic circuit designers to employ software to replace more costly — and bulkier — hardware components. It's no coincidence or surprise that radio amateurs have been among those investigators doing the ground-level research and experimentation to bring this technology from the laboratory to the marketplace. Transceivers built on the SDR model now are making inroads within the Amateur Radio community and represent the likely wave of the future in equipment design.

Affirming the relationship between Amateur Radio and cutting-edge technology, in 2009, Howard Schmidt, W7HAS, was appointed White House Cybersecurity Coordinator. ARRL member Schmidt is one of the world's leading authorities on computer security, with some 40 years of experience in government, business and law enforcement. Schmidt credits ham radio with helping him launch his career. "Building … computers to support my ham radio hobby gave me the technical skills that I need to … start doing computer crime investigations and work on the early stages of computer forensics, in turn enabling me to start working on cybersecurity issues." Hams are often found in industry and the military as technology presses ahead.

1.1.2 What's in it for Me?

As a community *of* communities, Amateur Radio can be whatever *you* want it to be. Whether you are looking for relaxation, excitement, enjoyment or a way to stretch your mental (and physical) horizons, Amateur Radio can provide it — even for those with time and money constraints. However it happens, communication between or among individuals is at the core of nearly all ham radio activities. In its most basic form, ham radio is two people saying "Hello!" to each other over the air, perhaps using inexpensive handheld transceivers or even homemade gear. In "Hamspeak," a two-way, on-the-air communication is known as a "QSO" — an old radiotelegraph, or Morse code, abbreviation often pronounced "CUE-so."

It's nearly as simple for *groups* of hams with common interests to gather on the airwaves to share their thoughts and even pictures. These on-the-air get-togethers are called "nets" or "roundtables," depending on their formality. When hams meet and engage in extended on-the-air conversations, they call it "ragchewing."

Nets often provide an on-the-air venue to find other hams with similar interests both inside and outside of Amateur Radio. Topics may be as diverse as vintage radio, chess, gardening, rock climbing, railroads, computer programming, teaching or an interest in certain types of radio equipment. Religious groups and scattered friends and families may also organize nets. Nets form when like-minded hams gather on the air on a regular schedule. You can find your special interest in *The ARRL Net Directory* search on the ARRL website.

With your ham radio license in hand, you can meet new friends, win awards, exchange "QSL cards" to confirm radio contacts by mail, challenge yourself and others, learn and educate, contribute to your community, travel, generate international goodwill and continue a century-old wireless communication tradition. Let's take a closer look.

1.2 Joining the Ham Radio Community

Although you no longer have to learn the Morse code to become an Amateur Radio licensee, you must have a license granted by the Federal Communications Commission (FCC) to operate an Amateur Radio station in the United States, in any of its territories and possessions or from any vessel or aircraft registered in the US. There is no age requirement, nor do you have to be a citizen to obtain a license a US Amateur Radio license. Children as young as four and five have passed ham radio exams!

In the US, there are three classes — or levels — of Amateur Radio license. From the easiest to the most difficult, they are Technician, General and Amateur Extra class. You must only take and pass a written examination for each license. The higher you climb up the ladder, the more challenging the test and the more generous the privileges the FCC grants. To reach the top — Amateur Extra — you must pass the examinations for all three license classes.

1.2.1 Getting Started

Most people start out in Amateur Radio by getting a Technician license or "ticket," as a ham license is sometimes called. Technicians enjoy a wide, but somewhat limited, range of voice and digital radio operating privileges. These include access to some "high frequency" (HF) or short-wave spectrum (hams have access to HF "bands" or frequency segments in the range from 1.8 MHz to 29.7 MHz), where most direct international communication happens. Most Technician privileges are in the VHF-UHF and microwave spectrum, however. These allow operation on widely available FM voice repeaters. A repeater greatly extends the communication range of low-power, handheld transceivers or mobile

Ham Radio's Rules of the Airwaves

International and national radio regulations govern the operational and technical standards of all radio stations. The International Telecommunication Union (ITU) governs telecommunication on the international level and broadly defines radio services through the international *Radio Regulations*. In the US, the Federal Communication Commission (FCC) is the federal agency that administers and oversees the operation of nongovernmental and nonmilitary stations — including Amateur Radio. Title 47 of the *US Code of Federal Regulations* governs telecommunication. The Amateur Radio Service is governed by Part 97.

Experimentation has always been the backbone of Amateur Radio and the Amateur Service rules provide a framework within which amateurs have wide latitude to experiment in accordance with the "basis and purpose" of the service. The rules should be viewed as vehicles to promote healthy activity and growth, not as constraints that lead to stagnation. The FCC's rules governing Amateur Radio recognize these five aspects, paraphrased below, as the basis and purpose of the Amateur Service.

- Amateur Radio's value to the public, particularly with respect to providing emergency communication support
- Amateur Radio's proven ability to contribute to the advancement of the radio art
- Encouraging and improving the Amateur Service through rules that help advance communication and technical skills
- Maintaining and expanding the Amateur Service as a source of trained operators, technicians and electronics experts
- Continuing and extending the radio amateur's unique ability to enhance international goodwill

The Amateur Radio Service rules, Part 97, are in six sections: General Provisions, Station Operation Standards, Special Operations, Technical Standards, Providing Emergency Communication and Qualifying Examination Systems. Part 97 is available in its entirety on the ARRL and FCC websites (see the Resources section at the end of this chapter for further information).

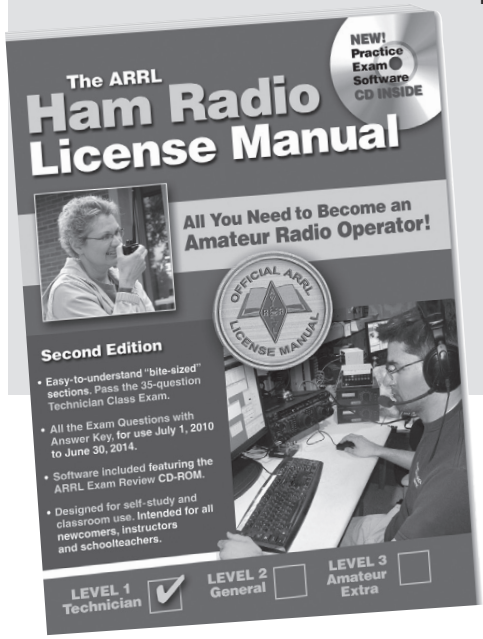

Fig 1.6 — ARRL's *Ham Radio License Manual* contains all the information you need to study for your Technician license.

stations too far apart to transmit to each other directly. The "Tech ticket" is a great introduction to the fun and excitement of ham radio and to the ways of the hobby.

The sole requirement for the Technician license is passing a 35-question written exam. It covers FCC rules and regulations that govern the airways, courteous operating procedures and techniques and some basic electronics. The privileges granted give Technicians plenty of room to explore and activities to try. For some, the Technician is the only ham license they'll ever want or need.

By upgrading to General class, a Technician licensee can earn additional operating privileges, such as access to all of the Amateur Radio HF bands. Upgrading to General entails passing another 35-question written exam. In addition to Technician privileges, General-class hams enjoy worldwide communication using voice, digital, image and television techniques.

Reaching the top rung of the Amateur Radio ladder — Amateur Extra class — means passing a more-demanding 50-question examination. Amateur Extra licensees enjoy privileges on all frequency bands and modes available to hams. The exam may be challenging, but many hams consider it well worth the effort!

1.2.2 Study Guides

You can prepare for the exam on your own, with a group of friends or by taking a class sponsored by a ham radio club in your area. ARRL has materials and lesson plans for hams who wish to teach Amateur Radio licensing classes for newcomers. Anyone can set up license classes. Many Amateur Radio clubs hold periodic classes, usually for the Technician license. The ARRL supports Registered Amateur Radio Instructors, but registration is not necessary to conduct a class. Check the ARRL website, **www.arrl.org**, for classes, clubs or volunteer examiners (VEs) in your area (more on VEs below).

Help is available at every step. The ARRL publishes study materials for all license classes. Visit the ARRL website or contact ARRL's New Ham Desk for more information on getting started. The Resources section at the end of this chapter includes telephone number and address information. The ARRL can help you find ham radio clubs in your area as well as ARRL-registered instructors and local VE teams. A lot more information is on the ARRL website, including frequencies hams can use, popular operating activities and how to order the latest ARRL study guide.

For newcomers seeking to obtain a Technician license, *The ARRL Ham Radio License Manual* includes the complete, up-to-date question pool with the correct answers and clear explanations. The manual assumes no prior electronics background. It delves into the details behind the questions and answers, so you will understand the material, rather than simply memorize the correct answers.

If you already have some electronics background or just want brief explanations of the material, you might decide that *ARRL's Tech Q&A* manual is a more appropriate choice. It also includes the entire Technician question pool to help you prepare.

When you are ready to upgrade to a General class license, *The ARRL General Class License Manual* or *ARRL's General Q&A* can help you prepare. In like fashion, *The ARRL Extra Class License Manual* and *ARRL's Extra Q&A* will guide your study efforts for the Amateur Extra class license. Check the ARRL website for detailed information on these and other options to study for your license.

1.2.3 Taking the Test

While the FCC grants US Amateur Radio licenses, volunteer examiners (VEs) have taken over the task of administering Ama-

teur Radio test sessions. Other countries also have adopted volunteer-administered exam systems. Many ham radio clubs sponsor regular exam sessions, so you shouldn't have to wait long or travel far once you're ready. Exam sessions often are available on weekends or evenings. Most volunteer examiner teams charge a small fee to recover the cost of administering the test and handling the FCC paperwork.

The ARRL is a Volunteer Examiner Coordinator (VEC) and supports the largest VE program in the nation. More information about the VE program is available on the ARRL website.

The questions for each 35 or 50-question test come from a large "question pool" that's specific to each license class. All three question pools — Technician, General and Amateur Extra — are available to the public in study guides and on the Internet. If you're studying, make sure you're working with the latest version, since question pools are updated on a set schedule. The Resources section at the end of this chapter has more information on where to find the question pools.

1.2.4 Your Ham Radio Mentor

Ham radio operators often "learn the ropes" from a mentor. In ham radio parlance, such an experienced ham who is willing to help newcomers is called an "Elmer." This individual teaches newcomers about Amateur Radio, often on a one-to-one basis. Your local ham radio club can pair you up with an Elmer, who

ARRL — the national association for Amateur Radio®

The American Radio Relay League (ARRL) is the internationally recognized society representing Amateur Radio in the US. Since its founding in 1914, the ARRL — the national association for Amateur Radio (as it now is known) — has grown and evolved along with Amateur Radio. ARRL Headquarters and the Maxim Memorial Station W1AW are in Newington, Connecticut, near Hartford. Through its dedicated volunteers and a professional staff, the ARRL promotes the advancement of the Amateur Service in the US and around the world.

The ARRL is a nonprofit, educational and scientific organization dedicated to the promotion and protection of the many privileges that ham radio operators enjoy. Of, by and for the radio amateur, ARRL numbers some 150,000 members — the vast majority of active amateurs in North America. Licensees can become Full Members, while unlicensed persons are eligible to become Associate Members with all membership privileges except for voting in ARRL elections. Anyone with a solid interest in Amateur Radio belongs in the ARRL.

The ARRL volunteer corps is called the Field Organization. Working at the state and local level, these individuals tackle ARRL's goals to further Amateur Radio. They organize emergency communication in times of disaster and work with agencies such as American Red Cross and Citizen Corps. Other volunteers keep state and local government officials abreast of the good that hams do at the state and local level.

When you join ARRL, you add your voice to those who are most involved with ham radio. The most prominent benefit of ARRL membership is its monthly journal *QST*, the premiere Amateur Radio magazine. *QST* contains stories you'll want to read, articles on projects to build, announcements of upcoming contests and activities, reviews of new equipment, reports on the role hams play in emergencies and much more.

Being an ARRL member is far more than a subscription to *QST*. The ARRL represents your interests before the FCC and Congress, sponsors operating events and offers membership services at a personal level. A few are:

- Low-cost ham equipment insurance
- the Volunteer Examiner program
- the Technical Information Service (which answers your questions about Amateur Radio technical topics)
- the QSL Bureau (which lets you exchange postcards with hams in foreign countries to confirm your contacts with them)

For answers to any questions about Amateur Radio, e-mail, call or write ARRL Headquarters. See the Resources section at the end of this chapter for contact information.

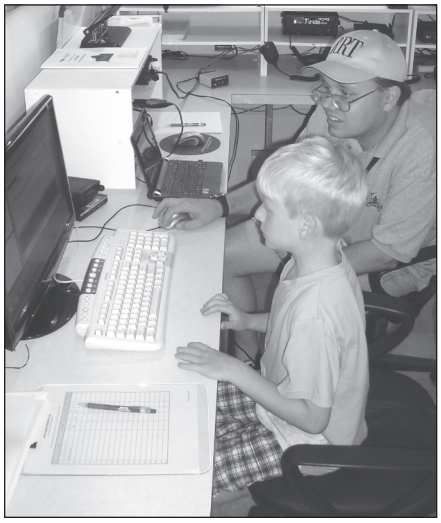

Fig 1.7 — ARRL Field Day is a great opportunity for new hams and visitors to get a look at many facets of Amateur Radio. At the St Charles (MO) Amateur Radio Club, KØA's Field Day operation, the Get On The Air (GOTA) station was visited by Joshua Connell, who made seven contacts with the gentle guidance of GOTA Coach Jeff Coval, ACØSC. (*NØAX photo*)

Fig 1.8 — W1AW, the station operated by the ARRL in Newington, Connecticut, is known around the world as the home of ham radio. W1AW memorializes Hiram Percy Maxim, one of the founders of the ARRL. Visitors are welcome and often operate the station.

will be there for you as you study, buy your first radio and set up your station — which many hams call "the radio shack" or "ham shack." Elmers also are pleased and proud to help you with your first on-the-air contacts.

Elmers belonging to the international Courage Handi-Hams organization focus on making study materials and ham radio station operation accessible to those with physical disabilities. Local Handi-Hams assist such prospective radio amateurs in getting licensed, and the Handi-Ham System may lend basic radio gear to get the new ham on the air.

1.2.5 Your Ham Radio Identity

When you earn your Amateur Radio license, the FCC assigns you a unique *call sign* (some hams shorten this to simply "call"). With your license and your unique call sign, you have permission to operate an Amateur Radio station. Your call sign not only identifies your station on the air, it's a personal ham radio identity, and many hams become better known by their call signs than by their names! US call signs, for example, begin with W, K, N or A followed by some combination of letters and one numeral. Each combination is different. One well-known ham radio call sign is W1AW, assigned to the Hiram Percy Maxim Memorial Station at ARRL Headquarters in Newington, Connecticut.

FCC-assigned call signs come in several flavors, with the shortest — and typically most desired — combinations available only to Amateur Extra class licensees. The FCC typically assigns the longest call sign format to new Technician licensees. These call signs start with two letters, a numeral from 0 to 9, and three more letters. The first part of a call sign including the numeral is called a *prefix*. The part following the numeral is called a *suffix*. Each country in the world issues its own distinctive set of call sign prefixes, which can make it easy to tell where a particular station is. For example, typical prefixes in Canada are VE and VA. The common prefix in Mexico is XE.

At one time, the numeral indicated a US station's geographical region — 1 for New England, 6 for California and 9 or Ø (zero) for the Midwest. The FCC has made ham radio call signs portable, however — just like telephone numbers. So a call sign with "1" following the prefix may belong to a ham located in Florida.

You don't have to keep the call sign the FCC assigns. For a modest fee, the FCC's vanity call sign program permits a ham to select a new personalized call sign from among the database of certain unassigned call signs based on the applicant's license class.

1.3 Assembling Your Station

Amateur Radio costs as much or as little as your budget permits and your enthusiasm dictates. Many thrifty hams carry their stations with them, in the form of relatively inexpensive handheld transceivers, some the size of a typical cell phone. Without requiring any antenna beyond the one on the radio itself, such radios can come along when you're away from home or on a trip. On the other end of the scale, radio amateurs who are serious about radio contesting or DXing (contacting distant stations in other countries) often invest in the latest equipment and large antenna systems. The majority of hams fall somewhere in between, however. They have modest stations, simple wire antennas between two trees and maybe a small "beam" (directional antenna) on a backyard tower. Either way, you'll talk to the world.

Fig 1.9 — Hams enjoy building and comparing antennas — all the way up to the microwave bands! In this photo from the 2010 Microwave Update convention, Kerry Banke, N6IZW (right) is measuring the performance of the 5.7 GHz dish built by Michelle Thompson, W5NYV. (*W1GHZ photo*)

1.3.1 How Much Will It Cost?

Early radio amateurs generally built their own gear — mainly out of necessity; there were no well-stocked radio emporiums in the early 20th century. Constructing ham radio equipment from kits gained a lot of popularity in the mid-20th century. Many manufacturers still provide parts kits and circuit boards to make building even easier. Some hams continue to enjoy designing and building their own equipment (called "homebrewing") and maintain a low fiscal profile as a result. Many of these amateurs proudly stand at the forefront of technology and keep up with advances that may be applied to the hobby. Indeed, the projects you'll find in this *Handbook* provide a wide variety of equipment and accessories that make ham radio more convenient and enjoyable.

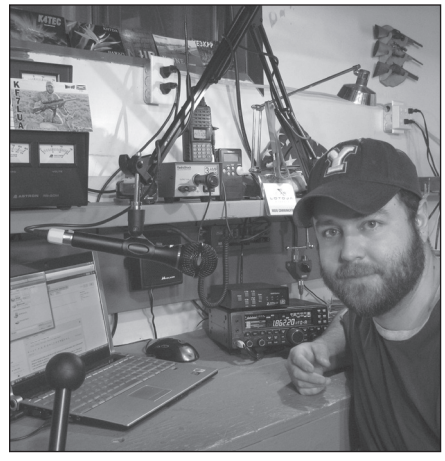

Fig 1.10 — Computers are an important part of most amateur stations. Jordan Johns, KF7LUA, uses a laptop computer for keeping a log of contacts and to control his radio, as shown here getting ready for the ARRL Rookie Roundup competition.

By and large, today's radio amateurs start out using off-the-shelf commercially made transceivers purchased new or on the used market, perhaps at a ham radio flea market or hamfest or from an Internet auction or classified ad site. A plethora of ham gear is readily available, and there's something

Fig 1.11 — John Merritt, K4KQZ, operates mobile from his car and uses a temporary clip-on gooseneck lamp base to mount his radio's control head for clear visibility and safe driving. (*K4KQZ photo*)

out there to meet your needs while not breaking the bank. Used VHF or VHF-UHF (or "dual-band") handheld transceivers can be purchased for $100 to $200, and sometimes for far less.

Those interested in HF work can get in on the ground floor with a used, but serviceable, transceiver in the $250 to $500 range, and there's a good selection of new transceivers available in the $500 to $1500 range. Flea-power transceivers covering single bands sell new for less than $100 in kit form. An HF antenna can be a simple backyard dipole. You'll find some great equipment choices advertised in ARRL's monthly journal, *QST*. In addition to advertising new ham gear, *QST* includes comprehensive equipment reviews.

Antennas and accessories can add appreciably to the cost of your station, but less-expensive alternatives are available, including building your own.

1.3.2 Computers and Ham Radio

If computers are your favorite facet of today's technology, you'll soon discover that connecting your PC to your ham station not only can make operating more convenient but can open the door to additional activities on the ham bands. A majority of radio amateurs have computers in their home stations, often one that's dedicated to ham radio tasks. Probably the most common use for a computer in the ham shack is for logging — keeping a record of — contacts. This is especially true for contesters, where speed and accuracy are paramount. While there's no legal requirement to maintain a logbook of your on-the-air activities, many hams still keep one, even for casual operating, and computer logging can make the task less tedious (see sidebar "Keeping a Log").

Interfacing a PC with your transceiver also can let you control many of your radio's functions, such as frequency or band selection, without having to leave your logging program. It's also possible to control various accessories, such as antenna rotators or selection switches, by computer.

In addition, a soundcard-equipped computer allows you to enjoy digital modes with

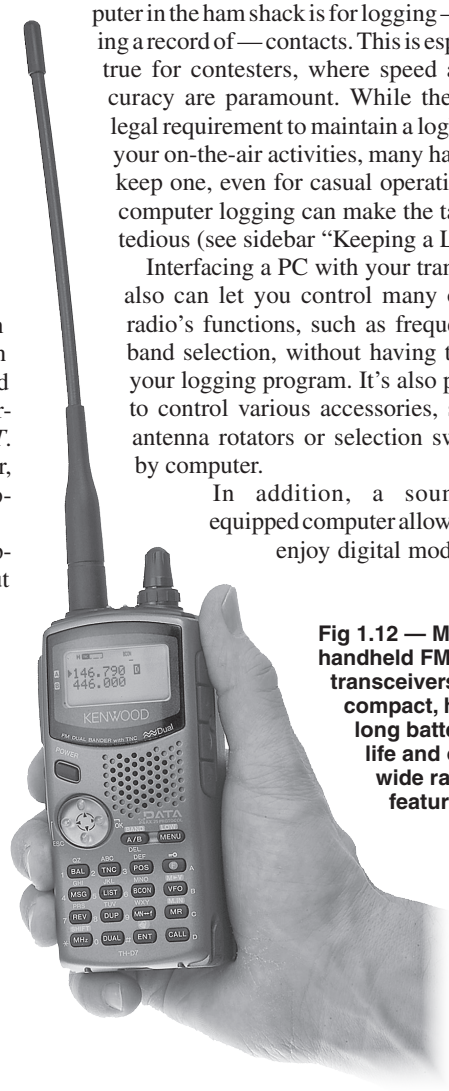

Fig 1.12 — Modern handheld FM transceivers are compact, have long battery life and offer a wide range of features.

Keeping a Log

Keeping a log — on paper or using your computer — of your on-air activity is optional, but there are some important reasons for doing so. These include:

Legal protection — Good record keeping can help you protect yourself if you are ever accused of intentional interference or have a problem with unauthorized use of your call sign.

Awards tracking — A log helps you keep track of contacts required for DXCC, WAS and other awards. Your log lets you quickly see how well you are progressing toward your goal.

An operating diary — A log book is a good place for recording general information about your station. For example, you may want to include comparisons between different antennas or pieces of equipment based on reports from other stations. Your log is also a logical place to make a note of new acquisitions (complete with serial numbers in case your gear is ever stolen). You can track other events as well, including the names and call signs of visiting operators, license upgrades, contests, propagation and so forth.

Paper and Computer Logs

Many hams, even some of those with computers, choose to keep "hard copy" log books. Paper logs do not require power, are flexible and can survive a hard-drive crash! Preprinted log sheets are available, or you can create your own. Computers with word processing and publishing software let you create customized log sheets in no time.

On the other hand, computer logs offer many advantages, especially if you enjoy contesting, DXing or awards chasing. For example, a computerized log can instantly indicate whether you need a particular station for DXCC or WAS. Contesters use computer logs to manage contact data during the contest and to weed out duplicate contacts in advance. Most major contest sponsors prefer to receive computer log files, and some prohibit the submission of paper logs altogether. Computer logs can also tell you at a glance how far along you are toward certain awards and help with printing QSL labels. Computer logs also make it easy to submit your contacts to ARRL's online Logbook of The World (see sidebar).

Computer logging programs are available from commercial vendors. Some are general-purpose programs, while others are optimized for contesting, DXing or other activities. Check the ads in *QST* and take a look at capabilities and requirements before you choose.

Hamfests

Amateur Radio's social world extends beyond on-the-air acquaintances. Regular ham radio gatherings, usually called "hamfests," offer opportunities for those attending to get to know each other in person — called "an eyeball contact" in ham parlance. Hams also enjoy buying, selling and trading ham radio equipment and accessories in the hamfest "flea market." *Every* ham loves a bargain. Others take advantage of classroom sessions or forums to learn more about particular aspects of the hobby.

Hamfests are great places to get good deals on gear — some vendors offer substantial hamfest discounts — and to expand your knowledge. Thousands of radio amateurs from the US and around the world each spring gather at Dayton Hamvention in Ohio. This truly international event epitomizes the goodwill that exists among the world's Amateur Radio enthusiasts.

The annual Dayton Hamvention (www.hamvention.com) attracts upward of 25,000 hams from around the world to meet and greet, learn, buy, sell and trade.

nothing more than a couple of connections, the right software (often free) and an interface. RTTY and PSK31 are two of the most popular HF digital modes. PSK31 lets you talk great distances with a very modest ham station, typically at very low power levels.

Computers also can alert you to DX activity on the bands, help you practice taking Amateur Radio license examinations or improve your Morse code abilities. Many ham radio organizations, interest groups and even individuals maintain websites too. There's software for many ham radio applications, from logging and award tracking to antenna and circuit design.

1.4 *Hello, World!* — Getting on the Air

Amateur Radio is a *social* activity as well as a technical pursuit. It's a way to make new friends and acquaintances over the air that you may later meet in person. Some ham radio relationships last a lifetime even though the individuals sometimes never meet face to face. Ham radio can be the common thread that keeps high school and college friends in touch through the years, with or without e-mail.

Amateur Radio also can cement relationships between radio amateurs of different nationalities and cultures, leading to greater international goodwill and understanding. When you become an Amateur Radio operator, you also become a "world citizen." In return you can learn about the lives of the radio amateurs you contact in other countries.

"*What do hams say to each other?*" you might wonder. When they meet for the first time on the air, hams exchange the same sorts of pleasantries that anyone might when meeting for the first time. Ham radio operators give their name, their location (abbreviated "QTH" by hams) and — specific to hamming — a report indicating how well they're hearing (or "copying") the other station's radio signal. This name-location-signal report pattern typically applies regardless of ham radio mode. With the preliminaries out of the way, hams' conversations often focus on their equipment or other interests.

Although English is widely used and understood on the ham bands, English speakers can make a favorable impression on hams in foreign countries if they can speak a little of the other person's language — even if it's as simple as *danke*, *gracias* or *arigato*.

1.4.1 Voice Modes

We've mentioned the use of voice (or phone) and Morse code (or CW) on the amateur bands. Although more hams are embracing digital modes every day, phone and CW by far remain the most popular Amateur Radio communication modes. Ham voice modes are amplitude modulation (AM), which includes the narrower-bandwidth single sideband (SSB), and frequency modulation (FM). For the most part, SSB is heard on HF, while FM is the typical voice mode employed on

VHF, UHF and microwave bands.

The great majority of ham radio HF phone (short for "radiotelephone") operators use SSB (subdivided further into upper sideband and lower sideband), but a few still enjoy and experiment with the heritage "full-carrier AM." Once the primary ham radio voice mode, this type of AM still is heard on the standard broadcast band (530 to 1710 kHz). Today's AM buffs enjoy its warm, rich audio quality, and the simplicity of circuit design encourages restoring or modifying vintage radios or building from scratch. For more information about AM operation, visit **www.arrl.org/am-phone-operating-and-activities**.

Fig 1.13 — Matt Wilhelm, W1MSW, is making contacts using single-sideband or SSB. The voice modes are the most common way to communicate using ham radio. (*N1FJ photo*)

1.4.2 Morse Code

Morse code was the first radio transmission mode, although it wasn't long before early experimenters figured out how to send the human voice and even music over the airwaves. Morse is also the original digital mode; the message is transmitted by turning a radio signal on and off (a "1" and a "0" in digital terms) in a prescribed pattern to generate individual letters, numerals and characters. This pattern is the International Morse Code, sometimes called the "radio code," which varies in many respects from the original Morse-Vail Code (or "American Morse") used by 19th century railroad telegraphers.

Federal regulations once required that prospective radio amateurs become proficient in sending and receiving Morse code. Although this is no longer the case for any class of Amateur Radio license in the US, many hams still embrace CW as a favorite mode and use it on a regular basis to communicate with one another. Hams typically send Morse code signals using a manual telegraph key or a CW "paddle" and an automatic keyer. Most hams receive Morse code "by ear," either writing down the letters, numerals and characters as they come through the receiver's headphones or speaker or simply reading it in their heads. Accessories, some computer based, have become available that will translate CW signals without the need to learn the code.

Hams who enjoy CW cite its narrow bandwidth —a CW signal takes up very little of the radio spectrum — simpler equipment and the ability of a CW signal to "get through" noise and interference with a minimum of transmitting power. CW is a common low-power (QRP) mode.

1.4.3 FM Repeaters

Hams often make their first contacts on local voice repeaters. These devices, which can greatly extend the useful range of a typical handheld FM transceiver, carry the vast majority of VHF/UHF traffic, making local mobile communication possible for many hams. Located on hilltops, tall buildings or other high structures, repeaters strengthen signals and retransmit them. This provides communication over distances much farther than would be possible without a repeater.

Typically, hams use repeaters for brief contacts, although socializing and "ragchewing" are routine on some "machines," as repeaters are often called. All repeater users give priority to emergency communications.

Most repeaters are maintained by clubs or groups of hams. If you use a particular repeater frequently, you should join and support the repeater organization. Some hams set up their own repeaters as a service to the community.

The best way to learn the customs of a particular repeater is to listen for a while before transmitting. Most repeaters are *open*, meaning that any amateur may use the repeater, although repeaters typically require users to transmit an access tone (which you can set on any modern FM transceiver). A few repeaters are *closed*, meaning that usage is restricted to members. Some repeaters have *autopatch* capability that allows amateurs to make telephone calls through the repeater. The *ARRL Repeater Directory* shows repeater locations, frequencies, capabilities and whether the repeater is open or closed.

Fig 1.14 — Portable or "mountaintopping" operation is very popular on the VHF and UHF bands. In this photo Bob Witte, KØNR, has set up a station atop Mt Herman, near Monument, Colorado. (*KØJJW photo*)

1.4.4 Digital Modes

Radioteletype (RTTY — often pronounced "Ritty") is a venerable data communication mode that remains in wide use today among radio amateurs. While RTTY does not support the features of newer computer-based data modes, it is well suited for keyboard-to-keyboard chats with other stations. It also is the most popular mode for worldwide digital contests and remains in common use among DXers and DXpeditions. RTTY was originally designed for use with mechanical teleprinters, predating personal computers by several decades. Today, Amateur Radio RTTY uses soundcard-equipped computers and dedicated RTTY software.

An HF digital mode for general domestic and DX contacts is PSK31. This mode is particularly effective for low-power (QRP) communication. It's easy to transmit and receive PSK31 using a PC and software — typically free — that operates via a PC soundcard. Quite a few different digital modes use the same basic PC and soundcard setup, and new ones are developed on a regular basis.

Another digital mode, packet radio, is much less popular in today's ham radio world than it was in the 1990s. Packet's most important applications include networking and unattended operation. The most common uses are the worldwide DX spotting network, the Automatic Packet/Position Reporting System (APRS) and regional or local general-purpose networks. Would you like to see what 20 meter stations in Asia have been worked or heard recently by stations in your area? Log onto your local PacketCluster node and find out. Is your friend out of range of your 2 meter packet radio? Send your message through the packet network.

APRS

Developed by Bob Bruninga, WB4APR, APRS or the Automatic Packet/Position Reporting System (**www.aprs.org**) is used for tracking stations or objects in motion or in fixed positions and for exchanging data. It uses the unconnected packet radio mode to graphically indicate objects on maps displayed on a computer monitor. Unconnected packets permit all stations to receive each transmitted APRS packet on a one-to-all basis rather than the one-to-one basis required by connected packets.

As with other packet transmissions, APRS data are relayed through stations called

Fig 1.15 — APRS is a popular ham radio digital mode that allows tracking of mobile stations transmitting beacons via packet radio as they travel.

digipeaters (digital repeaters). Unlike standard packet radio, APRS stations use generic digipeater paths, so no prior knowledge of the network is needed. In addition, the Internet is an integral part of the system that is used for collecting and disseminating current APRS data in real time.

Virtually all VHF APRS activity occurs on 2 meters, specifically on 144.39 MHz, the recognized APRS operating channel in the US and Canada. On UHF, you'll find APRS activity on 445.925 MHz.

Many groups and individuals that participate in public service and disaster communications find APRS a useful tool. Others use it to view real-time weather reports.

1.4.5 Image Communication

Several communication modes allow amateurs to exchange still or moving images over the air. Advances in technology have brought the price of image transmission equipment within reach of the average ham's budget. This has caused a surge of interest in image communication.

Amateur TV (ATV) is full-motion video over the air, sometimes called "fast-scan TV." Amateur Radio communication takes on an exciting, new dimension when you can actually *see* the person you're communicating with. In addition, ATV has proved to be very useful in emergency and disaster communication situations. Amateur groups in some areas have set up ATV repeaters, allowing lower-power stations to communicate over a fairly wide area. Since this is a wide-bandwidth mode, operation is limited to the UHF bands (70 cm and higher).

Digital ATV folds nicely into a recent Amateur Radio technological initiative called high-speed multimedia (HSMM) radio. The ham bands above 50 MHz can support computer-to-computer communication at speeds high enough to support multimedia applications — voice, data and image. One approach adapts IEEE 802 technologies, particularly 802.11b, operating on specific Amateur Radio frequencies in the 2400-2450 MHz band.

SSTV or "slow-scan TV" is a narrow-bandwidth image mode that has remained popular for many years in Amateur Radio. Instead of full-motion video, SSTV is for the exchange of photographs and other images. Individual SSTV pictures take anywhere from 8 seconds to about 2 minutes to send depending on the transmission method. These days most SSTV operation is done in color using computers and soundcards. Images are converted into a series of audio tones representing brightness level and colors. Since SSTV is a narrow-band mode, it is popular on HF on the same frequencies used for voice operation.

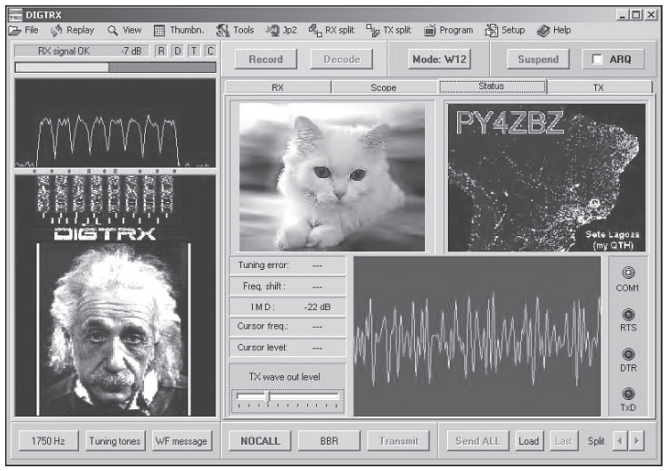

Fig 1.16 — Slow-scan television (SSTV) allows hams to exchange pictures over the air.

1.5 Your Ham Radio "Lifestyle"

After some on-the-air experience, many Amateur Radio enthusiasts focus on a particular mode or operating style and may identify themselves as contesters, DXers, CW ops or VHF-UHF enthusiasts. Others center their operating on such activities as specialized or experimental modes, mobile ham radio, low-power operating (known as "QRP") and radio direction finding.

1.5.1 Ham Radio Contesting — Radiosport

Ham radio contesting, called "radiosport," is growing in worldwide popularity. Hardly a weekend goes by when there isn't a ham radio contest of some sort. These on-the-air competitions range from regional operating events with a few hundred participants to national and worldwide competitions with thousands on the air.

Objectives vary from one event to another, but ham radio contests typically involve trying to contact — or "work" — as many *other* contest participants on the air within a specified period. In each contact, participants exchange certain information, often a signal report and a location, as the contest's rules dictate. A lot of contest scoring schemes place a premium on two-way contacts with stations in certain countries, states or zones. Top scorers in the various entry categories usually get certificates, but a few events bestow sponsored plaques and trophies.

There are contests for nearly every mode and operating preference available to Amateur Radio — voice, Morse code and digital modes. Some members of the contesting community are earnest competitors who constantly tweak their stations and skills to better their scores. Others take a more casual approach. All have lots of fun.

In the ARRL International DX Contest, for example, you'll try to contact as many DX (foreign) stations as possible over a weekend. During such a weekend, experienced hams with top-notch stations easily contact more than 100 different countries! Even a modest

station can contact dozens of countries in a single weekend.

Other popular contests include state QSO parties, where the goal is to contact stations in as many of the sponsoring state's counties. ARRL November Sweepstakes (SS) is a more high-energy full-weekend contest that attracts thousands of operators each fall. One weekend is dedicated to CW, another to phone. VHF, UHF and microwave contests focus on making contacts using our highest-frequency bands. Digital-mode contests have gained in popularity in recent years, thanks to computer soundcards, radios that offer digital-mode capabilities and often-free software.

You can find information on contests each month in ARRL's monthly membership journal *QST;* the contest calendar on the ARRL website also provides up-to-date information on upcoming operating events. The ARRL's bi-monthly publication *National Contest Journal* (*NCJ*) focuses on topics of particular interest to contesting novices and veterans alike. For timely contest news and information, check "The ARRL Contest Update" e-newsletter at **www.arrl.org/contest-update-issues**, available every other week via e-mail and on the ARRL website.

Fig 1.17 — Eric Hall, K9GY/T6MO, is an active contester and DXer whether at home in Illinois or serving overseas. In the photo, Eric is shown at the controls of his Afghanistan station, ready for another session of DXing between missions. *(K9GY photo)*

ARRL FIELD DAY

An emergency communications training exercise with some elements of a contest, ARRL Field Day, held each year on the fourth full weekend in June, attracts thousands of participants. Portable gear in tow, hams take to the hills, forests, campsites, parking lots and even emergency operations centers or vans to participate in Field Day. Tracing its origins to the 1930s, Field Day started out as a way to publicly demonstrate and exercise the ability of hams to operate "in the field" and "off the grid." The goal is not only to make lots of contacts but to operate successfully under conditions you could face in the aftermath of a disaster or emergency.

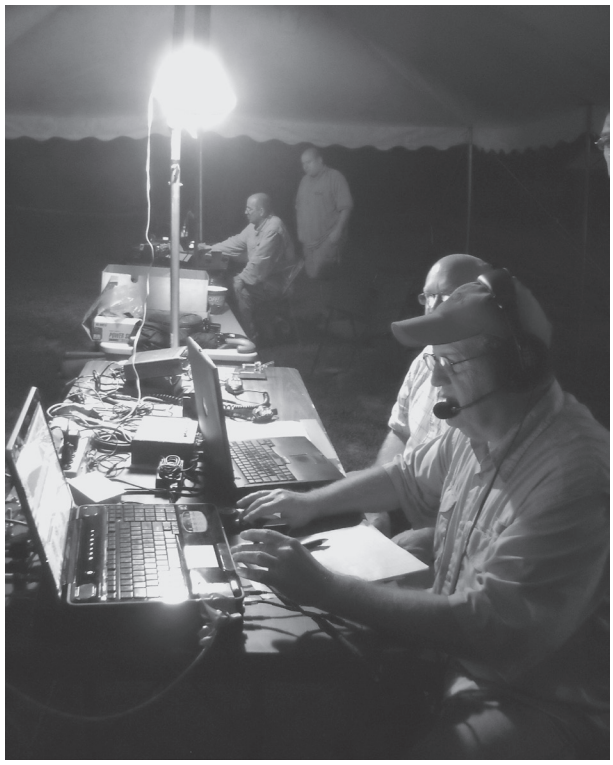

Fig 1.18 — Tens of thousands of hams participate in the 24-hour ARRL Field Day each June. It's the largest Amateur Radio event on the planet! These members of the St Charles (MO) Amateur Radio Club, KOØA, are operating the night shift. (*NØAX photo*)

Most stations are set up outdoors and use emergency power sources, such as generators, solar panels, wind turbines and occasionally even water wheels. Creativity reigns when it comes to power sources! Over the years, Field Day's contest-like nature has led to plenty of good-natured competition among clubs and groups. Field Day stations range from simple to elaborate. If a real disaster were to strike, these stations could be set up quickly wherever needed, without having to rely on commercial power that could fail.

1.5.2 Chasing DX

"DX" typically refers to stations in distant countries around the world. Hams who concentrate on making contacts with faraway stations are called "DXers." Chasing DX is a time-honored ham radio tradition, and many hams concentrate their efforts toward working stations in far-flung and rare locations. Often they have as their goal getting on the DXCC "Honor Roll" or entering the ARRL's annual DX Challenge.

Working DX does not necessarily require an expensive radio and huge antenna system. It's possible to work a lot of DX — even halfway around the world — with very low power or with modest antennas, including mobile antennas.

Some hams specialize in certain bands to work DX, such as 160 meters, where DXing can be challenging due to its low frequency, frequent noise and infrequent DX propagation. Others prefer "the high bands," such as 20, 15 and 10 meters.

DXPEDITIONS

DXers who have run out of new countries to work sometime *become* the DX! "DXpeditions" travel to countries with few or no hams. Participants often make thousands of contacts in the space of a few days. They not only have a great time but often can spread international goodwill.

Some DXpeditions are huge productions. In 2008, an international team activated

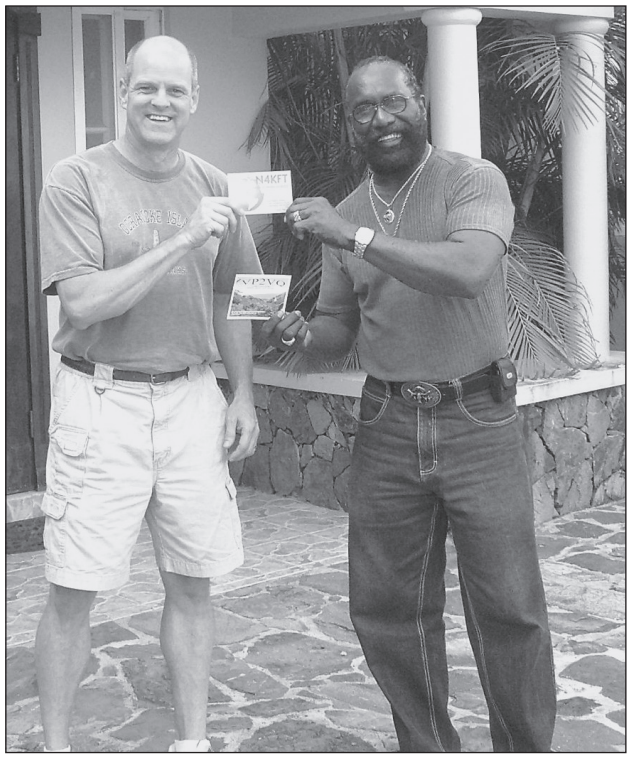

Fig 1.19 — Traveling to foreign countries and operating is a great way to make friends! Parke, N4KFT (left) and George, VP2VQ exchanged traditional QSL cards on Parke's visit to Tortola, British Virgin Islands. (*N4KFT photo*)

Fig 1.20 — The ARRL Worked All States (WAS) certificate is awarded for confirming contacts with hams in all 50 states. Confirmations may be made by traditional paper QSL cards, or electronically through ARRL's Logbook of The World online database.

Logbook of The World

Rather than exchange and collect paper QSL cards, more and more radio amateurs are taking advantage of the ARRL's Logbook of The World to confirm contacts for award credit. LoTW is a repository of individual radio contact records submitted by users from around the world. When both participants in a QSO submit matching QSO records to LoTW, the result is a virtual QSL that can be applied toward ARRL award credit. Uploading contact data costs nothing; users only pay to "redeem" their QSO credits for an award, such as DXCC or WAS.

Once signed up as a Logbook user, you can submit new contact records whenever you wish. Your contacts will be matched against the logs of other Logbook users. Whenever a match occurs, you receive instant credit for the contact.

To minimize the chance of fraudulent submissions, all LoTW QSO records are digitally "signed" by the licensee, who must hold an LoTW certificate. LoTW began operation in 2003 and has tens of thousands of users, with several hundred million resulting QSL records! Visit the Logbook of The World website, **www.arrl.org/logbook-of-the-world**, to learn more.

Ducie Island, a tiny atoll in the South Pacific with no indigenous population. In the space of two weeks, the team completed nearly 184,000 two-way contacts with other hams around the globe. Ducie Island counts as a separate country (or "entity") for the DXCC award.

Most DXpeditions are smaller affairs in which one or two operators combine a vacation with some on-air fun. Activity often peaks in conjunction with the major DX contests. If you don't want to drag your radio and antennas along, fully equipped DX stations are available for rental.

DX SPOTS AND NETS

The beginning DXer can get a good jump on DXCC by frequenting the DX spotting sites on the Internet. A DX spotting website is essentially an Internet clearing house of reports — or "spots" — posted by other DXers of stations actually heard or worked. The PacketCluster systems offer much the same information via packet radio. Users from around the world post spots nearly in real time, and each spot gives the station posting the spot and the DX station's frequency.

DX nets offer another DX gateway. On DX nets, a net control station keeps track of which DX stations have checked into the net. The net control station then allows a small group of operators to check in and work one of the DX stations. This permits weaker stations to be heard instead of being buried in a pileup.

1.5.3 Operating Awards

Earning awards that reflect Amateur Radio operating accomplishments is a time-honored tradition. Literally hundreds of operating awards are available to suit your level of activity and sense of accomplishment.

WORKED ALL STATES

One popular and longstanding award is the Worked All States (WAS) award, sponsored by the ARRL. To earn the "basic" WAS a radio amateur must confirm two-way radio contacts with operators in each of the 50 United States. If you enjoy operating different bands and a greater challenge, try for the ARRL's 5-Band WAS (5BWAS) award by confirming contacts with all 50 US states on each of the 80, 40, 20, 15 and 10 meter bands.

A new twist on the WAS award is the ARRL's Triple Play Award. Introduced in 2009, it became an instant hit with hams. To earn the Triple Play Award, an amateur must contact other amateurs in each of the 50 US states using voice, Morse code and a digital mode such as RTTY or PSK31. All qualifying contacts must be confirmed via the ARRL's Logbook of the World (LoTW — see sidebar, "Logbook of The World). The Triple Play Award is available to hams all over the world.

QSL Cards

Long before the Internet and e-mail, hams began the custom of exchanging postcards that became known as QSL cards or simply QSLs. "QSL" is another radiotelegraph, or Morse code, abbreviation that means "I confirm receipt of your transmission." Exchanging QSL cards can enhance your ham radio enjoyment and even lead to a regular correspondence.

Hams still take great pride in having distinctive QSL cards to exchange following a contact, although today, thanks to the Internet, electronic means exist, such as ARRL's Logbook of The World (see sidebar, "Logbook of The World") to confirm contacts. A QSL card contains information that verifies a two-way contact took place.

DX stations, especially those in very rare places, are often inundated with QSL cards and requests from US hams. To ease the cost and administrative burden, most DX QSLs travel via QSL bureaus, which ship cards in bulk, then sort and distribute them on the receiving end. The Outgoing QSL Service is available to ARRL members at nominal cost. The incoming QSL bureaus are available to all amateurs. Bureau instructions and addresses are on the ARRL website.

DX CENTURY CLUB

The most prestigious and popular DX award is the DX Century Club (DXCC), sponsored by the ARRL. Earning DXCC is quite a challenge. You must confirm two-way contact with stations in 100 countries (or "entities," as they're known in the DXCC program). Hams with very simple stations have earned DXCC. Operating in various DX contests when stations all over the world are looking for QSOs is a good way to combine DXing and contesting, and to get a leg up on earning DXCC. There's also a 5-Band DXCC (5BDXCC) for earning DXCC on each of five bands.

Top-rung DX enthusiasts have been challenging themselves and each other through the ARRL DXCC Challenge. This activity, which is ongoing, involves confirming contacts with DXCC entities on all bands from 160 through 6 meters.

The Worked All Continents (WAC) certificate is a good starting point for newcomers. Sponsored by the International Amateur Radio Union (IARU), earning WAC requires working one station on each of six continents (excluding Antarctica).

1.5.4 Satellite Communication

Amateur Radio has maintained a presence in space since 1961 with the launch of OSCAR 1 (OSCAR is an acronym for Orbiting Satellite Carrying Amateur Radio). Since then, amateurs have launched some five dozen satellites, most of the low-earth orbit variety and a small number in the high-earth orbit category. The history of Amateur Radio satellites and information on which ones are in operation is available on the AMSAT website, **www.amsat.org**.

Amateurs have pioneered several developments in the satellite industry, including low-earth orbit communication "birds" and PACSATs — orbiting packet bulletin board systems. Operating awards, such as VUCC (VHF/UHF Century Club), WAS and DXCC, are available from ARRL and other organizations specifically for satellite operation.

Satellite operation is neither complex nor difficult; it's possible to work through some satellites with nothing more than a dual-band (VHF/UHF) handheld transceiver and perhaps a small portable antenna. More serious satellite work requires some specialized equipment. You may be able to work several Amateur Radio satellites (OSCARs) with the equipment that's now in your shack!

AMATEUR RADIO IN SPACE

In 1983, the first ham-astronaut made history by communicating from the space shuttle *Columbia* with ground-based hams. NASA subsequently made Amateur Radio a part of many shuttle missions and later as a permanent presence aboard the International Space Station. The space agency promotes ham activity because of its proven educational and public relations value — and because ham radio could be used for backup communication in a pinch.

Today, the Amateur Radio on the International Space Station (ARISS) program allows for digital and analog/voice communication with ISS crew members and with other terrestrial amateurs via an onboard packet mailbox and APRS digipeater (**www.arrl.org/amateur-radio-on-the-international-space-station**). Most ISS crew members are Amateur Radio licensees. Scheduled contacts are frequently made with demonstration stations in school classrooms around the world. Questions and answers are exchanged between astronauts and schoolchildren via FM voice on VHF.

1.5.5 QRP: Low-Power Operating

One very active segment of the Amateur Radio community enjoys operating with a minimum of transmitting power. They call themselves "QRP operators," after the Morse code abbreviation for "I shall decrease transmitter power." While the FCC allows hams with the proper license to run up to 1500 W (watts) PEP and many hams run 100 W, QRPers typically use 5 W or less — some *far* less (one ham achieved WAS while running 2 milliwatts — that's two-thousandths of a watt!). Operating QRP is a challenge; for starters, you won't be heard as easily, so patience becomes a real virtue both for the low-power enthusiast and the station on the other end of the contact! With effective antennas and skillful operating, however, QRPers make contacts around the world. This operating style has become so popular that many contests now include an entry category for stations running 5 W or less output power.

One of the best reasons to operate QRP is that low-power equipment typically is light-

Fig 1.21 — Commander Mike Fincke, KE5AIT, makes FM voice contacts from NA1SS aboard the orbiting International Space Station. (*NASA photo*)

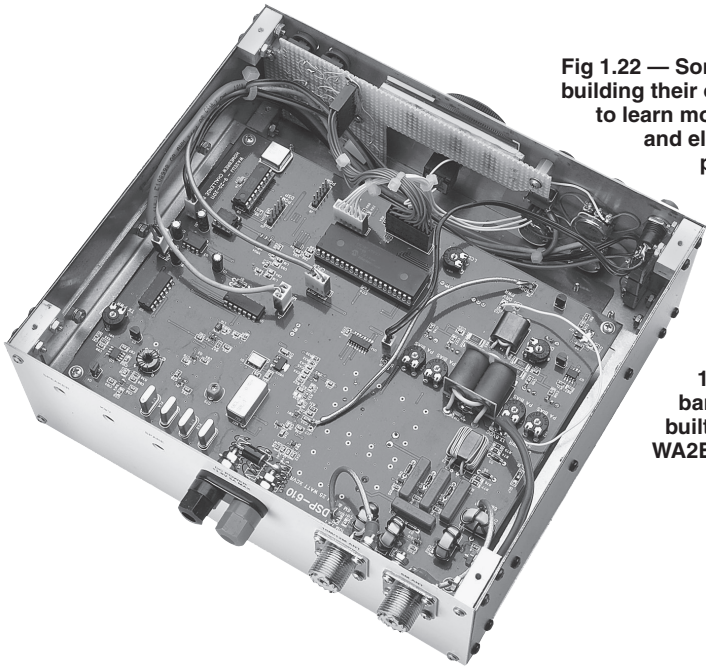

Fig 1.22 — Some hams enjoy building their own equipment to learn more about radio and electronics. This photo shows one of the winning entries in a recent ARRL "homebrew" competition — a complete transceiver for the 6, 10 and 12 meter amateur bands designed and built by Jim Veatch, WA2EUJ.

weight and less expensive. Many QRP operators enjoy designing and building their own "flea-power" transceivers, and various organizations promoting low-power operating offer kits, circuits and advice. A few commercial manufacturers also market QRP equipment and kits.

1.5.6 Operating Mobile

Many hams enjoy operating on the fly — usually from a car or truck but sometimes from a boat, a motorcycle, a bicycle and even while on foot! Operating "mobile" from a car is the most common form, and manufacturers today offer a wide range of ham radio gear, including antennas, just for this type of operating. A mobile station can be something as simple as a basic VHF or dual-band VHF/UHF transceiver and a little antenna attached magnetically to the roof, or as complex as an HF station and a more substantial antenna system. Some mobile stations are very sophisticated, with capabilities that rival those of many fixed stations.

While most hams who operate mobile use FM or SSB, a growing number operate CW while on the road. It takes a bit of practice, in part because the operator must learn to understand Morse code without having to write it down.

Hams on bicycle treks or hikes can easily carry along lightweight radio gear. A lot of cyclists or hikers pack a small ham radio transceiver and wire antenna along with their sleeping bag, food and water.

1.5.7 VHF, UHF and Microwave Operating

Hams use many modes and techniques to extend the range of their line-of-sight signals on the VHF, UHF and microwave bands. Those who explore the potential of VHF/UHF communications are often known as "weak-signal" operators to differentiate them from FM operators — although signals are often not really *weak*. These enthusiasts probe the limits of propagation with the goal of discovering just how far they can communicate.

They use directional antennas (beams or parabolic dishes) and very sensitive receivers. In some instances, they employ considerable transmitter output power, too. As a result of their efforts, distance records are broken almost yearly. On 2 meters, for example, conversations between stations hundreds and even thousands of miles apart are not uncommon. The distances decrease as frequencies increase, but communication regularly can span several hundred miles, even at microwave frequencies.

Weak-signal operators for many years depended on SSB and CW, but computer/sound card based digital modes are now part of their arsenal. These modes use state-of-the-art digital signal processing (DSP) software for transmitting and receiving very weak signals, often below levels that the human ear can detect.

EME

EME (Earth-Moon-Earth) communication, also known as "moonbounce," fascinates many amateurs. The concept is simple: use the moon as a passive reflector of VHF and UHF signals. Considering the total path of some 500,000 miles, EME is the ultimate DX — at least to date. The first two-way amateur EME contacts took place in 1960.

Traditionally EME was a CW mode activity requiring large antennas and high power. Advances in technology, such as low noise receivers and digital signal processing (DSP) tools, are making EME contacts possible for more and more amateurs with modest stations.

METEOR SCATTER

As a meteor enters the Earth's atmosphere, it vaporizes into an ionized trail of matter. Such trails are often strong enough to reflect VHF radio signals for several seconds. During meteor showers, the ionized region becomes large enough — and lasts long enough — to sustain short QSOs. It's exciting to hear a signal from hundreds of miles away pop out

Fig 1.23 — Since antennas for the VHF, UHF and microwave bands are small enough for travel, "rover" stations are popular in competitions for these bands. John D'Ausilio, W1RT, is shown here adjusting his rover's antennas during the September VHF Contest. (*K1RA photo*)

of the noise for a brief period!

Amateurs experimenting with meteor-scatter propagation use transmitter power of 100 W or more and beam antennas. Most contacts are made using SSB, CW or digital modes. Although most SSB and CW QSOs are made during annual meteor showers, digital mode contacts are possible any day of the year.

1.5.8 Vintage Radio

Present-day commercial Amateur Radio equipment has reached a level of complexity that often requires specialized test and troubleshooting equipment to repair or align. Modern component manufacturing technology such as surface-mount devices (SMDs) has come into such common use that a modular approach to equipment repair has now become customary. Rather than troubleshoot and replace a defective component, many manufacturers now prefer to swap out an entire module.

Many amateurs still prefer to repair and adjust their own equipment and covet the days when it was easier to do so. This is but one reason for the surge in attention to vintage radio operating and collecting. Some others have to do with equipment cost, availability, rarity and, of course, nostalgia. Many of these radios are affectionately called "boat anchors" by their vintage radio aficionados, since early radio gear tends to be relatively large and heavy.

Some enthusiasts enjoy the challenge of collecting and restoring older radios, sometimes striving to bring the equipment back to its original factory condition. Other vintage radio enthusiasts may have a parallel interest in conventional AM voice transmission. These activities take vintage radio fans back to an era when amateurs knew how their equipment worked and repaired it when it didn't.

Fig 1.24 — Hams enjoy restoring and using old radio equipment. Rod Bunn, KA6ROD, restored his Heathkit transceiver and station monitor to use during the annual ARRL Straight Key Night special operating event.

1.5.9 Radio Direction Finding (DF)

DFing is the art of locating a signal or noise source by tracking it with portable receivers and directional antennas. Direction finding is not only fun, it has a practical side as well. Hams have been instrumental in hunting down signals from illegal jammers and malfunctioning transmitters in addition to locating noise (interference) sources.

"Fox hunting" — also called "T-hunting," "radio-orienteering" or "bunny hunting" — is ham radio's answer to hide-and-seek. One player is designated the fox; he or she hides a transmitter, and the other players attempt to find it. Rules vary, but the fox must generally place the transmitter within certain boundaries and transmit at specific intervals.

Fox hunts differ around the world. American fox hunts often employ teams of fox hunters cruising in vehicles over a wide area. European and other fox hunters restrict their events to smaller areas and conduct fox hunts on foot. *Radiosport* competitions typically follow the European model.

DF techniques can come into play when tracking down sources of interference on the ham bands — intentional or inadvertent — or when there's a suspected "pirate" (unlicensed ham station) in the area.

1.6 Public Service

The ability to provide communication as a free public service has been a traditional responsibility of Amateur Radio from the start. Today, this most often involves ham radio's volunteer efforts during disasters and emergencies. When floods struck North Dakota and Minnesota in the spring of 2009, the Amateur Radio community rallied to supplement overly stressed public safety systems. Hams volunteered around the clock to provide communication for sandbagging operations and evacuation efforts, as well as to link hospitals, emergency operations centers and non-government relief agencies. Public service also can take less dramatic forms: Hams also step forward to provide communication for walkathons, marathons, bike races, parades and other community events.

Practice makes perfect. On any given weekend, hams associated with emergency communication teams might be found supporting radio communication in the aftermath of a simulated disaster or weather emergency, to sharpen their emergency-preparedness skills.

1.6.1 Emergency Communication

The FCC rules governing Amateur Radio list emergency communication as one of the purposes of the Amateur Radio Service. The ability to provide emergency communication is a big justification for Amateur Radio's existence.

Despite the proliferation of cell phones and other personal communications devices, Amateur Radio continues to prove its value, since it can operate without an existing infrastructure. Ham radio doesn't need the cellular network or the Internet. When all else fails, Amateur Radio works. Battery-powered equipment allows hams to provide essential communication even when power is knocked out. If need be, hams can make and install antennas on the spot from available materials. In the wake of hurricanes, forest fires, earthquakes and other natural disasters that cripple or compromise normal communications, hams may be called upon to handle thousands of messages in and out of the stricken region. The work that hams do during crisis situations cultivates good relations with neighbors and with local governments.

Amateur Radio operators have a long tradition of operating from backup-power sources. Through events such as Field Day, hams have

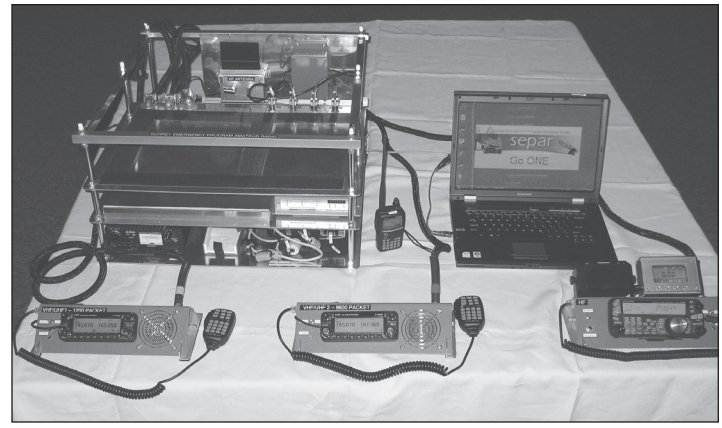

Fig 1.25 — When disaster strikes, amateurs are ready to provide emergency communications by preparing compact "grab and go" kits of radio gear, such as the three-radio, multi-band, multi-mode package built for the Surrey (British Columbia, Canada) Emergency Program Amateur Radio team by VE7IO, VE6XS, VA7DRW, and VA7XB.

cultivated the ability to set up communication posts wherever they are needed. Moreover, Amateur Radio can provide computer networks (with over-the-air links as needed) and other services such as video that no other service can deploy on the fly, even on a wide scale.

1.6.2 Emergency Communication Organizations

Many hams join a local volunteer Amateur Radio emergency communication organization and regularly practice their communication skills. Should an emergency arise, volunteer teams from these organizations cooperate with emergency personnel such as police and fire departments, the Red Cross and medical personnel to provide or supplement communication. Hams sometimes are called upon to fill the communication gap between agencies whose radio systems are incompatible with one another.

ARES AND RACES

The Amateur Radio Emergency Service (ARES) and the Radio Amateur Civil Emergency Service (RACES) are the umbrella organizations of Amateur Radio emergency communication. ARES is sponsored by ARRL and handles many different kinds of public service activities. RACES is administered by the Federal Emergency Management Agency (FEMA) and works with government agencies to maintain civil preparedness and provide communication in times of civil emergency. RACES is activated at the request of a local, state or federal official.

Amateurs serious about emergency communication typically are active in ARES or RACES or may carry dual ARES/RACES membership. FCC rules make it possible for ARES and RACES to use many of the same frequencies, so an ARES group also enrolled in RACES can work within either organization as circumstances dictate.

MILITARY AUXILIARY RADIO SYSTEM (MARS)

MARS is administered by the US armed forces. Its primary mission is supporting Department of Defense-sponsored emergency communications on a local, national and international basis as an adjunct to existing military communications. This service has existed in one form or another since 1925.

There are three branches of MARS: Army MARS, Navy/Marine Corps MARS and Air Force MARS. Each branch has its own membership requirements, although all three branches require members to hold a valid US Amateur Radio license and to be at least 18 years old (in some cases, amateurs who are 17 years old may join with the signature of a parent or legal guardian).

MARS operation takes place on frequencies adjoining the amateur bands and usually consists of nets scheduled to handle traffic or to handle administrative tasks. Various MARS branches may also maintain repeaters or packet systems.

While MARS usually handles routine traffic, the organization is set up to handle official and emergency traffic if needed.

1.6.3 Public Service and Traffic Nets

The ARRL was formed to coordinate and promote the formation of message-handling nets, so public service and traffic nets are part of a tradition that dates back almost to the dawn of Amateur Radio. In those early days, nets were needed to communicate over distances longer than a few miles. From their origination point, messages (also called "traffic") leapfrogged from amateur station to amateur station to their destination — thus the word "relay" in American Radio Relay League. It still works that way today, although individual stations typically have a much greater range.

Some nets and stations are typically only active in emergencies. These include Amateur Radio station WX4NHC at the National Hurricane Center, the Hurricane Watch Net, SKYWARN (weather observers), The Salvation Army Team Emergency Radio Network (SATERN), The Waterway Net and the VoIP (voice over Internet protocol) SKYWARN/Hurricane Net.

THE NATIONAL TRAFFIC SYSTEM (NTS)

The National Traffic System (NTS) exists to pass formal written messages from any point in the US to any other point. Messages, which follow a standard format called a "Radiogram," are relayed from one ham to another, using a variety of modes, including voice, Morse code, RTTY or packet. An NTS operator who lives near the recipient typically will deliver the message by telephone.

During disasters or emergencies, Radiograms are used to communicate information critical to saving lives or property or to inquire about the health or welfare of disaster victims. At these times, the NTS works in concert with the Amateur Radio Emergency Service (ARES) and other emergency and disaster-relief organizations, such as the American Red Cross and The Salvation Army.

The NTS oversees many existing traffic nets, which meet daily. Most nets are local or regional. Handling routine message traffic such as birthday and holiday greetings keeps NTS participants prepared for emergencies.

1.7 Ham Radio in the Classroom

Amateur Radio can complement any school curriculum and give students a chance to make a direct and immediate connection with their studies. For example, the math and science used in Amateur Radio apply equally in the classroom. Even geography takes on a new meaning when students are able to contact other countries around the globe and speak with people who live in them!

Local volunteers are important to establishing an active Amateur Radio presence in schools. An HF or satellite station or even a VHF or UHF handheld transceiver tuned to the local repeater can prove an exciting and educational experience for pupils and volunteers alike.

Thanks to the Amateur Radio on the International Space Station (ARISS) program, amateurs all over the nation have made it possible for students to speak directly with astronauts in space via ham radio. Many individuals began their path towards careers in electronics and wireless communication thanks to their experiences with Amateur Radio as children and teenagers.

1.7.1 ARRL Amateur Radio Education & Technology Program

Through the ARRL Amateur Radio Education & Technology Program (ETP), Amateur Radio can become a significant resource for the classroom teacher. Applying Amateur Radio as part of the class curriculum offers students a new dimension to learning. The ARRL has developed an education project to introduce teachers to this resource and enable them to make the most effective use of it in their classrooms. The program's goal is to improve the quality of education by providing an educationally sound curriculum focused on wireless communication.

Amateur Radio emphasizes self-challenge, the value of lifelong learning and the importance of public service. From a more practical standpoint, future employers will be looking for candidates who are familiar not only with computers but with the sorts of wireless communication concepts used in Amateur Radio.

The ETP offers a range of resources to encourage educators. These include publications related to the use of technology in wireless communications; workshops, tips and ideas for teaching wireless technology in schools, community groups and clubs; and lesson plans and projects to help provide authentic, hands-on technological experiences for students.

The ETP emphasizes the integration of technology, math, science, geography, writing, speaking and social responsibility within a global society. Schools interested in incorporating Amateur Radio into their curricula, using it as an enrichment program or as a club activity may apply to become Project schools. See **www.arrl.org/education-technology-program** for more information on the ARRL Education & Technology Program.

Fig 1.27 — Project Blue Horizon was a balloon launch that served as a final class project for a team of Cornell University students. The balloon carried an instrumentation and control package that operated via an Amateur Radio control link, traveling more than 1100 miles in just over 30 hours. Shown here getting ready to release the balloon are (left to right) team members Matt Howells, NS3FD; Steve Orzechowski, KC2UFK; Angela Bratt, KC2UFL, John Ceccherelli, N2XE; and Dan Rondeau, KC2UFJ. (*Photo courtesy N2XE*)

Fig 1.26 — Members of the Wagoner Windtalkers, WI5ND, the Amateur Radio club at Wagoner High School in Wagoner, Oklahoma proudly display certificates they received for participating in the School Club Roundup on-the-air event. (*AF4CM photo*)

1.8 Resources

ARRL—the National Association for Amateur Radio
225 Main St
Newington, CT 06111-1494
860-594-0200
Fax: 860-594-0259
e-mail: **hq@arrl.org**
Prospective hams call 1-800-32 NEW HAM (1-800-326-3942)
www.arrl.org
Membership organization of US ham radio operators and those interested in ham radio. Publishes study guides for all Amateur Radio license classes, a monthly journal, *QST*, and many books on Amateur Radio and electronics.

Amateur Radio Service Rules & Regulations — FCC Part 97
Available on the ARRL website: **www.arrl.org/part-97-amateur-radio**
Available as a PDF file on the FCC website: **www.fcc.gov/Bureaus/Engineering_Technology/Documents/cfr/1998/47cfr97.pdf**

AMSAT NA (The Radio Amateur Satellite Corporation Inc)
850 Sligo Ave — Suite 600
Silver Spring, MD 20910
888-322-6728 or 301-589-6062
www.amsat.org
Membership organization for those interested in Amateur Radio satellites.

Courage Handi-Ham System
3915 Golden Valley Rd
Golden Valley, MN 55422
763-520-0512 or 866-426-3442
www.handiham.org
Provides assistance to persons with disabilities who want to earn a ham radio license or set up a station.

The ARRL Ham Radio License Manual
www.arrl.org/ham-radio-license-manual
Complete introduction to ham radio, including the exam question pool, complete explanations of the subjects on the exams. Tips on buying equipment, setting up a station and more.

The ARRL's Tech Q&A
www.arrl.org
Contains all of the questions in the Technician class question pool, with correct answers highlighted and explained in plain English. Includes many helpful diagrams.

General Information and Other Study Material
The ARRL website (**www.arrl.org**) carries a wealth of information for anyone interested in getting started in Amateur Radio. For complete information on all options available for study material, check out the "Welcome to the World of Ham Radio" page, **www.arrl.org/what-is-ham-radio**, and click on the WeDoThat-Radio.org link. You can also use the ARRL website to search for clubs, classes and Amateur Radio exam sessions near you.

1.9 Glossary

AM (Amplitude modulation) — The oldest voice operating mode still found on the amateur bands. The most common HF voice mode, SSB, is actually a narrower-bandwidth variation of AM.

Amateur Radio — A radiocommunication service for the purpose of self-training, intercommunication and technical investigation carried out by licensed individuals interested in radio technique solely with a personal aim and without pecuniary interest. (*Pecuniary* means payment of any type, whether money or goods.) Also called "ham radio."

Amateur Radio operator — A person holding an FCC license to operate a radio station in the Amateur Radio Service.

Amateur Radio station — A station licensed by the FCC in the Amateur Radio Service, including necessary equipment.

Amateur (Radio) Service — A radiocommunication service for the purpose of self-training, intercommunication and technical investigations carried out by licensed individuals interested in radio technique solely with a personal aim and without pecuniary interest.

AMSAT (Radio Amateur Satellite Corporation) — An international membership organization that designs, builds and promotes the use of Amateur Radio satellites, which are called "OSCARs."

APRS—Automatic Packet/Position Reporting System, a marriage of an application of the Global Positioning System and Amateur Radio to relay position and tracking information.

ARES (Amateur Radio Emergency Service) — An ARRL program specializing in emergency communication.

ARISS — An acronym for Amateur Radio on the International Space Station. NASA, ARRL and AMSAT cooperate in managing the ARISS Program.

ARRL — The national association for Amateur Radio in the US; the US member-society in the ***IARU***.

ATV (Amateur television) — A mode of operation that amateur radio operators use to share video.

Band — A range of frequencies in the radio spectrum, usually designated by approximate wavelength in meters. For example, 7.0 to 7.3 MHz (megahertz) is the 40 meter amateur band. Hams are authorized to transmit on many different bands.

Bandwidth — In general, the width of a transmitted signal. FCC definition: "The width of a frequency band outside of which the mean power of the transmitted signal is attenuated at least 26 dB below the mean power of the transmitted signal within the band."

Beacon — An amateur station transmitting communication for the purposes of observation of propagation and reception or other related experimental activities.

Beam antenna — A type of ham radio antenna with directional characteristics that enhances the transmitted signal in one direction at the expense of others. A "rotary beam" can be pointed in any direction.

Broadcasting — Transmissions intended for reception by the general public, either direct or relayed. Amateur Radio licensees are not permitted to engage in broadcasting.

Call sign — A series of unique letters and numerals that the FCC assigns to an individual who has earned an Amateur Radio license.

Contact — A two-way communication between Amateur Radio operators.

Contest — An Amateur Radio operating activity in which hams and their stations compete to contact the most stations within a designated time period.

Courage Handi-Ham System — Membership organization for ham

radio enthusiasts with various physical disabilities and abilities.

CW — Abbreviation for "continuous wave," today a synonym for radiotelegraphy (ie, Morse code by radio.

Digital communication — Computer-based communication modes such as RTTY, PSK31, packet and other radio transmissions that employ an accepted digital code to convey intelligence or data.

Dipole antenna — Typically, a wire antenna with a feed line connected to its center and having two legs, often used on the high-frequency (HF) amateur bands.

DSP (digital signal processing) — Technology that allows software to replace electronic circuitry.

DX — A ham radio abbreviation that refers to distant stations, typically those in other countries.

DXCC — DX Century Club, a popular ARRL award earned for contacting Amateur Radio operators in 100 different countries or "entities."

DX PacketCluster — A method of informing hams, via their computers, about DX activity.

DXpedition — A trip to a location — perhaps an uninhabited island or other geographical or political entity — which has few, if any, Amateur Radio operators, thus making a contact rare.

Elmer — A traditional term for someone who enjoys helping newcomers get started in ham radio; a mentor.

Emergency communication — Amateur Radio communication during a disaster or emergency that support or supplants traditional means of telecommunication.

FCC (Federal Communications Commission) — The government agency that regulates Amateur Radio in the US.

Field Day — A popular, annual Amateur Radio activity sponsored by the ARRL during which hams set up radio stations, often outdoors, using emergency power sources to simulate emergency operation.

Field Organization — A cadre of ARRL volunteers who perform various services for the Amateur Radio community at the state and local level.

FM (Frequency modulation) — A method of transmitting voice and the mode commonly used on ham radio repeaters.

Fox hunt — A competitive radio direction-finding activity in which participants track down the source of a transmitted signal.

Fast-scan television — A mode of operation that Amateur Radio operators can use to exchange live TV images from their stations. Also called ATV (Amateur Television).

Ham band — A range of frequencies in the radio spectrum on which ham radio communication is authorized.

Ham radio — Another name for Amateur Radio.

Ham radio operator — A radio operator holding a license granted by the FCC to operate on Amateur Radio frequencies.

HF (high frequency) — The radio frequencies from 3 to 30 MHz.

HSMM (high-speed multimedia) — A digital radio communication technique using spread spectrum modes primarily on UHF to simultaneously send and receive video, voice, text, and data.

IARU (International Amateur Radio Union) — The international organization made up of national Amateur Radio organizations or societies such as the ARRL.

Image — Facsimile and television signals.

International Morse Code — A digital code in which alphanumeric characters are represented by a defined set of short and long transmission elements — called "dots and dashes" or "dits and dahs" — that many Amateur Radio operators use to communicate.

ITU (International Telecommunication Union) — An agency of the United Nations that allocates the radio spectrum among the various radio services.

Mode — A type of ham radio communication, such as frequency modulation (FM voice), slow-scan television (SSTV), SSB (single sideband voice) or CW (Morse code).

Morse code — A communication mode characterized by on/off keying of a radio signal to convey intelligence. Hams use the International Morse Code.

Net — An on-the-air meeting of hams at a set time, day and radio frequency.

Packet radio — A computer-to-computer radio communication mode in which information is broken into short bursts called packets. These packets contain addressing and error-detection information.

PEP (peak envelope power) — The average power supplied to the antenna transmission line by a transmitter during one RF cycle at the crest of the modulation envelope taken under normal operating conditions.

Phone — Emissions carrying speech or other sound information, such as FM, SSB or AM.

Public service — Activities involving Amateur Radio that hams perform to benefit their communities.

QRP — An abbreviation for low power.

QSL bureau — A system for sending and receiving Amateur Radio verification or "QSL" cards.

QSL cards — Cards that provide written confirmation of a communication between two hams.

QST — The monthly journal of the ARRL. *QST* means "calling all radio amateurs."

RACES (Radio Amateur Civil Emergency Service) — A radio service that uses amateur stations for civil defense communication during periods of local, regional or national civil emergencies.

RF (Radio frequency) — Electromagnetic radiation.

Radio (*or *Ham) shack — The room where Amateur Radio operators keep their station.

Radiotelegraphy — See **Morse code**.

Receiver — A device that converts radio signals into a form that can be heard.

Repeater — An amateur station, usually located on a mountaintop, hilltop or tall building, that receives and retransmits the signals of other stations on a different channel or channels for greater range.

RTTY (radio teletype) — Narrow-band direct-printing radioteletype that uses a digital code.

Space station — An amateur station located more than 50 km above Earth's surface.

SSB (Single sideband) — A common mode of voice of Amateur Radio voice transmission.

SSTV (Slow-scan television) — An operating mode ham radio operators use to exchange still pictures from their stations.

SWL (Shortwave listener) — A person who enjoys listening to shortwave radio broadcasts or Amateur Radio conversations.

TIS (Technical Information Service) — A service of the ARRL that helps hams solve technical problems.

Transceiver — A radio transmitter and receiver combined in one unit.

Transmitter — A device that produces radio-frequency (RF) signals.

UHF (Ultra-high frequency) — The radio frequencies from 300 to 3000 MHz.

VE (Volunteer Examiner) — An Amateur Radio operator who is qualified to administer Amateur Radio licensing examinations.

VHF (Very-high frequency) — The radio frequency range from 30 to 300 MHz.

WAS (Worked All States) — An ARRL award that is earned when an Amateur Radio operator confirms two-way radio contact with other stations in all 50 US states.

Wavelength — A means of designating a frequency band, such as the 80-meter band.

Work — To contact another ham.