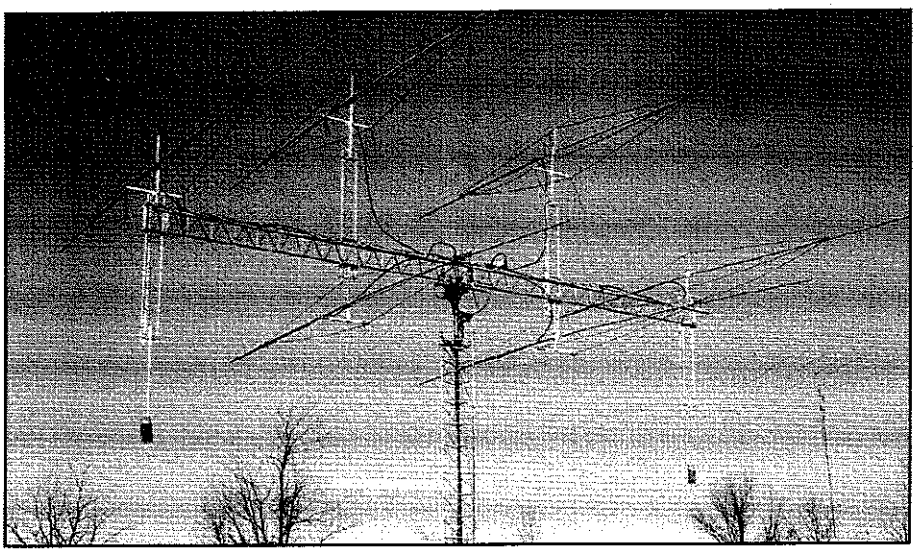
By Steve Ford, WB8IMY

A Conversation With... Mike Cook, AF9Y

The first in an occasional series of interviews with hams who are making important contributions to our hobby.

Mike Cook, AF9Y, describes himself as an "incurable experimenter." What else would you expect from a ham who attempts to bounce signals off comets? Living in Huntertown, Indiana, Mike is the Communications Systems Engineering Director for ITT Aerospace Communications Division in Fort Wayne. He received his BSEE from Clemson University.



AF9Y's homebrew moonbounce (and "cometbounce"?) array. The antennas are 6 × 22 elements on 42-foot booms. The H-frame has a 50-foot cross boom made from 22-inch tower sections and 20-foot risers made from 14-inch tower sections. The array can be tilted ±50° in elevation, as well as the normal azimuth/elevation control. The whole tower tilts over with an electric winch to allow on-ground maintenance.

Q: I heard that you once issued a challenge to the ham community—$100 to anyone who correctly copies a specific moonbounce signal. How did the challenge work?

Yes, the $100 prize has been offered on my Web page (**http://www.webcom.com/af9y**) since 1995. Anyone who visits the site will find a one-minute digital recording (a WAV file) of a weak moonbounce station responding to my CQ. The downloadable file is called UNKN422.ZIP.

I couldn't complete the contact because the caller's signal was so far down in the noise. I couldn't even decipher one letter of his call sign during his one-minute transmission. Fortunately, the computer was recording the signal directly to disk. Using that recording, I attempted various signal processing techniques, combined with audio and visual methods, on and off for about a year before coming up with a reasonable guess. A telephone call to the station confirmed that my guess was correct. Since I had spent so much time attempting to decode the call sign, I wondered if anyone else could do it easier. That became the challenge.

The intent of posting the prize was to push the technology beyond the simple filtering techniques used by the standard DSP boxes sold today. A processing approach that can make this signal copyable to an average user would represent a major advancement in technology.

Q: Did you have a winner?

Yes. After two years and hundreds of submissions from around the world, Gary Huntress, a nonham, correctly identified the station. I felt sure that one of those super CW operators we all hear about would have the edge, so Gary's win was a surprise. Gary has agreed to keep the identity a secret so that the contest can continue for at least one more $100 award.

Q: Do you think it's ironic that a nonham won the prize?

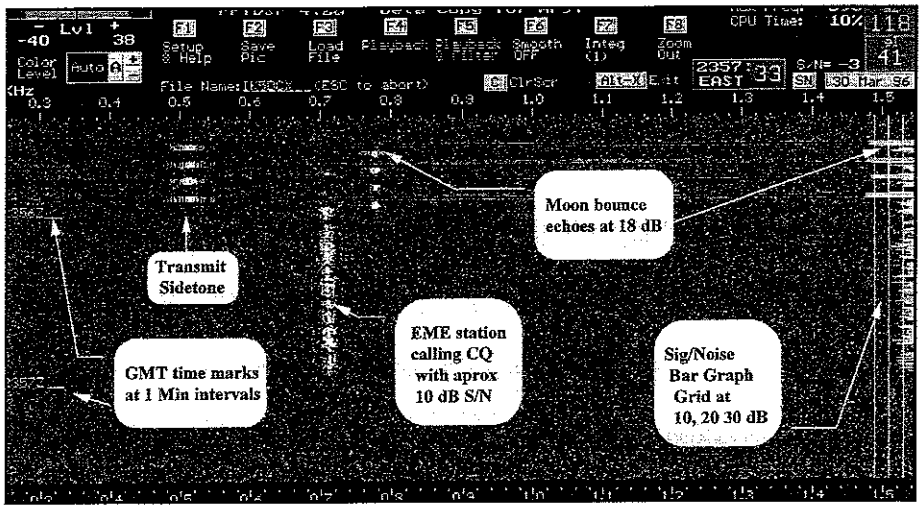
Yes, especially since there were many more submissions by hams than nonhams!

Q: Some hams believe that digital signal processing techniques will revolutionize weak signal work—particularly moonbounce. Is this true?

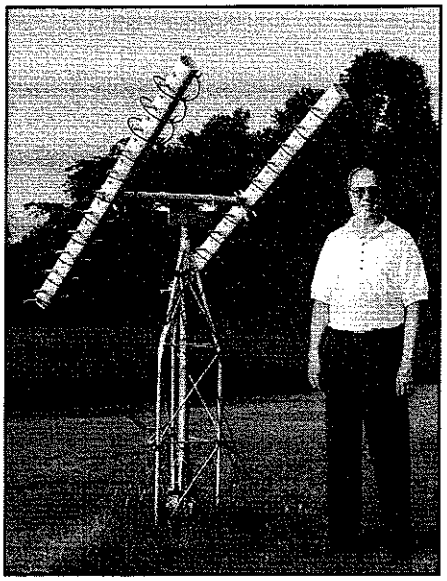
The revolution will come only with new waveforms. Digital signal processing techniques applied to our current CW, SSB and FM waveforms can provide modest improvements in perceived quality, but little in real information gain. The UNKN422 file is a good example. A good CW operator can usually pick my call out of the noise using either a 500-Hz analog audio filter or "state-of-art" DSP 20-Hz filter. The human brain can filter at between 20 and 50 Hz, so the DSP filter is not providing any real information gain. I am not saying that a DSP filter has no value. It can make listening in noise less tiring and for some operators it may make the difference in copying a few extra letters.

Q: Will DSP ever make it possible for hams with small stations to work moonbounce?

What constitutes a small station for moonbounce? I believe we should be working toward an approach that allows a two-way exchange of calls during a 30 minute period with the following minimum system



A sample of the *FFTDSP* software (with labels added by Mike) as seen on his Web site at **http://www.webcom.com/af9y**.



Mike Cook and the twin 70-cm helix antennas he used to receive signals from the Mars Global Surveyor.

at both ends of the link:

- 200-W transmitter output
- A pair of 10-foot antennas, or one 20-foot antenna
- 0.5 dB NF receive system

It appears that 432 MHz offers the greatest opportunity to meet this objective with current technology. Still, a processing gain of approximately 15 dB over the typical CW waveform would be required for a better than 50% chance of completion.

Polarity rotation has a major impact on moonbounce operation. Signals are very likely to arrive at angles other than the receive antenna polarity. Leif Asbrink, SM5BSZ, has spearheaded a small revolution in this area by developing practical polarity controlled antenna/receiving systems. We need a similar breakthrough in the waveform area. Phil Karn, KA9Q, and Tom Clark, W3IWI, have studied and proposed several good ideas, but nothing has yet been demonstrated.

Q: Tell me about the* FFTDSP *software you've developed. What can the average ham do with it?

With help from W9HLY, the *FFTDSP* program has evolved over several years. It allows an IBM compatible computer to "see" weak radio signals. It interfaces to your radio by connecting the receiver audio output to the computer sound card. A continuous running color map of the sound is displayed and updated every half second. The map shows sound frequency and intensity level. This type of map is called a spectrogram and will show signals far below the level detectable by the ear. SETI searches as shown in the movie *Contact* often use this type of display.

Potential uses are:

- Find a weak CW signal while in the receiver full bandwidth mode (2.4 kHz). The signal can then be centered for better copy with external audio/DSP filters.
- Monitor beacons over several hours and then review drift and peak receive periods.
- Check receiver alignment within 2 Hz using WWV audio
- Monitor meteor burst Doppler shifts and signal strength
- N6EGQ has used it to detect earthquakes in California!

A demo version of the *FFTDSP* program is downloadable from my Web page. It only runs for about 60 seconds, but it gives you a small taste of what it can do. Hams can buy the registered version from me. All the details are on the Web page.

Q: I heard that you managed to copy the 70-cm beacon signal from the Mars Global Surveyor. How did you do it? How far away was the spacecraft when you received the signal?

NASA provided data on the expected signal level at Earth during a planned Mars Global Surveyor transmitter test on November 25, 1996. My calculations showed that the signal would be too weak for audio detection with reasonable-sized antennas. Using a pair of 5-foot helix antennas and a mast mounted preamp, the signal level would be less than –171 dBm! As a comparison, my "mystery moonbounce" signal is barely detectable by ear and it's approximately 16 dB stronger.

On the plus side, the continuous carrier from MGS was ideal for detection with the *FFTDSP* program. An integration feature of the program was used to further increase the sensitivity for carrier detection. My tests showed that signals as low as –179 dBm could be detected over a 1300-Hz search window.

When the transmitter was activated at 1413 UTC, I was delighted to see a clear carrier line forming in the *FFTDSP* display. The line clearly showed the expected Doppler shift, as well as the varying signal strength as the MGS antenna rotated. During the test, the satellite was about 3.5 million miles from Earth. That's seven times the round-trip distance to the moon!

Pictures of the received signal, as well as construction information on the helix antennas, are also available on my Web page.

Q: I know that you've attempted to bounce signals off the tails of comets. Any success?

Not yet. During the March 1996 appearance of comet Hyakutake, I made an attempt using my moonbounce array and the *FFTDSP* program. A continuous 1500-W, 144.1 MHz carrier was transmitted for 45 seconds. The receive period was 75 seconds. Any reflection from the comet should have been visible as a line trace during a portion of the software's receive window. Nothing was seen. The comet ionization was probably too poor at VHF.

Q: How do you feel about the future of Amateur Radio? Where are we heading?

I'm a little worried that Amateur Radio is not attracting the creative talent it did years ago. Instead of blaming Internet and computers for our decline, we should be embracing them as tools to attract and inspire the next generation. The lines that used to separate computer hobbyists and hams are dissolving; the hobbies are beginning to merge. Huge numbers of hams now have e-mail addresses and surf the Web regularly (or have Web sites of their own). I see this as a positive development, not as a threat to Amateur Radio.

Sometimes we're our own worst enemies. We need to reduce the in-fighting on issues like spread spectrum, CW and so on. We should set our differences aside and combine forces to fight the real enemy, which is the continued government sell-off of the RF spectrum.