Radio Waves
News you can use for license instruction and radio science education
ARRL — The national association for AMATEUR RADIO
Fall 2015

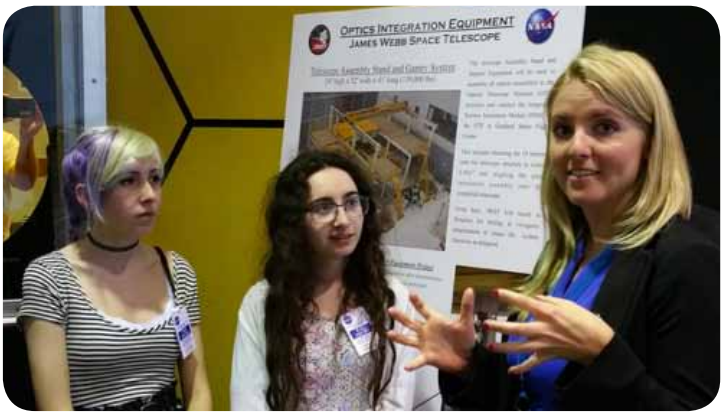
INSIDE THIS ISSUE:

Don't Miss...

The biannual School Club Roundup is an educational and fun way to get students involved in Amateur Radio through school club sponsors. The next SCR will be held in February. Find out what it's all about and how your school club can participate in the October *QST* article by Steve Williams, W3JX, "Getting an Education at School Club Roundup" (for the online article, ARRL members point your web browsers here).

Using Sensors to Explore Terraforming

BY RICHARD MUREK, W2LCN



Pequannock Joint Technology Activity Club students Julia Squier and Alexa Mileski speak with a NASA scientist about data collection using optical sensors. (Photo by R. Murek)

In Pequannock Township (New Jersey) High School where I teach, students benefitted from techniques I learned in the ARRL's Teachers Institute TI-2 session on remote sensing and data gathering.

Recently, a group of girls in my meteorology class asked me about remote sensing and data collection to expand on an earlier project that examined the concept of terraforming on Mars. The initial project touched on processing methodologies, robotics, and coding that could be used to separate frozen water from soil.

I explained some methods the students could use for data collection, including satellites, high-altitude balloons, and ground stations. Then the best solution hit me: the remote sensing marine research buoy introduced during the TI-2 session.

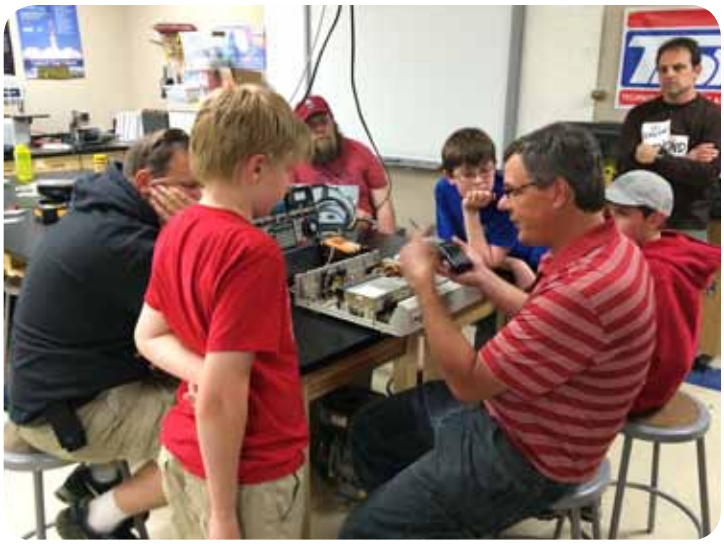
The TI-2 session gave me the know-how to show the students some ways of converting electrical signals into usable information that could be sent over APRS (automatic packet reporting system). The circuit created for the TI-2 course was especially suitable for this.

The students decided to use the buoy to collect real data and show the APRS data with a graph. We ran the buoy for several weeks in the classroom as outdoor conditions weren't conducive during the winter. The students next added a pico balloon (a party-sized balloon that can carry about a 60g payload) to simulate another way to collect data near the Earth's surface.

The project was followed by a presentation on gathering remote data from deep space through multiple devices on Earth's surface. The team then took it a step further and contacted NASA to learn more about the technology. Since then, students from PTHS have visited the Goddard Space Flight Center — what a proud moment for all.

Richard Murak, W2LCN, is a STEM teacher. He and his students formed a Joint Technology Activity Club and school station KD2HWZ.

STEM School and Academy ARC Builds Repeater



STEM School and Academy students and involved parents look on as the repeater is tested. (Photo by Paul Veal, NØAH)

The award-winning STEM School and Academy in Highlands Ranch, Colorado, is a charter school that offers a wide variety of diverse, project-based learning (PBL) opportunities for middle and high school students. Armed with an ARRL Education & Technology Program grant and Teachers Institute training, its faculty is making Amateur Radio an important element of that mission, and that's paying big dividends in the PBL educational approach of the school's Amateur Radio club, ABØBX ARC, and RF education modules in its engineering curriculum.

With the TI support — augmented by generous donations of equipment and teaching time from club Elmers — STEM School and Academy students recently installed a 70cm school repeater, ABØBX/R, which serves the south metro Denver community.

Sixteen-year-old Skyler Fennell, KDØWHB, a senior at the Denver School of the Arts (STEM Academy programs are unique in that they are open to any student in the area) and ABØBX member, was the student project manager and visionary on the three-month repeater project. Receiving IT guidance from the school's parent group, Skyler designed the repeater operations, programmed the Raspberry Pi-2 board, and taught fellow students how the repeater functions.

ABØBX/R operates off 5 W on 447.225 MHz. The PL tone is 141.3, offset –5 MHz with AllStar 41967 and EchoLink 373051. Its LMR-400 feed lines and Diamond X-50 antenna, which is approximately 28 feet above the ground on top of the school's two-story building, are from the ARRL ETP grant. Although there are currently some minor line-of-sight issues because of topography, "coverage is pretty good from 15 – 20 miles away," says Skyler, who holds an Amateur Extra class license.

In addition to ABØBX/R, the STEM School and Academy has been engaged in other radio-related learning projects since last year, including getting a team involved in amateur radio direction finding and an Edge of Space Mission (EOSS 202), in which 12 others schools participated in a high-altitude balloon launch carrying an assortment of payloads. Plans are also under way to build a satellite antenna array.

Student in the Lead

Skyler Fennell, KDØWHB, the driving force behind the STEM School and Academy repeater project, has created Amateur Radio-related videos and uploaded them on YouTube. For his basics on the AllStar link system, which is installed on the school's repeater, check out his posting at **https://youtu.be/nPl5bf4BiWE**. He also made a video on setting up your own AllStar node with a PC; to view it, point your web browser to **https://youtu.be/jJa0Rsj3ZyY**.

Amateur Radio Extra Skyler Fennell, KDØWHB, works on the repeater he designed. (Photo by Paul Veal, NØAH)

Community College's DIY Spirit Shines for ARISS Contact

Tulsa Community College students pose with elements of the temporary ARISS set-up they built. The school group even built the HB tilt over tower.

Students at Tulsa Community College, Northeast Campus, Tulsa, Oklahoma, learned about space communications with Amateur Radio on the International Space Station (ARISS) from the ground up.

Preparing for their scheduled ARISS contact — during which they would actually speak with an astronaut in space via Amateur Radio —TCC students participated in a design contest for the 2-meter antenna to be used during the event. They even assembled the temporary ground station that would make the contact (the school's Amateur Radio club also has a permanent station).

Led by teacher Thomas Henderson, WD5AGO, an associate professor of electronics at Northeast Campus, students tested their antennas by hand-tracking the ISS and conducted receiving tests with the assembled ground station prior to the day of the contact to sharpen their skills.

"We did the students' antenna receiving tests *before* the ARISS contact, as I believed (and now know) there would have been too much going on during that 10-minute ISS window," says Henderson.

The hard work paid off on July 1, 2015, when students ranging in age from 13 to 60 successfully worked ISS station RSØISS, asking cosmonaut Gennady Pedalka, RN3DT, 13 questions. These included a question from a deaf engineering student, which was managed through an interpreter (the campus is home to the Resource Center for the Deaf and Hard of Hearing).

TCC is Oklahoma's largest community college and its Northeast Campus, located near Tulsa's industrial and aerospace hub, is where Electronics and Engineering Technology classes are held. The club station, TCC-ARC, consists of two towers for HF and VHF, along with two Earth-Moon-Earth and radio astronomy arrays.

A video recording of the contact with the ISS is available **here**.

Ears on the ISS

What kind of antenna would you choose if you were homebrewing for an ARISS contact? The TCC group went with these:

Antennas: Two homebrew 8-element, optimized wideband low impedance (OWL), measured 11.0 dBD (decibels related to dipole antenna) each, or 14 dBD total, mounted at 45 degrees, fed with 75 feet of LMR 600 (½ inch hardline), under 1 dB loss measured

Backup: Two omnidirectional Big Wheels stacked ½ wavelength above each other, horizontally polarized, gain measured 5 dBD

"I built the first 8-element prototype Yagi, then we added a second and experimented between circularly polarized and operating vertical/horizontal together," says TCC Associate Professor Thomas Henderson. "We also calculated for this pass (of 20° max) that a stacked omni horizontal antenna as a backup would work fine, and the backup station heard RSØISS great. Our stationary TCC ham station and towers are in back of the building and would have taken another 200 feet to get at the best operating spot. Besides, the students needed to see how a temporary set would work."

***Editor's Note**: The Amateur Radio on the International Space Station program lets students worldwide experience the excitement of talking directly with crew members of the ISS, inspiring them to pursue interests in careers in science, technology, engineering, and math, and engaging them with radio science technology through Amateur Radio. The scheduled contact between TCC students and the ISS was one of 34 sponsored by ARISS so far this year. Learn more about ARISS and how to apply for a scheduled Amateur Radio contact with the ISS at* **www.arrl.org/amateur-radio-on-the-international-space-station**.

Outreach

Amateur Radio Club Helps Boy Scouts Earn Radio Merit Badges

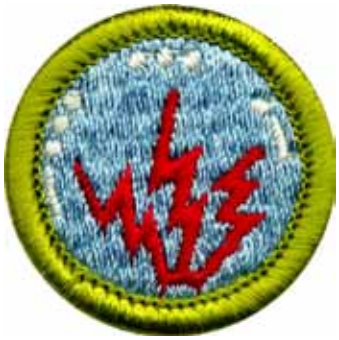
BY RON OCHO, KOØZ

After operating a busy Field Day at Boy Scout Camp Bunn, near Hettick, Illinois, the Macoupin County Amateur Radio Club, K9MCE, realized it could reach even more youngsters by helping campers achieve the Boy Scouts of America's Radio Merit badge. We proposed our idea to the organization's Abraham Lincoln Council (Springfield, Illinois), and it gave its approval.

Working toward a Radio Merit badge introduces scouts to commercial and hobby radio as well as to pathways to related careers. Macoupin Club would provide instructors: Mark Kerhlikar, WD9HBF, a music teacher with summers off; Jim Pitchford, N9LQF, the Macoupin County EMA director with flexible working hours; and me, a retired teacher. Before we could become Radio Merit badge counselors, though, we needed to complete the online Boy Scouts of America Youth Protection training course. That done, we were ready to offer our camp course.

We met for one hour a day for four days and offered another hour of "free time" for on-the-air activities after each class. We told the scouts on day one that we were there for them, and that if they committed that time with us, at the end they would have their Radio Merit badge requirements met.

Mark Kerhlikar, WD9HBF, making a satellite contact with Boy Scouts of America campers. (Photo by Ron Ocho, KOØZ)



Boy Scouts of America's Radio Merit badge.

Mark obtained a nice Powerpoint© presentation about the badge along with worksheets we used throughout the course. Being strong believers in visuals and hands-on learning, however, our "educational centerpiece" was an HF transceiver connected to a 20 meter bazooka antenna that we used every day, and which was augmented by HTs. Every scout was encouraged to make a contact, and each one who did received an ARRL First Contact award. We didn't force anyone to make a contact, but for those who did Mark, Jim, and I would start the next day's session with a little ceremony presenting the scout with his award. The scouts loved this, and the fun quickly became contagious.

The four days spent with the scouts were intense, but highly rewarding. Without exception, they walked away knowing a lot more about radio and, more importantly, feeling that the time spent was worthwhile. One reason we felt we were successful is that we didn't present ourselves as professors looking down on scouts as lowly students. Instead, we encouraged active participation and checked for comprehension. Our biggest indicator of success was when the scouts were not only less fuzzy about a concept, but wanted to delve even further into it. With the limited time at our disposal, we offered the scouts some resources (ARRL, clubs, and websites) to help them become involved in radio communications. It didn't get better than when some scouts asked, "What does it take to get a Technician license and who should I contact?"

Camp Bunn Director Jerry Daniels, KC9HQB, summed up the experience best: "It's exciting to see these kids so pumped up about this hobby. You've presented the true sense of this merit badge, which is to introduce the scouts to hobbies and careers."

Ron Ocho, KOØZ, has been licensed since 1974. He enjoys all things ham radio and sharing it with others.

Getting New Hams on the Air: The Evolution of a Licensing Class

Located on an island in the San Francisco Bay, the city of Alameda and its population of over 75,000 has to be self-sufficient in case of an emergency. It needs topnotch citizen emergency response teams (CERTs).

The city's first CERT teams, sponsored by the Alameda Fire Department, soon realized that having some licensed radio amateurs operating FRS radios was insufficient for its growing needs, mainly due to the poor performance of the radios, their short range, and disappointing NiMh battery life. The Alameda CERT Executive Committee (ACEC) knew they had to swell their amateur ranks and take advantage of the reliable HTs Amateur Radio operators could use.

Step one was to offer a licensing path, initally with a series of six weekly training classes. While the course success rate was very high, it was obvious that merely having a ticket wasn't enough, so Alameda CERT's Get on the Air class was born.

Going beyond the typical "Ham-Cram" licensing session, GOTA classes focused on using VHF/UHF communications and included reviews of two-way radios; technical orientation for the radios; operating protocols and types of messaging for simplex and repeater operations; and hands-on exercise.

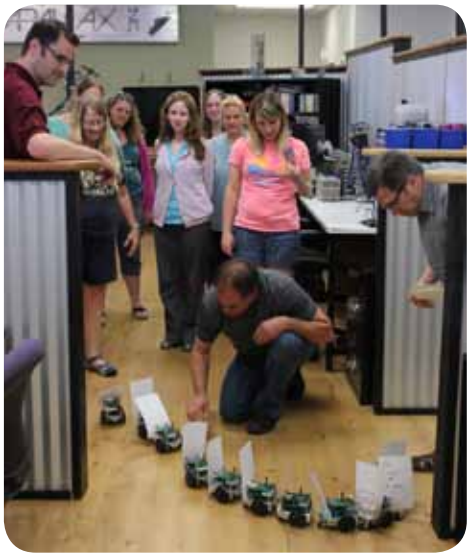
Not only did GOTA classes lead to the desired increase in the number of effective radio operators, those operators were better prepared. To maintain high standards, all newly licensed CERT operators are now required to participate in the GOTA class before they can be recognized as full-fledged radio communicators. They are also encouraged to participate in a weekly net, which most eagerly do.

Given the success rate of this approach, the ACEC decided to completely abandon the use of FRS equipment, a radical step made feasible thanks to Amateur Radio and a fresh outlook on training.

Former Alameda CERT member David Haycock, KI6AWR (he has since relocated), developed the GOTA curriculum, which focuses on practical skills to get new licensees comfortable on the air. Topics in the syllabus include simplex and repeaters, programming radios, and simplex and repeater protocols. Haycock has shared his course outline with the ARRL (see **www.arrl.org/instruction-teach-and-train-new-hams**).

Education & Technology Program News

The ARRL conducted three sessions of the Teachers Institute on Wireless Technology this past summer, which included two introductory sessions of the TI-1 "Introduction to Wireless Technology," and one session of the TI-2 "Remote Sensing and Data Gathering." Thirty-two teachers from 21 states participated. Teachers at the TI-1 learned some basic electronics, experienced Amateur Radio activities, such as foxhunting and satellite communications, and programmed robots to navigate a maze. This year, the TI-2 was expanded to five days so that additional topics could be incorporated. The new material covered exploring satellite telemetry data, practice with the MAREA project transceiver (**www.arrl.org/marea**), and configuring a marine buoy with electronic sensors. You can find comments from participants and more about the summer 2015 workshops in this **ARRL news story**.



Teachers at the introductory TI-1 held at Parallax headquarters in Rocklin, CA, watch their programmed robots complete a follow-the-leader exercise. (Photo by Andy Lindsay)

Instructor Corner — News, Ideas, Support

Resources for Instruction

Instructors looking for new ideas to freshen up their lessons should check out the following Internet resources:

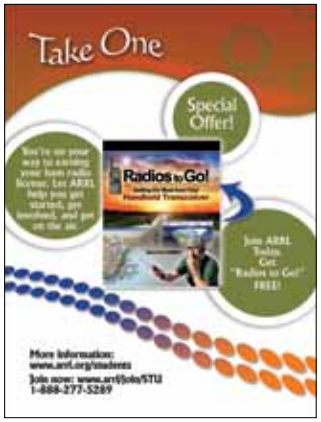
- Electronics Engineering Video Blog — This engineering vlog and Youtube channel has basic but well-presented video tutorials. Visit **www.eevblog.com**.
- Spark Fun Electronics — Primarily microcontroller information and parts, this site offers an expanding library of website tutorials. Check out the one on basic electronics concepts found **here**.
- Uses of Electromagnetic Spectrum/Radio Waves — A very comprehensive NASA video that explains the uses of all parts of the electromagnetic spectrum can be found at **www.youtube.com/watch?v=HPcAWNlVl-8**.

New Logo Items Available for Registered Instructors

ARRL-Registered Instructors may now purchase logo items offered in ARRL's online store. Add a patch or pin to your lapel when you represent ARRL as one of our Registered Instructors, or purchase a black polo shirt with the ARRL instructor identification. You can get a closer look at these items in the "Instructor Resource" section of the ARRL store (visit **www.arrl.org/shop/Instructor-Resources/**).

Revised Offer for New Techs Included in the Graduation Kit

The newest addition to the Graduation Kit is a student offer of a free copy of "Radios To Go! Getting the Most From Your Handheld Transceiver," by ARRL author Steve Ford, WB8IMY, with a new membership subscription. The printed flyer with the offer includes a full-color US Amateur Radio Technician Privileges Band Chart on the reverse. See **www.arrl.org/instruction-getting-organized** for more on what's available to ARRL instructors.



Ham Radio Instruction for People with Disabilities

Amateur Radio attracts many people with disabilities. The Courage Handiham organization exists to help those individuals and their instructors meet specifics needs. To find out more, read "**The Handiham Program: Ham Radio Learning for People with Disabilities**," written by Patrick W. Tice, WAØTDA, in the July issue of *QST*. Tice is the coordinator of the Handiham Program, and he offers a wealth of information in this article. For a link to his piece and other useful information, vist **www.arrl.org/instruction-teaching-and-study-aids** and scroll down to "Instructing Disabled Students."

Instructors, don't forget to support the organization that supports you. Please encourage your students to find out about the ARRL and all that membership offers them. Refer them to **www.arrl.org/membership**.

Resources for Ham Improvement

Reader Denny, KØJYD, has this to say about one of the electronics courses available through EdX, the free online learning destination and MOOC (massive open online course) provider: "I've taken several courses from EdX that concern electronics and when I saw this one ['**Electronic Interfaces: Bridging the Physical and Digital Worlds**'], it struck me that lots of our members could find this interesting and useful." The course guides students in:

- Fundamentals for engineering electronic interfaces between the physical world and digital devices
- Developing an understanding of the building blocks of electronics
- Analyzing, designing, and building different parts of a robot from scratch

A free online electrical engineering textbook provides a series of volumes covering electricity and electronics. The information provided is great for students, makers, and professionals who are looking to refresh or expand their knowledge in this field. It can be found at **www.allaboutcircuits.com/textbook/**.

Class Central's MOOC catalog lists online courses in electronics, including the following:

- "Circuits and Electronics" from MIT
- " A System View of Communications: From Signals to Packets (Part 3)" from The Hong Kong University of Science and Technology
- "Signals and Systems" from the Indian Institute of Technology Bombay

For the full course list, visit **www.class-central.com/subjects/**.

Radio Waves readers are invited to send in their own suggestions for enrichment opportunities. Contact Debra Johnson, K1DMJ, at **djohnson@arrl.org**.

Licensing Updates

Recent Licensing Statistics

The following report of FCC licenses issued is supplied by Maria Somma, AB1FM, ARRL VEC Manager.

Somma notes that, while new Amateur licenses issued are down by 6% from last year's record-setting pace, they are 11% above the typical totals from previous years. Upgraded licenses are up 7% compared to the same period last year. The total number of U.S. Amateurs has continued to grow steadily each year since the FCC license class restructure in 2007. As of September 30, 2015, the number of licensees reached a new all-time high of 731,974.

NEW AND UPGRADED FCC LICENSES ISSUED, YEAR TO YEAR COMPARISON

FCC License Activity	2011 thru Sept. 30	2012 thru Sept. 30	2013 thru Sept. 30	2014 thru Sept. 30	2015 thru Sept. 30
Technician	15,974	18,132	19,195	22,781	20,526
General	7,742	7,994	7,372	8,401	8,572
Extra	2,827	2,564	2,326	2,913	2,914
Total Issued	**26,543**	**28,690**	**28,893**	**34,095**	**32,012**

Amateur Extra Question Pool Being Revised for 2016

The Question Pool Committee of the NCVEC is currently working on revisions to the Amateur Extra exam question pool for FCC Amateur Extra license exams to be issued starting July 1, 2016. Stay tuned for an update on revisions to the syllabus in the *Radio Waves* Winter 2016 issue.

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Education & Technology Program:
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Teachers Institute on Wireless Technology:
www.arrl.org/teachers-institute-on-wireless-technology

ARISS Program:
www.arrl.org/amateur-radio-on-the-international-space-station

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Announcements, Upcoming Events, Opportunities, and Deadlines

ARRL Foundation Scholarship — The ARRL Foundation is currently accepting applications from eligible radio amateurs pursuing higher education. See www.arrl.org/scholarship-program.

Kids Day, Sunday, January 3, 2016 — Kids Day gives young people on-the-air experience and provides a chance to interest them in getting a license of their own. See www.arrl.org/kids-day.

School Club Roundup, February 8 – 12, 2016 — This biannual event fosters contacts with and among school radio clubs. See www.arrl.org/school-club-roundup.

ARISS, February 2016 — The next window for proposals to host a contact will open for contacts to be scheduled January – June 2017. See www.arrl.org/hosting-an-ariss-contact.

Teachers Institute, Summer 2016 — Plans are under way to offer three sessions of the Teachers Institute next summer. The 2016 TI schedule will be announced and the application period opened in February. It will be published on the ARRL website, in *Radio Waves* and in *QST*. Contact Debra Johnson at djohnson@arrl.org if you want to be added to our notification list to receive an announcement when we post the 2016 schedule.

Support the ETP and Teachers Institute with a Donation

ARRL is currently raising funds for the work of the Education & Technology Program (ETP). Our goal of $65,000 for donations from ARRL general membership will provide grants for equipment for stations in schools and other resources for wireless technology education, as well as allow us to offer 36 seats for classroom teachers at our Teachers Institute on Wireless Technology next year. Please consider donating to help us meet our goal. You may donate online here.

ARISS Program Raising Funds

The ARISS program is also raising funds to support continuing operations and to upgrade equipment on the ISS. You will receive an ARISS Challenge Coin for a donation of $100 or more. To contribute, point your Web browser here.

You are subscribed to receive the ARRL Instructor/Teacher E-Letter. If you have an ARRL website user account, you can manage all of your e-mail preferences at www.arrl.org/myarrl.

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