by Kees Kaper, NCE

Spreading the Word

TEACHING WIRELESS TECHNOLOGY

Kees Kaper was born in Holland. Beginning at about age 14, Kees attended technical school. He moved to Canada in 1980 where he has lived ever since. Among his many life experiences, Kees has had the opportunity to teach "non-technical" students a thing or two about wireless technology through a course at a local college. He shares some of his experiences in this article.

In December, 2001, I noticed that a college in Alberta offered a Telecommunications Certificate Program. The program consisted of 5 sections: Fundamentals of Telecommunications, Telephony, LANs, Public and Private WANs, and Wireless Communications.

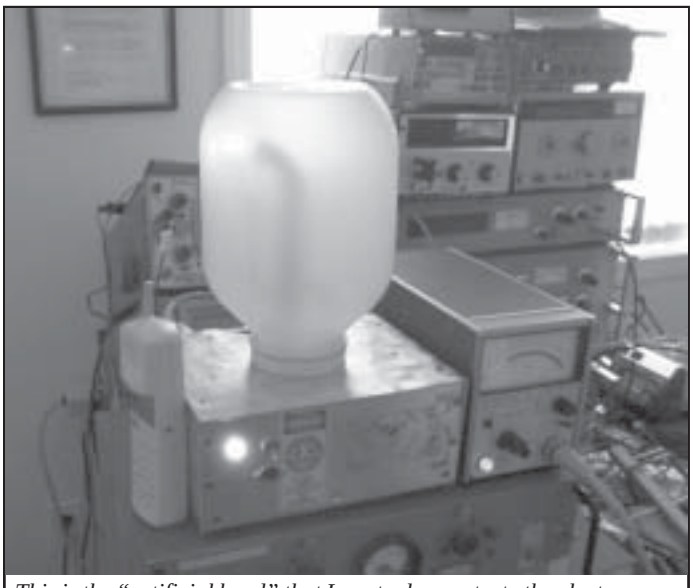
I contacted the college and talked to the program director as I was interested in giving a lecture about wireless applications as part of the Wireless Communications segment of the course. She was amenable to the idea and after further conversation, she asked me to consider teaching the entire wireless communications segment of the program. I said that yes, I would like to do that. "This will be a piece of cake!" I thought. After all, I had previously lectured at three universities, various schools, and at many ham radio clubs. I had also given lectures to co-workers at two of the companies where I had previously worked. So I thought teaching this wireless communications course would be easy. But was I wrong.

As the program director explained, most, if not all, of the students who would be enrolled in the course would not have a technical background. They wouldn't know much about the field of telecommunications and wouldn't know anything about, or even have heard of, Marconi, Tesla, or Armstrong. So, I had to gear my lectures to a new kind of audience compared to the lectures I had previously given.

I found that the equipment I used in my lectures was particularly helpful to the students. Some of the equipment I use on a regular basis includes a spectrum analyzer, an oscilloscope, a function generator, antennas, wireless cameras, and my "artificial head."

The Adventure Begins

My adventure in teaching non-technical students began on February 21, 2002. I was prepared for this first class with my equipment set up on two long tables and my overheads ready to go. As I looked at the students, though, they appeared to have glazed eyeballs. They had never seen this kind of equipment before in their lives and some of them appeared to be overwhelmed, so I had to be sure to thoroughly explain the basic functions of the equipment so that they would understand.



This is the "artificial head" that I use to demonstrate the electromagnetic field in a person's head and the effects of a wireless or cordless phone in proximity to the head.

I began by showing the radio spectrum from the cell phone base stations on the spectrum analyzer. That seemed to go well, so I went on to demonstrate sinewaves and pulse on the oscilloscope. Then, on to a discussion about Hertz and the difference between frequency and wave length. The students would have learned about frequency and wave length in the Fundamentals of Telecommunications classes that they took prior to this class.

So, after one hour and fifteen minutes, we took a coffee break.

I use a spectrum analyzer to show the students the signals from a wireless modem.

Four of the fifteen students did not come back.

I was feeling badly about those four students, but the other eleven stayed, and I continued to demonstrate the equipment.

Next on the agenda was the "artificial head." (See photo) The head (plastic bottle) is used to demonstrate that there is a magnetic field created in a person's head. Inside the bottle are a probe and a light. If a wireless or cordless phone comes in close proximity to the head, the probe will pick up the RF signal from the phone. The probe is connected to a power meter and also to a light bulb in the head. The closer the phone gets to the head, the brighter the light, which is a representation of the electromagnetic field in the head. The power meter was calibrated so that if a person held a phone 2 inches from the artificial head, the power meter would display 0 dbm where 0 dbm represents 1 mW. Since there is 20 dB attenuation between the phone and the probe, the power output from the phone is actually 100 mW.

The students loved it. The artificial head was a hit. Each student then used his or her own phone to interact with the head.

After some additional demonstrations with the equipment, it was time to conclude for the night and the students left.

The next day, I phoned the program director and told her that four students had left my class at the break. Her response was that that wasn't bad at all; if all of the students had left, that would have been bad. That made me feel much better. At least the other eleven students persevered through the end of the semester.

The Basics of Cellular Networks

At the beginning of the second class, I conducted a quick review of the content I presented during the first class and then moved on to the basics of cellular networks. The discussion included information about cell coverage areas, the geography of the region, cell phone towers, and antennas. I included an explanation about the function of an antenna based on its size versus its wavelength, as well as the function of the antenna feed or feedhorn and transmission lines. Some of the antennas I displayed included telescopic, yagi, and parabolic in the 46 MHz to 47 GHz range. I also demonstrated directivity and antenna gain by using 860 and 915 MHz yagis connected to the spectrum analyzer.

Some of the concepts about cell phones included the basics about the transmitter and receiver in each cell phone or cordless phone as well as in the base station, and their functions. Again, the spectrum analyzer came in handy to demonstrate the frequencies between the phones and the base stations.

Another topic of discussion was attenuation, including an explanation of line of sight or lack thereof and what affect that has on the higher frequencies (above 1 GHz). This was an opportunity to present a real-life situation from my pioneering days 28 years ago, of which I have a tape recording for posterity. I had designed a 10 GHz receiver in 1975 and used it in 1976 to make the first 10 GHz transmission from Belgium to England conducted by super refraction propagation. Of course, first I had to explain super refraction propagation to the students. Once I took care of that little detail, I played the recording, explaining that the transmission had traveled over 60 miles when a ship interrupted the link about 4 miles outside of Dover. The ship was a large oil tanker, so the massive size of the ship blocked the transmission path for a minute or so. Once the ship sailed past a certain point, the transmission successfully continued to its final destination. I still use that receiver, mostly for demonstration purposes.

By the end of the second evening, the students seemed to be feeling a little more comfortable around the equipment and appeared to enjoy the demonstrations. They even asked over a dozen questions, so I knew that, not only were they listening, they were comprehending.

To top off the night, I told the students to meet at a satellite ground station for the next class the following week – everyone likes field trips! During the tour, most of the students seemed to be truly impressed with the size and amount of equipment at the station and they recognized several pieces of machinery, including a spectrum analyzer and the feedhorns from the parabolic dish antennas. After our two-hour tour, we thanked our guide for an interesting evening and everyone went home satisfied customers.

This is the satellite ground station we visited during a class field trip....

...and here we are inside the ground station.

Speakers and Quizzes

During the fourth evening of class, I invited a guest speaker from Telus Communications to address the students. The gentleman discussed the company infrastructure and answered many questions the students had about cell phones. Some of the other topics covered that evening included a review of our tour at the satellite station, Bluetooth and very short-range connections, the IEEE 802.11b wireless standard regarding spread spectrum, and interference in the ISM band, and then finished with a 15-question quiz.

A guest speaker was also on the agenda for the fifth evening of class. The speaker talked about what it takes to plan and set up wireless internet. As a demonstration, he and I set up wireless modems at 915 MHz and 2.4 GHz using two laptops and a spectrum analyzer. The students were able to see what the spectrum looks like during frequency hopping and direct sequence spread spectrum. After the demonstration and a coffee break, we reviewed all of the subjects from the previous four classes and finished with a short quiz.

For the sixth and final class, the students endured a final exam. The exam was open book and included thirty-one questions, such as, "If a frequency is high, what is the wavelength?" After two and a half hours, all of the students had completed, and passed, the exam.

The Adventure Continues

Since that initial semester, I have taught the course for a second and a third semester. I have found teaching to be very challenging, particularly when dealing with "non-technical" people, but I have also found teaching to be a very satisfying experience.

I learned later that the four students had taken the wireless course on the internet. They found the internet course to be more difficult, particularly since they missed out on the equipment demonstrations, not to mention the field trip to a Canadian satellite ground station where the students were able to see some of the equipment being used in a real-life setting.

I'm happy to report that after that first coffee break in both the second and third semesters, not one student walked out. Not bad!

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Kees can be reached via email: kaperk@3web.net and welcomes the opportunity to appear as a guest speaker in the U.S. or in Canada.