# Morse Code: Efficient or Over the Hill?

*Why learn it if you haven't, and how to copy faster if you have.*

**William E. Packard, NN9U**

"Oh Morse code, Morse code, how I wish I could copy thee faster." This has been my lament for 20 years. I learned the code back in the '80s and easily passed the 13 WPM code test, but the 20 WPM test, which was required then for the Extra class license, was a different story. I failed that test by one letter — one little bitty letter. After the first examiner told me I'd passed the test, the second examiner, upon careful rechecking found "a wrong letter" in one of the fill-in-the-blank questions and failed me. That event has haunted me for 20 years.

At the time, I lived in an apartment and could only operate mobile so I used SSB and that only occasionally. Consequently, I never became adept at Morse code. Then, after a 15 year absence from the airways, in 2005, I decided to put up an antenna, fire up the rig and learn the code. I decided not to hook up the radio's microphone until I had the code under control.

## Worth Learning Today?

After getting back on the air, I was disappointed to learn that the code requirement had been cut to only 5 WPM and so the license motivation for learning faster code was gone. [In February 2007 the FCC dropped all Morse code testing from the Amateur Radio licensing requirements. — *Ed.*] I wondered if there was any advantage at all to learning the code, especially because of all the technological advances that had been made since the '80s when I went QRT (went off the air). It seemed like code might be obsolete and not worth the time investment to hone that skill.

What I found, though, was quite the opposite. For HF work, CW is still a very good choice for a number of reasons. Its major drawback is the large effort required to gain proficiency. Certainly there must be "tricks" to make learning code easier. I will discuss some of these "tricks" or tools that I have found helpful for becoming proficient with the code later in this article. First, let's discuss some of the reasons Morse code is still a valuable mode and worth investing the time to learn.

MIKE CLARE, WB3ILM

## It Breaks Through the Noise

I found that code gets through when other modes cannot. It is amazing what a great filter the combination of your ear and brain produces and how a good operator can pull signals out of the noise. There is something about dahs and dits that make them discernable in noisy conditions. If code is playing on the radio in one room, it is easy to pick out letters from several rooms away. It is hard to do that with the human voice. In addition, SSB puts energy over a large bandwidth while CW puts essentially all the signal energy into one frequency. This allows CW to get through when SSB cannot.

It has been calculated that SSB requires 13 dB more power than CW under noisy conditions to produce the same signal-to-noise ratio.[1] This amounts to a gain of 20 times. That means 100 W for CW is equal to 2000 W for SSB — pretty good. On the other hand, 5 W for CW would be equivalent to 100 W for SSB. Nowhere does an operator need to get through the noise more than when operating QRP (low power, generally 5 W or less), so CW is the mode of choice there.

One Saturday morning I picked up a faint signal from Bill, W7WEL, on 7.040 MHz. I did not know this was a QRP frequency. [Most QRP activity on the 40 meter band has since moved down to 7030 kHz. — *Ed.*] I was testing a Collins 30L-1 amplifier, blasting out 400 W. Bill tapped out his location as ST MARIES, ID and his power as 2 WATTS. I was sure I had misread him since my code was quite rusty, especially for numbers. So I tapped back DID YOU SAY TWO WATTS? When he came back with TWO W YES TWO I about fell off my chair. He was 250 miles away from me. Then he proceeded to tell me that his rig fit in an Altoids tin and he was using a wire antenna. I was amazed.

Of course, since then I've found that there are a host of operators who work the world on a few watts or less. The farthest QRP contact I've made so far has been with Mark, AB2ML, of Wappingers Falls, New York, near New York City. Mark was operating with 2 W on 40 meters into Idaho. I was happy all night after working him, for it was (and still is) so incredible to me that a radio wave from an antenna putting out the energy of one Christmas-tree light bulb can travel so far and still be intelligible. In part it is the Morse code that makes this type of radio communication possible.

## Simple Equipment, Abundant Contacts

A simple rig and antenna will get you on the air with CW. I've talked with operators who used many different types of rigs, many of which were homebrew, with simple antennas. Most of the antennas were wires, such as dipoles, long wires or G5RV types. It is entertaining to see the number of different configurations people use to transmit CW. I heard one gentleman who was attending a conference by day and by night was operating with a 25 W radio from his fifth floor hotel room, using a wire strung out the window to a tree. Another time I worked Greg, KJ6MC, as he drove his car past Fresno on his way to San Diego (I was in Idaho). I have not figured out how a person can drive and send code at the same time. I've even heard of people transmitting code from their bicycles, but have yet to make such a contact.

There are lots of interesting people to meet and talk to on the bands. My CW experience has been mostly on 40 meters from

[1]Notes appear on page 58.

7.025 to 7.065 MHz and I find many operators there. I have often turned on the radio before retiring for the night just to listen and heard someone call CQ just a few seconds after I turned the radio on. There have also been times when I was tuning/testing an antenna or amplifier and someone came back and tried to start a QSO before I even sent a CQ. That is good fishing! Of course, there are dead times on the band, but it seems so much easier to make a contact with CW compared to what I remember with SSB back in the '80s when I used SSB almost exclusively. I have noticed that CW activity seems to have decreased since then, especially in the "Novice" sections of the bands. Nevertheless, contacts abound.

MARIA MELCHIORI, K4MFM

## Still a Fast Way to Communicate and it's Dynamic

Morse code, though very old, is still a reasonably fast way to communicate for experienced operators. This was illustrated on a Jay Leno program in which two adult ham radio operators had a sending race with two young text message champs.[2] At the word "GO!" each team began sending the same message at the same time, but the code operators, seemingly effortlessly, won over the text message champs. A similar contest took place in Australia between a 93 year old retired telegrapher sending code and a 13 year old girl using her text message phone. Again, the old technology beat the new and by a wide margin.[3]

An expert operator can send code almost as fast as a person can talk. I realized this when an older ham told me an interesting story about a receiver/announcer back in the '20s or '30s who used to report horse races. The receiver/announcer was on the East Coast of the United States receiving code over his headset from a telegrapher on the West Coast who was sending the details of a race in progress there. As he listened to the code, the receiver/announcer described the race in real time to the audience gathered at his location. The receiver/announcer was receiving the code in his ears, translating it and speaking it at the same time! This story has inspired me to improve my code ability and to do so sooner rather than later, before so many of the old timers — the excellent operators — become silent keys.

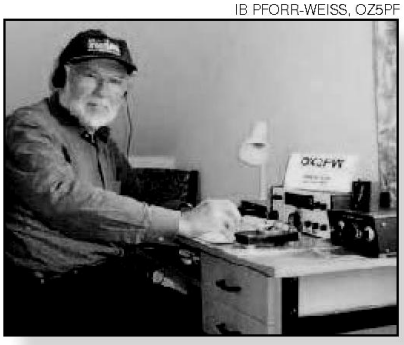
For experienced operators, code is dynamic. One can almost always hear operators on 40 meters who talk in code quickly back and forth like a fast paced voice conversation. One operator stops and immediately the other one starts sending. It sounds very dynamic, lively and fun, with no dead air time at all. Moreover, code delivered from a key or paddle — unlike typing at a computer terminal — has a more personal touch to it. The rhythm of the operator's sending, the speed of delivery and the pauses used, speak of the individual sender. This is known as their "fist." It is not as personal as speech, but it holds a firm second place. This personal and dynamic quality, which the code enables, is appealing because it is the contact with real people that makes Amateur Radio so exciting. When you call CQ, you never know what interesting person you are about to meet.

## Wisely Developed for Speed

The speed with which code can be sent is due in part to the foresight and care that Samuel F. B. Morse demonstrated when he designed it. He picked short sequences of dots and dashes, "short code" for letters that were used more frequently, such as the letter E (one dit), and "long code" for letters that were less used. It is said that he determined the frequency of letter usage by visiting a printer's shop and counting the number of characters in each type bin. The bins that had more type characters were used more frequently on the printed page than those that had fewer characters. In this way he determined which letters to assign "short code" and to which "long code."

When Morse developed his code, some of his characters had extra spaces (and non-uniform dashes), unlike the International Morse code we use today. The code we use has been modified to take out those spaces and some of the letters have been changed. It still, by-and-large, has the property that the more frequently used letters take less time to send than the less frequently used ones. Examining Figure 1 will help to illustrate this. This figure shows the International Morse code letter length (measured in units of a dit or a dot) for standard weighting for all the characters of the alphabet. E, for example, is represented by a single dot and so has a length of two dots — one for the E and one for the space that follows it. T, on the other hand, has a length of four dots — three dots for the dash and one for the following space. The graph shows that E has the shortest length (two) and Y, J or Q the longest at 14. As in normal writing E is used much more frequently than, say, Q.

IB PFORR-WEISS, OZ5PF



You will have to add extra spaces when you put the letters together to form words and sentences. There are a total of three dot spaces between letters in a word and a total of seven dot spaces between words.

Incidentally, Figure 1 can be used to compute the length of call signs and is very useful for those seeking short vanity calls.[4] In summary, code is still a viable way to communicate, in part, because it was well thought out and wisely constructed.

## For Speed, Copy Words Instead of Letters

If you would like to copy CW faster, I have some suggestions to help you. A retired telegrapher, who used to work for the Air Force back in WWII, gave me a useful hint when he said: "Learn to copy code in your head, a word at a time, and your copy speed will take a big leap forward." So I tried doing that, just listening to a QSO without pencil and paper. Sure enough, when I could pick out a word I would often know it before the last letters were sent, which caused the sender's code to seem to slow down. Unfortunately, though, I was only able to pick out a few words, and the task of learning the sounds for all the words in the English language seemed daunting. There must be a way, I thought, to exploit the recurring letters/words in the language to help learn high-speed code. In fact there is, and I want to offer some useful and practical tools for exploiting those recurring letters and words.

## Letters Appear in Groups

We learned in elementary school spelling class that letters in words appear in certain recurring patterns, not randomly. I remember in grade school being happy whenever there was an ING, OUGH or ER in a word, because those were word parts I could easily spell. Words have many more recurring patterns as a glance at the first sentence

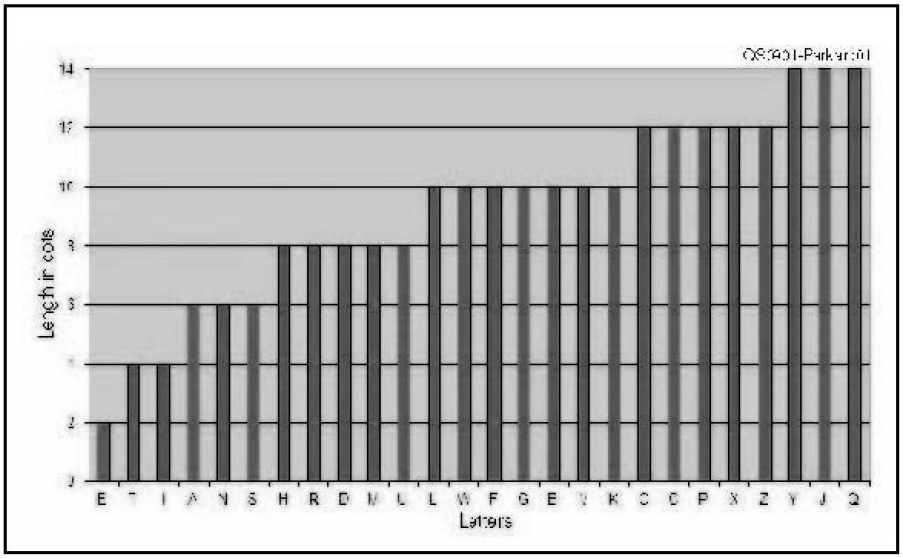



**Figure 1 — International Morse code letter length in units of dots for the letters of the alphabet arranged from shortest to longest. An E, for example, has the length of two dots, two units — one for the dot and one for the following space. T has four units — three for the dash and one for the trailing space. Standard weighting is used. Call sign length can be calculated using this figure (see Note 4).**

of this paragraph shows. That sentence has the letters IN appearing six times, the letters AR appearing three times and TT appearing twice with the double letters SS, LL, OO, RR and PP each appearing once. We ought to be able to exploit these recurring letters in our quest to learn the code, but how?

In principle, the answer to this question is easy. If we knew all the recurring letters/words in the language, provided there were not too many of them, we could turn them into code and record them on tape or on a computer and play them back until we knew them like familiar old friends. We would then be well on our way to learning high-speed code. But how can we find these recurring patterns?

Fortunately, there is a wealth of information on the subject of word and letter frequencies for both written and spoken English. Letter frequencies (the frequency with which each letter in the alphabet occurs in text) have been used by cryptographers to break substitution codes for centuries. In addition, frequency analysis for word and letter groups has been used by linguists for authorship analysis, to teach reading to children, to teach Braille and for the education of the deaf. Lists of frequent letter combinations and frequently used words are available. After listing them I will explain how to use them.

A *digraph* is a single sound in speech that is represented by two letters such as TH in "path." A *trigraph* is three such letters. The most common *di* and *tri-graphs* for the English language are given in Tables 1 and 2, respectively.[5] Table 3 presents the most frequently used double letters. These are the building blocks for words.

## Certain Words Appear More Frequently

Just as some letter groups appear more frequently in our language than others, so do certain words. Tables 4, 5 and 6 give the most common two, three and four-letter words in the English language. Table 7 lists the most common and/or frequently used words of any length. When learning the code, one of the first words the ear picks out is THE. Sure enough, this word appears in Tables 5 and 7. In fact, it is the most frequently used word in the language. A smart way to learn high-speed code, then, would be to learn the sound of each of these most frequently used words.

## Use Tables 1 Through 7 to Build Speed

Ideally, a telegrapher would know the Morse code sound for every word in the English language, or, at the very least, for every word in his common vocabulary. This is too difficult for the beginner to attain because of the sheer volume of words involved. Even a beginner, however, could learn the 150 or so words of Tables 4 to 7. These words are few enough to be easily learned, yet widely used enough to provide benefit. In addition, the letter groups of Tables 1 to 3 provide the building blocks for most of the other words in the English language. Learning the Morse code sound (as a unit and not as individual letters) for each of the words and letter-groups in the

**Table 1**

**Most Common Digraphs**

Listed in Order of Frequency for the English Language

TH, HE, AN, IN, ER, ON, RE, ED, ND, HA, AT, EN, ES, OF, NT, EA, TI, TO, IO, LE, IS, OU, AR, AS, DE, RT, VE, se, or, al, te, co

(Lower case letter groups are out of order and have been added from other sources.)

**Table 2**

**Most Common Trigraphs**

Listed in Order of Frequency for the English Language

THE, AD, THA, ENT, ION, TIO, FOR, NDE, HAS, NCE, TIS, OFT, MEN, ing, edt, sth

(Lower case letter groups are out of order and have been added from other sources.)

**Table 3**

**Most Common Double Letters**

Listed in Order of Frequency for the English Language

SS, EE, TT, FF, LL, MM, OO

**Table 4**

**Most Common Two-Letter Words in English**

Listed by Frequency

OF TO IN IT IS BE AS AT SO WE HE BY OR ON DO IF ME MY UP AN GO NO US AM

**Table 5**

**Most Common Three-Letter Words in English**

Listed by Frequency

THE AND FOR ARE BUT NOT YOU ALL ANY CAN HAD HER WAS ONE OUR OUT DAY GET HAS HIM HIS HOW MAN NEW NOW OLD SEE TWO WAY WHO BOY DID ITS LET PUT SAY SHE TOO USE

**Table 6**

**Most Common Four-Letter Words in English**

Listed by Frequency

THAT WITH HAVE THIS WILL YOUR FROM THEY KNOW WANT BEEN GOOD MUCH SOME TIME VERY WHEN COME HERE JUST LIKE LONG MAKE MANY MORE ONLY OVER SUCH TAKE THAN THEM WELL WERE

**Table 7**

**Most Common and/or Frequently Used Words in English**

Arranged Alphabetically

| | | | | | | |
|---|---|---|---|---|---|---|
| A | CAME | GOING | JUST | OFF | TAKE | WAR |
| ABOUT | CAN | GOOD | LARGE | ON | THAN | WAS |
| AFTER | COULD | GOT | LAST | ONE | THAT | WE |
| ALL | COUNTRY | GREAT | LIKE | ONLY | THE | WELL |
| AN | DAY | HAD | LITTLE | OR | THEIR | WENT |
| AND | DAYS | HAS | LOOK | OTHER | THEM | WERE |
| AM | DEBTS | HAVE | MADE | OUR | THEN | WHAT |
| ARE | DID | HE | MAKE | OUT | THERE | WHEN |
| AS | DO | HER | MANY | OVER | THESE | WHERE |
| AT | DOLLARS | HERE | MAY | PEOPLE | THEY | WHICH |
| BACK | DOWN | HIM | ME | PUBLIC | THIS | WHILE |
| BE | EVEN | HIS | MORE | SAID | THROUGH | WHO |
| BECAUSE | EVERY | I | MOST | SAW | TIME | WILL |
| BEEN | FIRST | IF | MUST | SEE | TO | WITH |
| BEFORE | FOR | IN | MY | SHE | TODAY | WOULD |
| BEING | FOUND | INTEREST | NEW | SINCE | TWO | YEARS |
| BETWEEN | FROM | INTO | NO | SO | UNDER | YOU |
| BIG | GENERAL | IS | NOT | SOME | UP | YOUR |
| BUT | GET | IT | NOW | STILL | UPON | |
| BY | GO | ITS | OF | SUCH | VERY | |

seven tables would put one well on the way to mastering high-speed code. What are some practical ways these words/letters can be learned?

One could regularly practice sending the letters/words from Tables 1-7, record the code for these on a cassette tape, CD or computer and regularly listen to them. (When recording them, be sure to send individual word/letter-groups at 20 WPM or more, putting ample space between them so the word/letter groups can be heard and learned as a unit.) Sending only tables can be pretty boring, so, in addition, use the letters/words to make sentences. This is important, because not only are there common words in the language, but there are also common phrases or arrangements of words. It will build your speed to hear the words in sentences, too. For example, I used the letters of Table 3 (the double letters) to make this funny little sentence to use for my own code practice:

"Dell's little feet looked different during summer session classes especially after he fell off the roof and shattered his goofy little glasses."

Nearly every word in this sentence has a double letter from Table 3, and those that don't use the *di* and *tri-graphs* of Tables 1 and 2. In addition, the sentence offers good sending practice especially for words like "session" and "glasses," which are made of many "short code" letters. The number of sentences that can be made is endless. Perhaps you could make a family game out of writing funny little stories using the letters/words from these tables. In addition, these sentences and tables could be sent for code practice on the HF bands or even on 2 meters for a local practice group. Someone might even feel inspired to set up a Web page listing sentences using the words or letters from these tables (particularly Tables 3-7), which others could then use for code practice. The possibilities are endless. Let your imagination guide you.

## Conclusion

In this article I've tried to share with you the reasons I feel the code is still worth learning, even in the 21st century. It is still efficient and useful and that makes it appealing. More reasons for learning the code could also be listed, not the least of which is that it has a nostalgic character to it. Despite all its benefits, its major disadvantage is that it takes a seemingly inordinate amount of time to master. I hope this article will help in that respect.

I have presented several tools (Tables 1-7) for achieving high-speed code. I've found them useful in my own quest for faster code and I hope you will too. In fact, after sending and receiving these tables just a few times, it amazed me how many of those words/letters I picked out the next time I listened to high-speed code on the radio. After hearing so many of the words from the tables in the QSO, I began to wonder if the operators were using the tables. They weren't. They were just having a good ragchew.

The point is: The words in these tables are everywhere and these tables will work for you, too, if you give them a chance. Remember: Learning high-speed code may not be easy, but it is fun, and it is the journey, not the journey's end, that brings joy. Good luck, and together we can heat up the aether with our lightning-fast code and finally put to rest the lament, "O Morse code, Morse code, how I wish I could copy thee faster." Hope to hear you on the air. So for now 73, C U L and keep tapping.

**Notes**

[1]See **www.qsl.net/zs1an/morse.htm** and references therein.

[2]The video clip can be viewed at **http://blog.makezine.com/archive/2005/05/video_morse_cod.html**.

[3]"Old Tech Versus High-Tech," *World*, May 2005, p 11; **www.worldmag.com/articles/10686**.

[4]To calculate the length in units of dots for a call sign, determine each letter's length from Figure 1; then add two units for each character in the call (including the number) to account for spacing between characters and, finally, add in the units for the number, where numbers 0, 9, 8, 7, 6, 5, 4, 3, 2 and 1 are 20, 18, 16, 14, 12, 10, 12, 14, 16 and 18 units, respectively. For example, N5EE, one of the shortest US calls, is 28 units long, compared with, say, KJ0QYJ, one of the longest at 98 units.

[5]See **http://deafandblind.com/word_frequency.htm** for Tables 1-7.

*William Packard, PhD, is an ARRL member and a physics professor at Northwest Nazarene University, Nampa, Idaho. He has written numerous scientific papers, but this is his first QST article. Bill is the trustee for the university Amateur Radio station, N7NNC, and is involved with the Near Space Club on campus, where they launch weather balloons up to 100,000 feet. They use Amateur Radio for communications and to track the balloons as well as providing a video downlink for balloon flights.*

*First licensed as a Novice in 1984, Bill upgraded to Advanced class in 1986, but did not upgrade to Amateur Extra because of the 20 WPM Morse code exam in effect at that time. His old logs show that he operated throughout the 1980s, but went off the air during the 1990s. By the beginning of 2005 he decided it was time to learn high speed CW and get on the air again. In April 2005 he upgraded to Amateur Extra and then applied for his vanity call sign, NN9U. Bill can be reached at 2915 Sioux St, Nampa, ID 83686 or at* **nn9u@q.com**. QST

# New Products

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# Strays

## I would like to get in touch with...

◊ hams at any California State University or UC campus, whether student, alumni, faculty or staff, who would like to get involved with emergency communications. Our group was formed to alleviate communication problems as experienced after the Northridge quake. — *Glen Shiery, AF6Z,* **grshiery@csupomona.edu**