Morse Code Practice for Radio Amateurs

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At the beginning of the wire telegraph era, Samuel Morse and others devoted much effort to building elaborate electromechanical devices that captured and decoded the information embodied in the pulses coming over the wire: tiny spark gaps, electromagnets, chemically treated tapes, gears and motors. Imagine their surprise when a young man hired to monitor and maintain this gadget collection discovered he could simply *write down the message* by listening to the timed patterns of clicks and clanks from the machinery. The best scientists of the day had underestimated human capabilities.

The rest, of course, is history. Most of the electromechanical stuff was thrown out, and wire telegraphy came of age thanks to one fellow with a good ear and a quick mind. By the time radio arrived many decades later, it was widely accepted that anybody could, with practice, learn to read the timed patterns of clicks (and later, beeps) of Morse code. Generations of radio operators have applied their Morse code skills, in peace and war, to providing vital communications via radio. Today, more than a century after Marconi's first demonstrations of practical wireless communication, and despite the advent of numerous other methods for sending and receiving information over thin air, Morse code remains one of our most effective communication modes.

For much of the last century radio amateurs were required by international agreement to demonstrate a knowledge of Morse code in order to get a license to operate a personal radio station. Passing a code exam, however, rarely prepared us for on-air communication. Once qualified, many of us put aside our code keys and practice tapes and returned to the comfort of everyday spoken language. In 2007 the FCC unilaterally ended all code requirements, as did governments in most other countries. Learning to copy and understand Morse code would not longer be the licensing hurdle many of us had struggled with. Yet interest in Morse code communication has continued. To the surprise of us old-timers, it seems stronger than ever.

Present-day instructional materials aimed at helping newcomers acquire code proficiency often retain the priorities of earlier times: how to gain copying speed and prepare for the exam. Advice on sending Morse code by hand? Or making the jump to on-air enjoyment? Not so much. Despite the claims of purveyors of code practice software, of code-generating and code-reading gizmos, and the proliferation of on-line practice sites and self-help guides, there are no easy paths to Morse code mastery. But there are ways to make the necessary practice physically and mentally less burdensome.

This article is intended for newcomers to amateur radio, whether licensed or not, who wish to explore the possibilities and potential of Morse code communication. I list some of the reasons for learning and mastering the code, point out several common roadblocks that stand in the way of success, and offer a number of practical suggestions for developing and improving your code communication skills.

My aim is to supplement, not replace, other practice strategies and sources of information. Many radio amateurs argue that effective use of Morse code as a communication method requires two related skills: (1) code copying and sending; and (2) knowledge of on-air operating practices. Learning these aspects *together* can help relieve the tedium and tension of mastering the code.

A Morse code defense

CW is a language.[1] In our first exposure to the code, when our effort is centered on just getting the letters and numbers firmly in mind, it's easy to forget that CW is more than letters and numbers. As in every other language, CW has a vocabulary and grammar all its own, knowledge of which is essential if we are to communicate with others. Viewed as a language, CW is a mix of misspelled and abbreviated English, along with numerous borrowings from other languages. Like most languages, CW's usages shift over time; clichés and turns of phrase—even the meanings of words—have changed noticeably in the sixty years since I first started talking CW. I dwell on these properties of CW-as-a-language to reinforce the following points.

First, while code-copying skill is surely a necessary part of CW communication, it is not by itself sufficient. Speaking (sending) CW is equally important. Code-practice strategies devoted solely to character recognition, once suitable for the exams, are unlikely to promote conversational proficiency. It's important to keep in mind the capabilities of CW as a medium for *actually talking with other human beings*. This concept can serve as a useful rationale for expending the necessary effort to learn the code. Without such impetus the needed practice can soon become tiresome and boring. Accordingly, I advocate getting on the air as soon as possible and talking via CW with other hams. After all, isn't amateur radio supposed to be enjoyable? Why not try to make it so.

Second, descriptions of the Amateur Radio Service, by both the International Telecommunications Union and by national governments, take serious note of its international character and of the unique and significant contributions radio amateurs can make to world understanding. We radio amateurs are expected to serve as representatives of our countries. But not everyone in the world speaks English (and most of us speak English only). Just as we expect diplomats to communicate effectively across language barriers, radio amateurs ought to be able to do so, too. CW, as a language in its own right, is widely spoken by radio amateurs around the world, enabling us to communicate across boundaries of language and culture.

Finally, it is to our benefit that a Morse code qualification is no longer required. Exam texts were said to represent a "typical contact" between operators, but seemed to be almost deliberately designed to discourage further on-air CW operating: callsigns, signal report, name, location, equipment, goodbye. Huh? In the absence of further information, it was easy to conclude that, if this was all there was to CW, why bother? Now, we can learn CW for its own sake.

CW is efficient. We all dream of that new rig or antenna that will allow us to talk louder, farther, or more reliably with other radio amateurs. But for the costs involved, most of us would be eager to enhance our station's effectiveness. CW, as a supplement to the voice modes we're already familiar with, can provide this at no additional expense. In technical terms a CW signal occupies a narrower span (bandwidth) of radio spectrum (ca. 150 Hz) than a typical voice signal (ca. 2500 Hz). For the same transmitted power, CW is at least an order of magnitude more effective than our usual voice modes. It's like getting that new kilowatt amplifier or Yagi antenna for free.

Barriers to learning the code

The Farnsworth method. In recent decades, one method for learning Morse code has come to dominate all others. The Farnsworth method posits that, if one can learn to copy each letter when sent rapidly (such that the overall rate of sending is governed mainly by the silent intervals between letters and words), then increasing one's code copying speed becomes a "simple" matter of progressively contracting the inter-letter and inter-word gaps. Primary cognitive evidence that this method actually works for all or most people is hard to come by, at least in the amateur radio literature of the past two decades. This could suggest that the evidence may be sparse or non-existent.

While the Farnsworth method offers a useful path to code proficiency, it can be counterproductive if, as often happens, instructors adopt character speeds that are too fast for beginners. When code speeds approach 20 words (100 characters) per minute, it becomes physically awkward to emulate the sound of Farnsworth CW in manual sending, an important practice strategy. The method sets a poor rhythmic precedent, resulting in a herky-jerky code that is difficult to send and tiring to copy. Character speeds in the low to mid teens are much to be preferred. The method also risks leading newcomers to conclude (incorrectly, in my view) that copying speed is *the* central goal of Morse code mastery. It requires us to learn *two* versions of Morse code: one to pass the exam (Farnsworth); and one to communicate with others on the air (manually sent, properly spaced CW). The first of these, of course, is no longer relevant; the second is a necessity. It's important to recognize these shortcomings of the method from the outset, to avoid difficulties in the future.

The writing problem. At the slower code speeds we all start out with, writing down what we hear is often useful and sometimes essential. It is natural in this case to neatly print the letters out, especially if this is our normal handwriting mode. Some code instruction manuals even encourage this, demonstrating in the best mechanical drawing tradition how to print neat uppercase letters (see Figure 1).

But the habit of printing out the letters and numbers sets a speed limit to one's code copying. Test yourself with a stopwatch; printing takes longer than writing in cursive script. My own checks suggest that I can write legible (to me) script some 60% faster than printing. This means that, ideally, I ought to be able

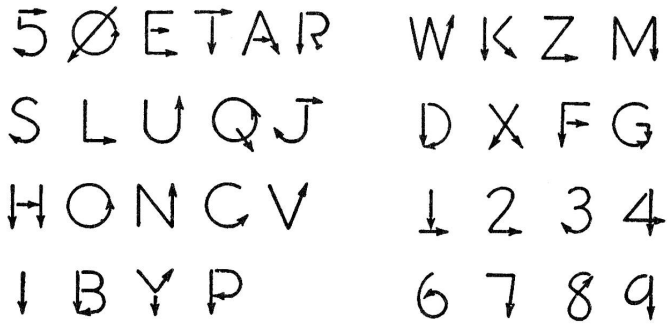

Figure 1. *Instruction manuals used to stress the importance of neat block printing when copying Morse code. Here, the letters and numbers are arranged in the order in which one manual suggests that they be learned.*[2, 3]

to copy code (i.e. write it down on paper) 60% faster if I write cursively than if I print. Since we no longer have to produce a legible copy for the examiner to read, we can employ our usual quick scribbles. I can't recommend too strongly to beginners to avoid tidy block printing in copying code. It took me months of practice to rid myself of this habit, and I still have to resist a tendency to revert back to slow writing.[4]

A secondary consequence of devoting all our effort to preparing for the code exams is that we may feel compelled to write everything down. This is another habit to avoid. The other ham sends "MY NAME IS JOE." Write down *joe* in your best scribble. (You may soon find that CW can begin to flow into whole words and phrases, and writing down every letter will become even less important.)

Other radio amateurs. It is a fact of amateur radio that the great majority of us rarely, or never, use CW as a communications mode. It is also true that all or most of us look for technical and operating advice from more experienced hams. It is likely that you will have already heard the widespread opinion that the code is too difficult, and that CW communication is too slow, too impersonal, too boring. These views have continued to be expressed even after CW's demise as a licensing requirement.

In my view, these attitudes are self-fulfilling. If you *expect* that CW practice will be a real drag, it will be. If, on the other hand, you can look forward to using CW for real conversations—for meeting other hams on the air—and are determined to do so as soon as you can, then there is a good chance you'll find learning and *using* CW to be an interesting challenge.

Learning Morse code from scratch

In this section, I offer some tips that might make your first steps in CW easier than they might otherwise be. Consider these suggestions along with others you encounter elsewhere, try them all out, and find what's best for you. There is no one right way to learn the code. (If you already know the code sounds, and are mainly seeking to improve your skills, feel free to skip this section.)

Learn the dits and DAHs as sounds. Find a recording of well-sent Morse code. Listen only enough to get a sense of how the letters *sound*, the relative lengths of the dits and DAHs, the silent gaps between sounds. Morse code consists not only of the two sound elements, short and long, but also of the *intervals* between sounds: between sound elements of single letters, between the letters, between words. Set the recording aside. Your task is to memorize the sounds of all 26 letters: the dits, the DAHs, the gaps. The best way I know to do this is old-fashioned rote memorization. This is rarely taught nowadays (if it ever was), so bear with me for a short digression.

Scientists tell us that human memory appears to consist of two parts: short-term memory and long-term memory. Experiences are first stored in short-term memory, and are only later transferred to long-term memory. Not all short-term memories find their way to long-term storage; indeed, most do not. The fact that we can remember what we had for lunch yesterday but not a week ago is a clue to the nature of short-term memory. It's temporary storage with a time-frame of a day or two. Here's the trick: If a particular bit of information can be maintained consciously in short-term memory for at least a couple days (48 hours), there's a strong likelihood it will be transferred to long-term memory. End of digression.

Now, how can you make use of this for learning the code? First, learning the code means learning the *sounds* of the letters and numbers. Divide up the 26 letters into groups of five or six.[3] Start with a group of easy letters, those consisting of just a few sound elements. Look at the suggested groupings in the manual(s), like that shown in Figure 1. (The stepwise structure of the numbers makes them easy to memorize as a group.) Speak the sounds out loud. By convention and long tradition, the long sounds (DAHs) are set to be three times longer than the short sounds (dits). The gaps between sound elements in each letter are equivalent to a single dit, and the gaps between letters are equivalent to a single

DAH. In letters that combine dits and DAHs don't feel the need to pronounce the terminal "t" in dit. The letter A is better pronounced "di-DAH;" the letter S is "di-di-dit."

Remember, you're memorizing *sounds*, not dots and dashes on a page, or on the screen of an electronic code reader or computer. Don't try to match your recording's speed. Pick a speed for pronouncing each letter sound that is comfortable for you. When you say the sounds of each letter out loud, emphasize or stress the DAHs and de-emphasize the dits. (Think of the DAHs as **louder** than the dits.) Go back to your recording if you're uncertain how to pronounce certain letters. Don't rush. The idea is to keep each group of letter sounds constantly in mind for at least a day or two.

Think of *whole words* you can say, using your first group of letters. Practice the proper spacing between letters. As you move on to the next group of letters, go back over previous groups to check that their sounds are still in permanent storage. Think of more two-letter, three-letter, and four-letter words to say. By the end of a couple weeks you should be close to having all 26 letter sounds firmly imprinted in long-term memory.

Don't quit now. Practice speaking the entire alphabet, from diDAH to DAHDAHdidit. Call out the numbers. Invent new multi-letter words. Say your name, your callsign, that street sign, that newspaper headline, spoken out loud in dits and DAHs. Try to space the letters and words properly, according to the standard scheme—roughly one DAH between letters, and two (or more) DAHs between words. Pretty soon, you'll be having imaginary conversations, telling your imaginary listener about your station, your job, your family, yourself. All in dits and DAHs.

CW is a spoken language. Learning to speak the letters and words, and to hear their sounds, is what you are aiming for and need to remember.

Use recordings with caution. Only at this stage, when you have the sounds of all the letters and numbers firmly imprinted in permanent memory, should you go back to your recordings or on-line practice sites. The principal aim of listening is to practice writing down a letter when you hear its sound. (My first code instructor said the ultimate goal in copying the code was to create a direct pathway between your ear and your hand, bypassing your brain altogether.) Writing the letters also forces us to listen more intently than is required when we call out the letters as they come. Since our speech muscles work only so fast, recordings can acquaint us with the characters sent at higher speeds than we can speak them. (ARRL's standard character speed is 18 wpm; it takes a nimble tongue to talk this fast.) Once you have all the letters firmly in mind, this secondary task is not as hard as it sounds. If your recording is plain language text, don't listen for too long or too often. Just as with the individual letter sounds, repeated exposure to a text will result in the same long-term memory transfer. Worse, copying a text is undoubtedly the most tedious method yet devised for code practice. Other methods are described below.

Code practice strategies

Practice by sending. CW licensing exams used to include a sending test, but this was discontinued many years before the Morse code copying requirement was ended. If CW is to be a language you can use for conversing with others, it clearly must be *spoken* as well as heard. Learning to send clear and steady code by hand is thus a vital part of mastering the code.

Since you've already had experience speaking CW out loud, sending by hand should come fairly easily. In addition to developing manual control and a sense of pace and rhythm, sending CW also helps in character recognition, the central skill in code reception. Most of us find that from the beginning we can send faster than we can receive, because in sending we know in advance the next letter or word. On the air, though, this disparity invites trouble and discomfort for the newcomer, since most operators will assume we can copy at our sending speed. Matching sending and copying speeds is not automatic, but a judgment that is acquired through practice.

What should you send? Anything. Text from a magazine. Song lyrics. Imaginary conversations. The emphasis should be on matching the spaces between letters and words to the speed of the characters. If in doubt, leave a bit of extra space. Experienced operators often slow down when there might be confusion, as in words with identical letters in sequence, or when a word is unfamiliar or has many short-character letters: "seen," "assessing," "little" "geneticist."

Radio amateurs face a pleasantly large choice of code keys and keying methods. It is not my purpose to evaluate specific commercial products, but a few

general comments may be appropriate. For sending at speeds less than about 15 wpm, the standard mechanical hand key is a good first choice (Figure 2). Hand keys are easily controlled, provide good manual feedback, and require few adjustments as your sending skills improve. Most hand keys have only two adjustments: spring tension, and spacing of the gap between the contacts. You get what you pay for. Some inexpensive keys have unusably stiff tensioning springs that must be replaced before the key can be used at all for proper sending.

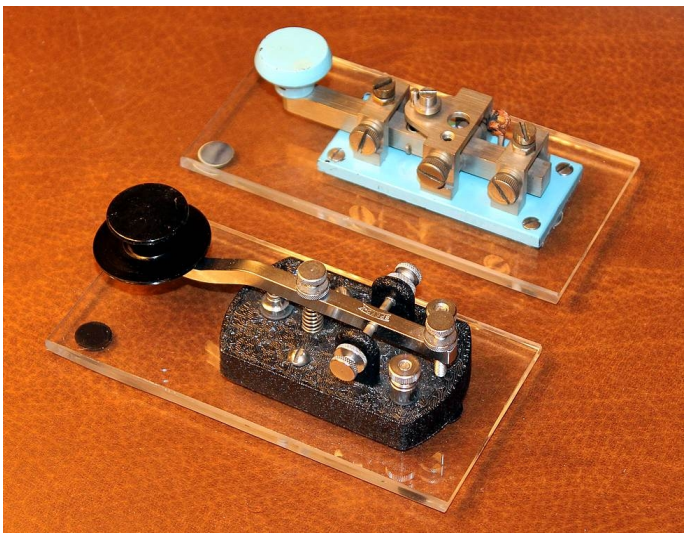

Figure 2. *Two types of hand keys, no longer made, that are often available (used, but still functional) online and at hamfests. Note the plastic bases and rubber feet.*

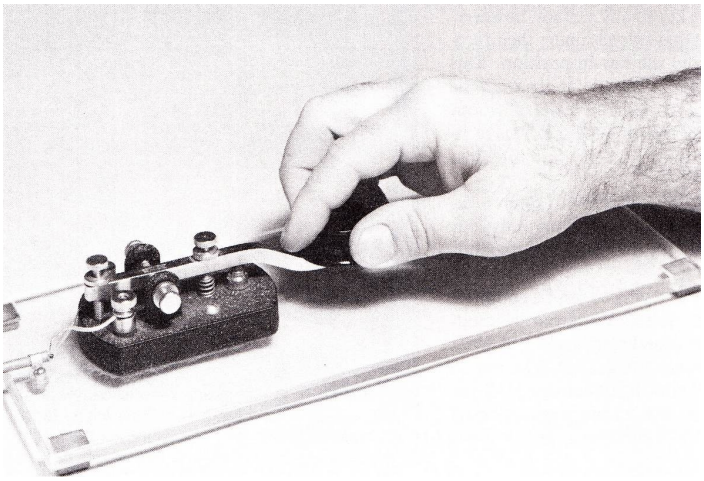

Figure 3. *Recommended position for comfortable CW sending with a basic hand key. ARRL photo.*

In sending with a hand key (also called a "straight" key), it's important to engage your whole arm, and avoid pivoting at the wrist (Figure 3). Place the key back from the edge of the desk or table, so that your elbow can rest lightly on the surface. Drape your fingers over and around the knob. Consider placing your thumb on the side of the knob. Try leaning in a bit when your make your DAHs, back a bit for dits.

The key alone is not sufficient for comfortable sending, but needs to be mounted in such a way that it won't slip or slide all over the table. Mount your key on a base of thin material (Plexiglas, Masonite, etc.), so it won't tilt or wobble when you press down. Some rubber feet will complete the installation.

At sending speeds greater than about 15 wpm, a non-manual means for generating strings of dits is needed. The semi-automatic key or "bug" produces strings of repeating dits with a single key-press, and can be used to send near-perfect code provided the operator's skills are up to the job. I don't recommend these keys for beginners. The typical bug has at least *eight* (8) interdependent physical adjustments, most of which are also speed dependent. A properly set bug will function correctly only within a narrow speed range. Changing the settings for a different speed is a time-consuming process. Despite these limitations, many amateurs continue to use mechanical bugs to send CW that is nearly indistinguishable from computer-generated perfection. Sending CW with a bug takes skill that can only be gained through serious off-air practice.

Electronic keyers, used in conjunction with a paddle-type key, generate strings of dits or DAHs with a single key-press. They are readily adjustable over a wide speed range, and accurately maintain the proper 3:1 DAH-to-dit ratio at all speeds. In many electronic keyers one can alter the DAH-to-dit ratio and/or the inter-element spacing, independent of overall speed setting. It is thus possible, contrary to popular opinion, to send totally unreadable CW with an electronic keyer.

Electronic keyers come in all sizes and shapes. They can include additional features, like memory banks for pre-recording message elements. Many keyers also generate an audio side-tone suitable for off-air code practice. You can buy a keyer, or you can build your own. The widely-available keyer-on-a-chip, the Curtis 8044/5 integrated circuit, simplifies keyer design and construction. I've used a home-made Curtis keyer for 25 years, and it still works fine (Figure 4).

Many modern HF transceivers now include built-in electronic keyers with most of the extra features of stand-alone commercial keyers. The main reason for keyer memory banks—contest exchanges—is now often provided by these integrated keyers or by computer logging software. CW contesting can certainly get the competitive juices flowing, but it's not usually for the beginner. Better to acquire a basic keyer.

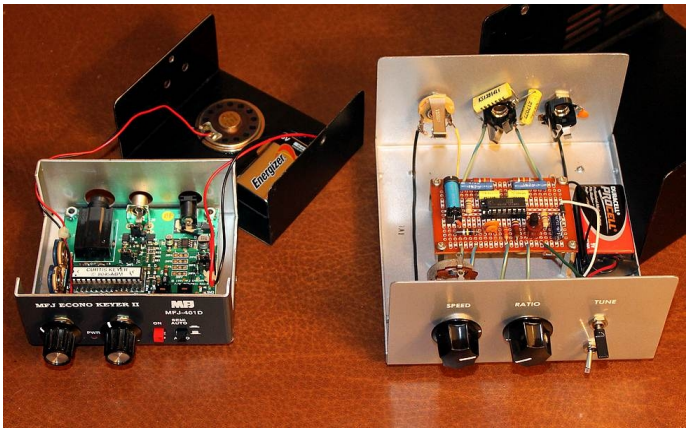

Figure 4. *Two electronic keyers. The commercial unit at left, and the home-built unit at right, employ the Curtis 8044/5 integrated circuit.*

Several single-paddle keys and numerous double-paddle keys are available for use with electronic keyers. Most have heavy bases to aid stability. You may still have trouble with lateral stability in these side-pivoting keys. If so, try placing the key on a pad of under-carpet cushioning or mouse-pad material, or the thin rubber friction pads used to help unscrew tight jar lids. Double-stick sticky tape also works.

Figure 5. *A single-lever paddle for use with an electronic keyer is shown at left. The double-paddle key at right is also suitable for iambic keying.*

In single-paddle keying, the keyer generates the proper spacing between strings of dits or DAHs. But the operator must control the proper timing of the dit-to-DAH and DAH-to-dit transitions in a code character. Double-paddle keys also allow *iambic* keying, a method in which the electronic keyer properly times all the transitions. The manual skills required by the two keying methods are distinct, and both require off-air practice. Single-paddle keying may initially be easier to learn but can become fatiguing at higher speeds. Iambic keying is rather harder to learn and control, but it does permit more relaxed sending. Although mechanically simpler than semi-automatic bugs, single- and double-paddle keys still require adjustments that depend in part on sending speed. Criteria for choosing such a key might include the range and autonomy (dit side independent of DAH side) of its adjustments.

Modern HF transceivers feature rapid switching, measured in milliseconds, between transmit and receive. At one extreme, the switching rate can be set so that the receiver comes on between each dit and DAH, no matter how fast you're sending. This feature is called "full break-in" or "QSK," and allows one to monitor the receive frequency even while sending. Some operators find QSK to be useful in contests, or when trying to contact a rare DX station that has attracted a horde of insistent callers. To others, QSK can be an annoying distraction, especially when (as I recommend) you are intent on listening carefully to your own sending. People are polite and won't usually interrupt (though you should also try to avoid being long-winded). The break-in delay is adjustable. You might try setting the delay so that your receiver stays off between letters and/or words, and comes back on between sentences. It's up to you.

Practice by operating. If you have HF capability, the absolutely best way to improve your code proficiency is to get on the air and enjoy some CW contacts with other radio amateurs. No matter what your CW speed level, you will find somebody to talk with. Don't be embarassed to ask the other operator to slow down, or to admit you're new to CW. After all, even the most experienced CW operators were beginners themselves, once upon a time. Code speeds decline as you go up from the bottom of the CW sub-bands: lickety-split at the low frequency end, more reasonable speeds farther up. Both 80 meters and 40 meters are open during the day for local contacts up to several hundred miles, and after dark to many areas of the country. Forty meters may be difficult for newcomers to use at night because of interference

from distant stations operating on voice and digital modes. When propagation permits, the 15, 12, and 10 meter bands provide world-wide communication during daylight hours. Twenty meters is often open all day long to some part of the world. Thirty meters has a good mix of local and DX stations on CW. And 17 meters often behaves much like 20 meters, but without the crowds.

Operating CW need not be traumatic. If you are unsure of your abilities, schedule some contacts with an experienced and sympathetic friend across town, or with a newcomer like yourself. Operating improves both code copying and CW operating skills. Learn when you can condense words (by omitting vowels, for example) and when you need to spell things out. This is often a matter of judgment; when a ham told me he was in *PNXAZ*, it took me a while to figure it out. When it comes to all the shorthand and jargon that hams use in CW conversation, don't feel obliged to sound like an insider. Spelling it out in plain English is always acceptable. Talk about topics other than rig, antenna and weather. Don't hesitate to ask for repeats or slower sending. If you get tired, sign off. Enter the contact in your log. Send a QSL card with a thank-you note. Whether it's your first contact or your hundredth, you will have practiced the code by using CW to communicate with another amateur.

Try making a contact every day. After a few weeks of this pleasant and rewarding activity, you'll find your CW speed increasing steadily, without any "practice" at all.

Practice by logging. If you have HF receiving capability only, or are not in the mood for a contact, try *logging*. Logging is the term I use to describe listening for and recording CW callsigns. Just callsigns. Most operators send their callsign at the beginning and end of each conversational segment. When calling CQ, they usually send their callsign more than once. Because of this repetition, it's often possible to copy callsigns at speeds that are higher than your comfort zone. Logging is an active process, requiring coordination of ear and hands: hearing, writing, tuning the receiver. In addition to providing a good code copying workout, logging also helps to develop in several valuable operating skills. Experienced CW operators know their international callsign *prefixes*, and can quickly assess propagation conditions by identifying the locations (countries) of stations heard. You can do the same by looking up any unfamiliar prefixes in the international prefix list.[5] Noting which bands are open to which corners of the world, and when, can aid in predicting future propagation conditions. Listing callsigns, wherever their place of origin, will furnish practice in gearing up the extra bit of concentration needed to copy the callsign when it does come. Recognize *73*? Callsign coming up soon. *CU AGN, AR, SK, TU, HW* all signal an upcoming callsign or two, as an operator is about to turn it over to the other person, or is coming to the end of a contact. Finally, no matter how carefully we adjust our receivers, we often can't avoid hearing several CW signals at once. Most of us can carry on a conversation with one person, even amidst the crowded hubbub of many other talkers. Being able to separate one CW signal from all the others, practiced and learned by logging, is a skill well worth developing.

All languages have a certain amount of conversational formula or ritual which allows our brains to go intermittently on automatic pilot while we continue to blab on. As a language, CW is no exception. Much of what is sent and received in a CW contact need not be written down at all. When the other person sends *MY QTH IS ATLANTA, GA. ATLANTA, GA. ATLANTA, GA*, do you write it all down (in cursive script, of course)? Or just *atlanta*. (Note that *MY QTH IS* is the same as "my my location is is.") The bare minimum contact may consist only of an exchange of callsigns and signal reports. In contests, or in pile-ups with that rare DX station in some exotic locale, this may be all you get. Learning to recognize the essential stuff and separate out the rest will reduce the level of concentration needed for effective CW communication, and will enhance your on-air enjoyment.

Listen to code practice from W1AW. ARRL's over-the-air code practice sessions are first-rate. Current W1AW schedules and frequencies can be found in *QST*, or at <www.ARRL.org>. The "fast code" format, which reduces code speed in steps from fast to slow, is especially helpful. Start by copying at a speed a bit higher than you're comfortable with. Then, when they drop down to the next lower speed, you'll be surprised at how slow it sounds (at least at first). The W1AW code sessions consist of a segment of plain text from a months-old *QST* article. Reference to the article's issue and page are given at the start of each session, and the code speed is announced (in code) at the start and end of each segment.

The Morse code from W1AW is very good, except at the slowest speeds where the Farnsworth distortion is pronounced. Experiment with NOT writing down what you hear. Listen for words and sentences. Unless you have a photographic memory, the text ma-

terial will likely be unfamiliar to you, thereby allowing a realistic appraisal of your current code copying abilities.

Further comments on code practice recordings. By now it should be apparent that I view prerecorded code practice materials to be inferior to the practice strategies outlined above. If you've already spent your money on an HF transceiver or receiver, why not put it to good use? Most importantly, listening *only* to recordings separates code copying from CW communication. Since the goal in learning the code is to enable us to speak with other people in this remarkable language, exercises that exclude this central pleasure of amateur radio can't possibly be much fun.

Recordings also have other shortcomings that make them less than ideal for improving code skills. The constant audio frequency may be not fit one's particular hearing, as when the dits and DAHs are accompanied by an audible ringing or echo that blurs the sound elements. Knowing one's own audio frequency response and preference is an important adjunct to getting the most out of a receiver. Copying at different audio frequencies is a useful operating skill, as is the ability (noted above) to copy one signal in the presence of other nearby signals. Single-speed, computer-perfect code rarely reflects the on-air reality of real CW sent by hand by real people. For these reasons, and those noted earlier, sole reliance on recorded practice materials should be avoided.

The principal aim of this article has been to encourage readers to regard Morse code as a useful and efficient medium for person-to-person conversation. Keeping this goal in mind can make the task of acquiring and improving one's CW skills a pleasure rather than a chore. I have presented a number of practice methods intended to complement those available from other sources, and have stressed the importance of moving as soon as possible to actual on-air communication as a way of combining this central aspect of amateur radio with achieving CW mastery.

Notes and references

1. "CW" means Continuous Wave(s), a term that arose in the 1920s to denote the new method for generating *constant amplitude* radio frequency energy from electronic oscillators using vacuum tubes. All radio signals today originate as continuous waves, but the term "CW" has come to mean specifically "communication by Morse code."

2. This illustration is from the ARRL's short book, *Learning the Radiotelegraph Code* (1970). Before World War II, the FCC required radio amateurs to present their code exam copy in cursive script. (We wrote neatly in those days.) Only afterward, with the return of servicemen who had learned to take down Morse code in block letters, did the FCC permit printed copy. See *QST* 30(9): 39 (1946) (September 1946).

3. Morse code instruction books often recommend a sequence of letter groups. In addition to that shown in Figure 1, the following sequence seems to have been popular: E T M A N I S O; R U D C; K P B G W F H; Q L Y J X V Z. Or, you can invent your own sequence. I cannot vouch for any of them. Be sure to include a few vowels in the first group, so you can speak and hear whole words from the beginning.

4. While I have touch-typed for more than 60 years, I have no experience copying code by this means. It is worth noting that a keyboard and other necessary electronic or mechanical paraphernalia may not always be available. Paper and pencils have yet to be discontinued.

5. The table of international callsign assignments can be downloaded from:

<http://life.itu.int/radioclub/rr/ap42.pdf.

Finley, D. (1997) *Morse Code: Breaking the Barrier*. Starkville, MS: MFJ Publishing Company. *This short book has an informative introduction to the history and development of Morse code, and describes a modified form of the Farnsworth method.*

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