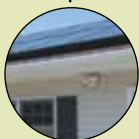
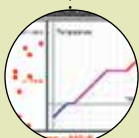


in this issue

3 Measure Solar Panel Efficiency



5 Vernier Sensors and Texas Instruments Simulations



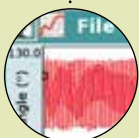
5 Celebrate Mole Day with an Experiment



6 Diet and Metabolism in Bean Beetles



7 Explore Heart Rate and Cadence



11 Software Updates



15 Professional Development



A Guide to Using Vernier Sensors with Arduino

Vernier has always supported hands-on, do-it-yourself projects for students (or teachers). The availability of very inexpensive, easy-to-program microcomputers, like the Arduino, makes projects easy and affordable. We recently posted a *Guide to Using Vernier Sensors with Arduino* on our web site (www.vernier.com/arduino). It is a free guide to connecting, calibrating, writing programs, and doing fun projects with our sensors. Sample programs and connection diagrams for all the projects are included.

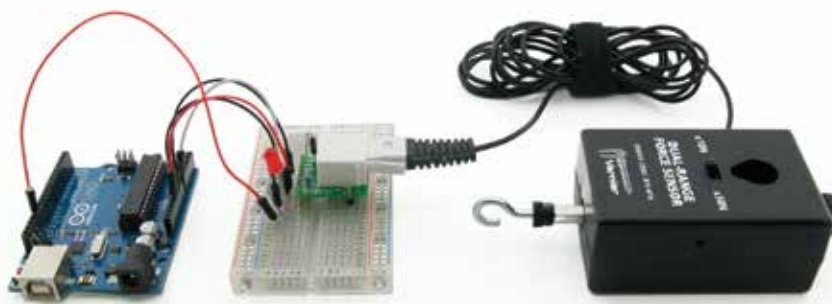
The projects will help you:

- Connect analog and digital Vernier sensors
- Import Arduino data to *Logger Pro*
- Turn on the Digital Control Unit (DCU) and a motor based on an analog sensor reading

- Produce a tone based on a sensor reading
- Turn on a buzzer based on a Motion Detector reading
- Drive a stepper motor or servo motors using our DCU
- Control an RGB LED with a 3-Axis Accelerometer

One easy way to make the connections from the Arduino to Vernier sensors is to use a small breadboard connected to our Proto Board Adapters (BTA-ELV and BTD-ELV, \$10 each), as shown below.

A more elegant solution is to use a Vernier Sensor Interface Shield. A shield is a circuit board made to fit on top of an Arduino board, making all the necessary connections with rows of pins. *(continued on page 2)*



An Arduino connected to a Vernier Dual-Range Force Sensor

Vernier and NGSS

Many of you have asked what Vernier is doing in response to the release of the Next Generation Science Standards (NGSS). We are taking the time to evaluate each and every one of our experiments and modify them, if needed, to help students meet the science and engineering practices called for in NGSS. One thing you won't see is

"Aligned with NGSS" stickers slapped on our existing lab books. As we create new products—whether it is hardware, software, or written investigations—we will work to align to NGSS, making it easy for teachers and science supervisors to help students meet these standards. *(continued on page 13)*

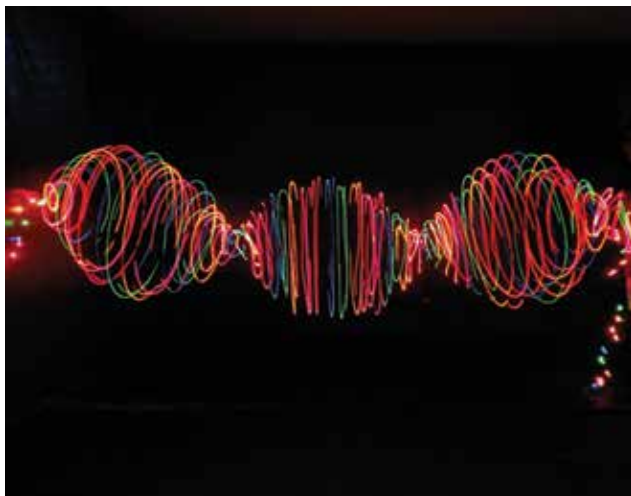
PHYSICS

AAPT Photo Contest

The 2013 AAPT Photo Contest, sponsored by Vernier, was held at the summer meeting of the American Association of Physics Teachers in Portland, Oregon. Students submitted photos that demonstrated physics concepts, along with an explanation of the physics involved. AAPT members voted on the entries. We continue to be astonished at the quality of the images. When digital photography became common, the number and quality of images was noticeably better, which makes an interesting pedagogical point about rapid feedback and ease of data collection.

The contrived winning photo shows a colorful standing wave pattern on a light string. The winning natural image is a breathtaking example of total internal reflection, and makes a common end-of-chapter optics problem quite real.

For details about the contest and to see all the photo winners for 2013, go to the AAPT web site, www.aapt.org/Programs/Contests



1st Place, Contrived Category: A Standing Wave, Glenbard West High School, Student: Jaime Mathew, Teacher: Bruce Medic



1st Place, Natural Category: Refraction and Reflection in a Pool, Atlee High School, Student: Matthew Jay Rohr, Teacher: Jeremy Watts

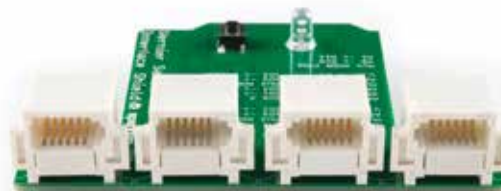
LabQuest Used in an Adrenaline-Fueled Investigation on the Dæmonen Roller Coaster

This year's International Physics Olympiad was held at Tivoli Gardens in Copenhagen, where young contestants investigated the "Dæmonen" (The Demon) roller coaster with an original LabQuest and a Vernier 3-Axis Accelerometer. The floorless roller coaster can reach speeds of up to 21 m/s (48 mph), and riders experience forces up to 4g. The participants found that the wildest ride on the roller coaster is experienced when they are sitting at the very back. For more information about the International Physics Olympiad go to www.ipho2013.dk



A Guide to Using Vernier Sensors with Arduino *(continued from cover)*

We are working with SparkFun Electronics to develop the Sensor Interface Shield that will make using our sensors on an Arduino Uno (or Uno-compatible) board extremely simple. This shield has two of our BTA connectors (for analog sensors) and two of our BTD connectors (for digital sensors and the DCU). For more information go to www.vernier.com/arduino



Prototype Sensor Interface Shield from SparkFun Electronics

Newton's Third Law: A Verification with Buoyancy Forces

Barry Feerman, Westtown School, West Chester, PA, came up with a unique demonstration of Newton's third law with a buoyancy experiment. He uses a Force Plate to measure the weight (downward force) of a large beaker of water. He lowers a can of soup, suspended from a Dual-Range Force Sensor, into the beaker. How does the change in apparent weight of the soup can compare with the change in downward force on the Force Plate? What do you get when you graph the sum of the two force sensor readings? Barry's handout can be found at www.vernier.com/r1315

PHYSICS

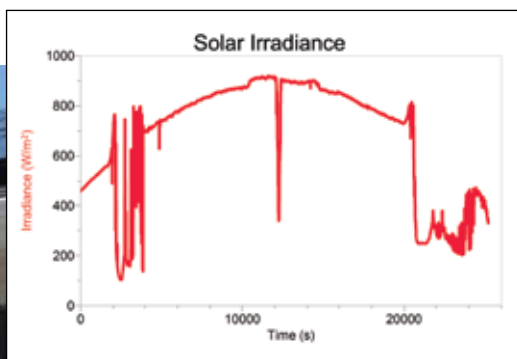
Determining the Efficiency of a Rooftop Photovoltaic System

Do you have solar panels installed at your home or school? How efficient are they? Are they as efficient as the manufacturer claims? Are they still as efficient as when they were installed?

Measuring panel efficiency requires knowing the energy produced by the panels, as well as the solar power incident on the panels over the same time period. The energy produced is easily determined by the monitoring software provided by the solar panel manufacturer. The incident solar energy can be measured with the Vernier Pyranometer (PYR-BTA, \$199). The Pyranometer measures the solar power received from the whole sky, with a cosine response designed to correctly measure the power integrated over all angles.

The efficiency measurement is challenging, since a real-world panel installation attempts to optimize the solar energy striking the panels, capturing more energy than the same area flat on the surface of the earth. However, the panels could also be in an orientation of convenience rather than the best possible position. How is this taken into account in an efficiency measurement?

Richard Born, a frequent contributor to *The Caliper*, has evaluated the efficiency of his solar panels and has thought through these questions of how to obtain the appropriate solar power measurement for his particular installation. In his work, you'll find enough information to perform the same measurement for your solar panels. Of particular interest, he observed a cloud effect, where the edge of passing clouds *increases* the solar power striking the panels. For the full story, see www.vernier.com/r1316



Students studying solar panels with LabQuest and a Pyranometer

AAPT Meeting in Portland

The American Association of Physics Teachers (AAPT) had their annual summer meeting in July in Portland, Oregon. Vernier Software & Technology was actively involved. We had several workshops at our office, gave dozens of office tours to teachers, and sponsored the picnic and the demo show.



Kenneth Laws speaks as Oregon Ballet Theatre dancers look on



Ballet dancer jumping off a Force Plate

Vernier in the Science Journals

The Orbit of Water Droplets Around a Charged Rod

The Physics Teacher, May 2013, by Andrew Ferstl and Andrew Burns, Winona State University, Winona, MN. The authors use Logger Pro video analysis and some of our sensors to estimate charges and model the motion of water droplets orbiting around a charged knitting needle on the International Space Station.

Observing the Forces Involved in Static Friction Under Static Situations

The Physics Teacher, April 2013, by Daniel Kaplan, Matawan Regional High School, Aberdeen, NJ. Mr. Kaplan uses our Dual-Range Force Sensor to investigate the forces involved in the classic physics problem of a ladder leaning against a wall. He varies the distance from the wall to the bottom of the ladder and the position of the ladder climber (mass) on the ladder.

PHYSICS & ENGINEERING

Studying Heat Islands

Forrest Mims III has done some interesting studies of “heat islands.” Heat islands are natural or man-made regions that store heat better than vegetation; examples include bare soil, rocks, and parking lots. On a cool evening after a warm Texas day, Forrest drove around with a LabQuest 2 and our Surface Temperature Sensor. LabQuest 2 recorded latitude and longitude from its built-in GPS while collecting data from the temperature sensor. As you can see from the screen, the temperature varies quite a lot. The great thing about this experiment is that when you get back from the trip, you can use *Logger Pro* to export the data to Google Maps™ and generate a color-coded path of your movement. The color of the graph on the map indicates the temperature in that area.



Forrest Mims' temperature data exploring heat islands

A New Face in Our Physics Department

Fran Poodry is joining our Technical Support group from Pennsylvania, where she acquired over 20 years of experience teaching high school physics. Fran taught various levels, from conceptual physics to AP Physics C. She has additional experience teaching university physics labs. Fran has a B.A. in Physics from Swarthmore College and a Master of Science in Education from Temple University. She recently volunteered at the National Youth Science Camp in West Virginia, teaching a three-day Arduino programming workshop to recent high school graduates. When not relaxing with a book or a soldering project, Fran enjoys Scottish and English country dancing.



Intel Engineers Take Vernier Equipment to Schools in Kenya

Employees from Intel and VMware spent two weeks in Kenya last May as part of a joint service-learning project sponsored by the Intel Education Service Corps and Team4Tech, in conjunction with the Portland-based nonprofit Orphans Overseas. The team upgraded the computer lab at the Karibu Centre preschool, opened permanent computer labs in two local public schools, and made preparations to open two additional labs, with the potential to impact over 1000 students. The team also made early plans for an after-school program in science and math, providing training on Vernier equipment to the local Kenyan teachers.



Intel engineers introducing Go!Motion in Kenya

Engineering Contest

Are you using Vernier sensors to teach engineering concepts or engineering practices in the classroom? If you are, you could win one of three \$5,500 awards (one for middle school, one for high school, and one for college).

Maybe your students are using Vernier sensors to test a design project. Or maybe you are challenging your students to build an automated device using the Vernier Digital Control Unit (DCU) and *Logger Pro* software. Perhaps your students are writing NI LabVIEW or ROBOTC code to read a Vernier sensor from a robotics platform such as LEGO, VEX, or Arduino. Tell us about your projects, and you might win!

Each award will consist of \$1,000 in cash, \$3,000 in Vernier technology, and \$1,500 toward expenses to attend either the 2014 NSTA STEM conference in New Orleans or the 2014 ASEE conference in Indianapolis. Entries will be accepted through January 15, 2014. For complete rules and to submit an online application and video showcasing your entry, go to www.vernier.com/grants/engineering

ENTRY DEADLINE: JANUARY 15, 2014

MATH & CHEMISTRY

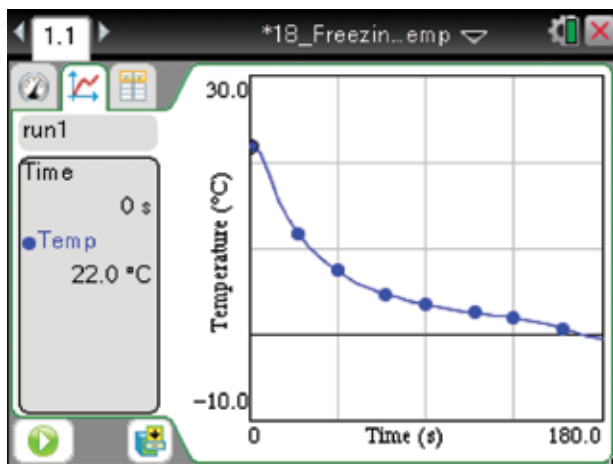
Vernier Sensors and TI Simulations

A Great Combination for Learning Science

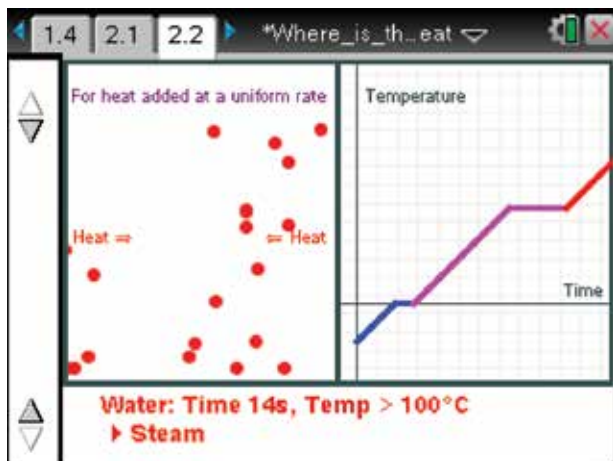
by Erick Archer, Texas Instruments

You probably already know that research¹ on educational technology has found that using probeware is beneficial for student understanding of difficult concepts in science. You may not know that research² also shows that educational simulations in science can have a positive impact, too. When you combine hands-on, sensor-based experiments with interactive simulations, you are sure to catch student interest and help them understand abstract concepts.

Texas Instruments has free, teacher-developed lessons that incorporate data collection and interactive simulations. The lessons are designed for use with TI-Nspire software and handhelds, and include data-collection labs, simulations, and built-in assessments. For example, in the chemistry lesson *Changes of State*, students explore a simulation that helps them visualize what is happening



Students use a temperature probe to investigate temperature changes as water undergoes a phase change.



Students explore a simulation that visually shows the behavior of particles in a substance as the temperature changes.

at the molecular level as a substance undergoes heating from a temperature below its melting point to above its boiling point. Additionally, the students use a temperature probe to investigate the heat of fusion of water. For this and other free lessons for biology, chemistry, physics, and earth science, visit www.sciencenspired.com

¹ Research available at www.vernier.com/whitepaper

² <http://education.ti.com/research>

Celebrate Mole Day with an Experiment

A Chemist's Favorite Holiday

Mole Day is celebrated at 6:02 a.m. on 10/23 in honor of Avogadro's number (6.02×10^{23}). The concept of a mole can be challenging for students to grasp, but is nonetheless an important one for them to master. The mole is one of the seven basic units in the International System of Units. It is also an accepted unit by the National Institute of Standards and Technology (NIST) metric program and the International Union of Pure and Applied Chemistry (IUPAC). To find out more about Mole Day, visit the National Mole Day Foundation's web site at www.moleday.org

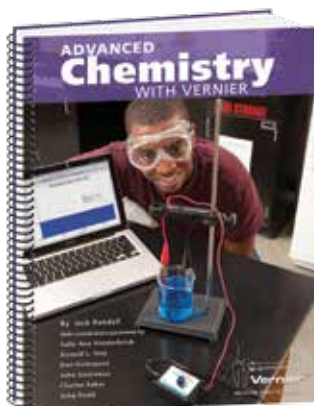
Just how big is Avogadro's number? Here are some fun examples you can share with your students. A mole of paper clips (3 cm long), chained together, would wrap around the equator 450 trillion times. A mole of cantaloupes (6 inches in diameter) has the same volume as Earth ($1.1 \times 10^{12} \text{ km}^3$). A mole of pennies distributed evenly to everyone in the world (7 billion people) would enable each person to spend \$1.6 million per minute for an entire year. A mole of stir bars (3 cm \times 6 mm) would cover the contiguous U.S. coast to coast, border to border, and pile about 40 miles high.



Looking for an experiment for Mole Day? Check out Experiment 31 "Determining Avogadro's Number" from *Advanced Chemistry with Vernier* lab book. In this experiment, you will confirm Avogadro's number by conducting an electrochemical process called electrolysis. In electrolysis, an external power supply, such as the Constant Current System, is used to drive an otherwise nonspontaneous reaction. The Constant Current System (CCS-BTA, \$59) is a combination current sensor and power supply delivering a constant current set by the user. To learn more about the Constant Current System and to download the experiment, go to www.vernier.com/ccs-bta

CHEMISTRY & BIOLOGY

Updated *Advanced Chemistry with Vernier* Lab Book is Now Available



CHEM-A, \$48

The 3rd edition of *Advanced Chemistry with Vernier* is now shipping. It contains changes we think chemistry teachers will really appreciate. First, we made important updates to several of the experiments; many of those revisions were a result of excellent suggestions from teachers. For example, Experiment 10, "The Determination of an Equilibrium Constant," has a new, streamlined procedure and a more comprehensive data analysis section. Second, we updated experiments to include the use of newer products, such as

the SpectroVis® Plus spectrophotometer and the Constant Current System (for electrolysis labs). Finally, we updated the appendix to correlate the experiments with the new AP Chemistry curriculum, which begins with the 2013–14 school year.

If you already own a copy of *Advanced Chemistry with Vernier* and would like the updated files for the student pages, email us at bookupdates@vernier.com. We'll send you a link to download the updated student files. If you'd rather have a printed copy that includes the updated student and teacher pages, appendices, and a CD, the book can be purchased for \$48 (order code CHEM-A). The AP correlations can be viewed at www.vernier.com/ap

Rate Law Determination of the Crystal Violet Reaction

A Fresh Look at a Classic Chemistry Experiment

A popular kinetics experiment in chemistry involves conducting a reaction between solutions of the indicator crystal violet and sodium hydroxide.

Vernier offers two versions of this experiment: Experiment 30 in *Chemistry with Vernier* and Experiment 35 in *Advanced Chemistry with Vernier*. Patrick Cunningham (Johnson High School, San Antonio, TX), modified this experiment for his pre-AP and AP Chemistry classes. Pat shared his modified experiment with us and has kindly offered to share it with you.

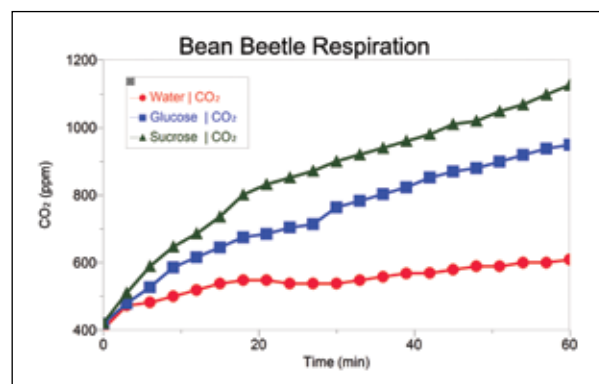
The Vernier version of this experiment guides the student to determine the rate law of the reaction with respect to crystal violet. Pat's version takes the additional step of determining the full rate law with respect to crystal violet and sodium hydroxide. Pat also suggests another path for the data analysis. If you're looking for a new take on a tried-and-true chemistry experiment, give this one a try. See the details of Pat Cunningham's experiment at www.vernier.com/r1317

Bean Beetles Exercise Uses Vernier Products

Investigating Diet and Metabolism in Bean Beetles

If you are looking for an excellent college-level animal physiology investigation that is inquiry based and incorporates data collection, you should take a look at the "Diet and Metabolism in Bean Beetles" experiment at the Bean Beetles web site (www.beanbeetles.org). This activity was developed by Greg Butcher and Scott Chirhart from Centenary College of Louisiana. The Bean Beetles web site is dedicated to using the bean beetle (*Callosobruchus maculatus*) as a model organism for inquiry-based exercises for college courses. The web site contains a set of laboratory investigations that include student handouts, teacher notes, and example data. Culturing methods and a variety of other useful resources are also available on the web site.

The "Diet and Metabolism in Bean Beetles" experiment investigates cellular respiration and metabolism. As shown in the data below, a CO₂ Gas Sensor (CO₂-BTA, \$249) is used to measure CO₂ gas production from sets of bean beetles that are provided with different sources of food. An Oxygen Gas Sensor (O₂-BTA, \$188) can also be used to measure oxygen consumption in this exercise. The original activity can be found at www.vernier.com/r1318



Measuring CO₂ gas production from bean beetles fed various sugars



A New Face in Our Biology Department

Colleen McDaniel joins the Technical Support group from Houston, TX. Colleen has a B.S. in Biology from Truman State University and a Master's degree in Science Education from Montana State University. Her thesis concentrated on project-based learning in an AP classroom. She has taught biology and AP environmental science in Spring Branch ISD for the past six years. Colleen has been an AP grader for the past three years, which she oddly does for fun. Colleen also enjoys activities like birding and hiking. She is looking forward to getting involved in ways to excite girls about STEM careers.



IBI Award Winner Uses Vernier Inquiry-Based Experiments with the Vernier Dissolved Oxygen Probe and pH Sensor

The American Association for the Advancement of Science (AAAS) sponsors the Science Prize for Inquiry-Based Instruction, or IBI Award. The award is designed to "encourage innovation and excellence in education by recognizing outstanding, inquiry-based science and design-based engineering education modules."

We were very excited to see Vernier products featured prominently in one of this year's IBI award-winning projects. As described in the June 28th edition of *Science* (vol. 340, pp.1537-38), the winning module consists of four guided inquiry-based experiments that investigate photosynthesis. Vernier Dissolved Oxygen Probes and pH Sensors were used to measure changes in dissolved oxygen and carbon dioxide concentrations in real time using aquatic plants.

This project is similar to the "Investigating Primary Productivity" activity in our *Investigating Biology through Inquiry* lab book (BIO-I, \$48). Our new Optical DO Probe (ODO-BTA, \$379) is ideal for use in this investigation. For more information about inquiry-based biology activities in our lab book, please contact our biology team at biology@vernier.com. For more information about the IBI award and this year's prize winners, see the link below.

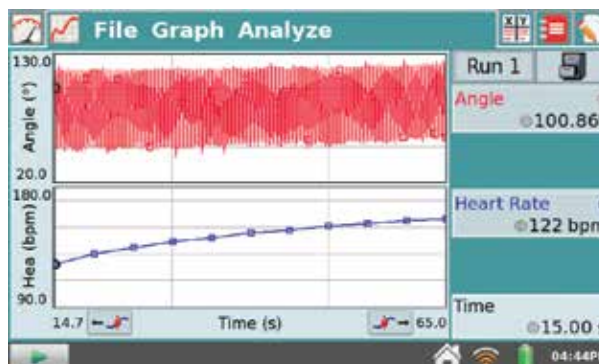
www.sciencemag.org/site/special/ibi

Using a Goniometer to Explore Heart Rate and Cadence

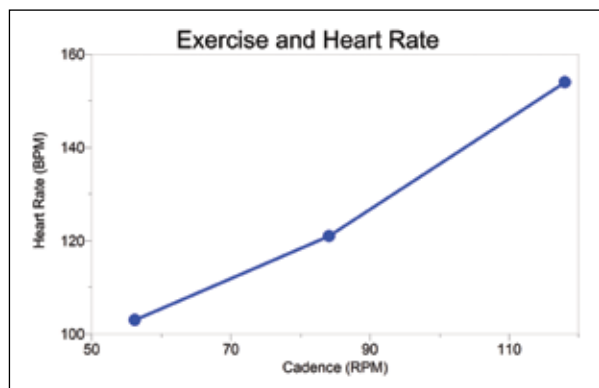
John Melville, our Biology Staff Scientist, has found that our Goniometer (GNM-BTA, \$159) and Exercise Heart Rate Monitor (EHR-BTA, \$93) are great sensors for investigating the effect that exercise has on the heart. As shown in the data below, students can easily use LabQuest with an Exercise Heart Rate Monitor and a Goniometer to record both heart-rate and joint-angle data from the knee while cycling.

With this in mind, we have developed two new experiments, "Heart Rate and Exercise (Cycling)" and "Heart Rate and Exercise (Running)." In each experiment, the student observes how the heart responds to the increased metabolic demand of the leg muscles as running or cycling speed is increased. The Goniometer is attached to the leg of a subject and the dynamic range of motion (ROM) of the knee is recorded while running or cycling. An Exercise Heart Rate Monitor is used to monitor the subject's heart rate. As shown in the data below, John's heart rate increases as cycling cadence increases.

For these very active experiments, the Exercise Heart Rate Monitor's chest belt works better than the hand grips from the Hand-Grip Heart Rate Monitor (HGH-BTA, \$119). If you have a Hand-Grip Heart Rate Monitor, just purchase a Chest Belt Transmitter (CBT, \$48) to perform both exercises. For more info, email physiology@vernier.com



Using LabQuest to collect heart-rate and joint-angle data while cycling



Increasing cycling cadence produces a corresponding increase in heart rate

BIOLOGY & ENVIRONMENTAL SCIENCE

Exploring Kilauea Volcano with LabQuest 2

Brian Kaestner, a science teacher at Saint Mary's Hall in San Antonio, TX, and an AP Environmental Science Summer Institute leader, used LabQuest 2 and a Vernier CO₂ Gas Sensor to sample steam vents along the rift zone of Kilauea volcano on the island of Hawaii. He used the built-in GPS of LabQuest 2 to sample time and location throughout the rift zone, in addition to using sensors to collect CO₂ and temperature data. While he hiked with his team, he practiced using LabQuest 2 with his iPad so that he could teach his AP Summer Institute participants how to use the Connected Science System.



Sampling steam from a volcano's vent

Use Digital Filtering to Get Better EKGs

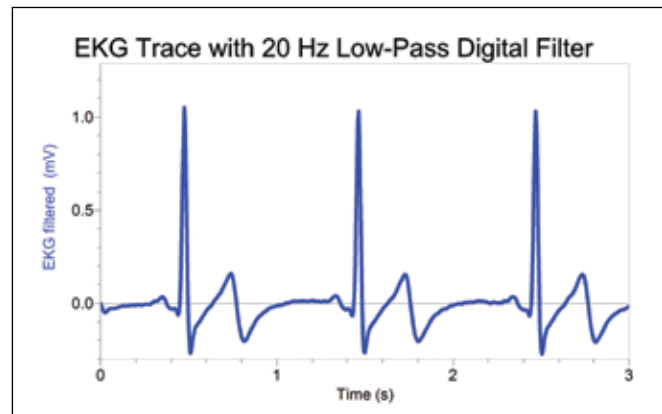
EKG and EMG Traces Just Got Smoother

John Melville, our Biology Staff Scientist, has created a set of files for Logger *Pro* and LabQuest App that use digital filtering to improve EKG and EMG traces when using our EKG Sensor (EKG-BTA, \$147). Logger *Pro* 3.8.6 and LabQuest App 2.2 both offer calculated columns that can be used to filter sensor data. Digital filtering is also referred to as signal processing and is a common tool that many biomedical engineers use to improve signal quality of physiological data.

In Logger *Pro*, the new files that utilize digital filtering can be found in the EKG Sensor folder, which is located inside the Probes & Sensors folder. You will find a low-pass filter file for reducing distracting, rapid variations in signals; a high-pass filter file to reduce the effect of a varying baseline on signals; and a time-decay filter file that applies a simple adjustable time constant to the data, smoothing out rapid fluctuations while preserving long-term trends. The parameters of each filter can be adjusted using arrows in the parameter control, which is found just below the digital meter. These filter types can be used to improve the signal quality of EMGs and EKGs. An example EKG trace using the low-pass filter file is shown below.

Similar files for use on LabQuest can be downloaded at www.vernier.com/r1321

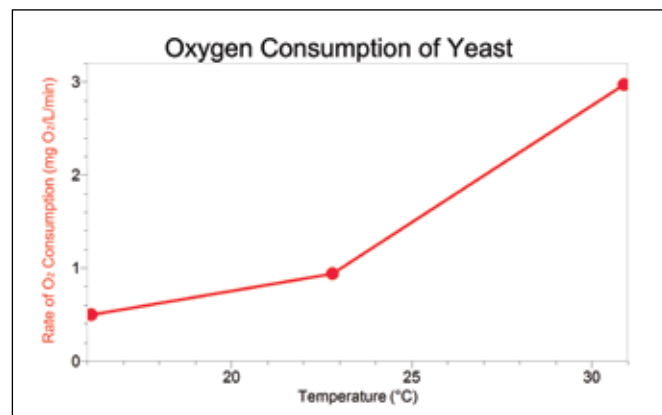
For more information on how to apply or use digital filters in Logger *Pro* or LabQuest App, contact John Melville at physiology@vernier.com. You can also watch a demonstration at www.vernier.com/v138



Using a digital filter to collect EKG data

Student Instructions for the Vernier Optical DO Probe

Now that the Optical DO Probe is shipping, we have had questions about updated student instructions for our experiments and investigations. The easy answer is that you just use the same instructions as before but take out all the prep work! The serious answer is that yes, we are working on them. If you already own a Vernier lab book that uses the Dissolved Oxygen Probe and you need the Optical DO version, just send an email to odo@vernier.com. Include your name, your school's name and address, the book title, the experiment name and number(s), and what version you need (e.g., LabQuest App, Logger *Pro*, or EasyData).



Using an Optical DO Probe to measure oxygen consumption of yeast at various temperatures

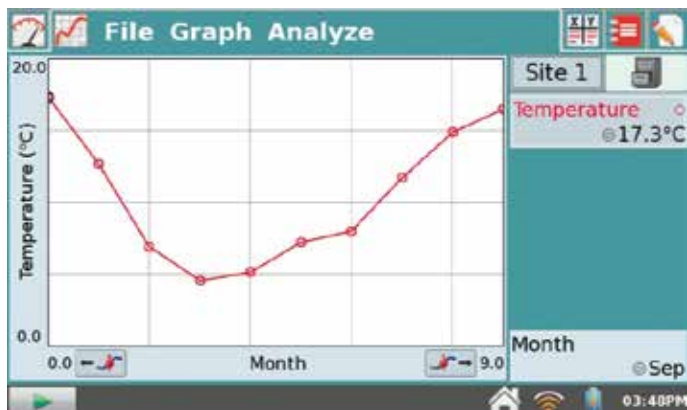
ENVIRONMENTAL SCIENCE

New! Pivot Your Data in Data Matrix Mode

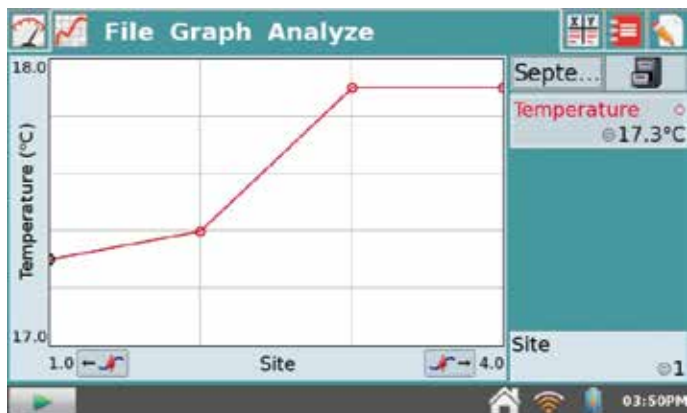
Have you used Data Matrix mode on your LabQuest yet? It's the best mode to use when conducting fieldwork such as water quality or ecology studies. Data Matrix mode addresses several key issues that used to limit fieldwork, including:

- Collecting data at multiple locations and over multiple days, all in one file.
- Collecting data from more sensors than there are ports available.
- Collecting data from certain combinations of sensors that previously could not be used together due to electrical interference.

In addition to these features, Data Matrix mode has been improved, beginning in LabQuest 2.2, with the introduction of the Pivot Data feature. Here's how it works: Imagine that your students are studying water quality at four different locations along a stream for the entire school year. They want to analyze the data at each site over the course of the year. For example, the first graph shows temperature data collected from September to June at Site 1. However, they might also like to compare temperatures along the stream on a particular day as shown in the second graph. To do this, they can use the new Pivot Data feature to swap the x-axis



Original graph showing temperatures over time at one location



Pivoted graph showing temperatures at all four sites on one day

values with the data set values, in this case swapping months for sampling sites. This new view of the data reveals warmer water at sites 3 and 4 as the stream flows through an area of slow water movement with no shade trees.

Previously, students needed to decide whether to analyze their data over time or over location before they even began. Now, with the Pivot Data feature, they can switch between the two as often as they would like.

Detailed instructions for using Data Matrix mode and the Pivot Data feature can be found at www.vernier.com/r1322

Rising CO₂ Levels in the Atmosphere Drive Sensor Change

In 1996, when Vernier introduced the CO₂ Gas Sensor, atmospheric carbon dioxide gas levels averaged around 360 ppm. Times have changed. Human activities, such as the burning of fossil fuels, have caused CO₂ concentrations to rise dramatically in recent decades, driving climate change. In May 2013, researchers at NOAA's Mauna Loa Observatory reported that for the first time in recorded history, the daily mean concentration of CO₂ gas in the atmosphere hit 400 ppm. This milestone made us consider making a change to our CO₂ Gas Sensor.

Currently, the one-point calibration of our CO₂ Gas Sensor conducted in outside air sets the reading to approximately 380 ppm. However, this value no longer matches the composition of our atmosphere. For this reason, beginning in late 2013, our CO₂ Gas Sensors will ship with a target calibration of 400 ppm rather than 380 ppm.

If you already use our CO₂ Gas Sensor with your students, you will understand that in practice, this change is primarily symbolic. This sensor is used to measure relatively large changes in CO₂ concentration, such as when studying the respiration of germinating peas or even humans, so a 20 ppm difference won't be noticed in most applications. However, we felt it was an important change to make.

For more information about NOAA's CO₂ measurements at Mauna Loa Observatory, see www.esrl.noaa.gov/gmd/ccgg/trends



CO₂ GAS SENSOR, CO2-BTA, \$249

"We greatly appreciate your prompt service... Once again Vernier shows excellent customer relations."
 Stephen W. Banks, Louisiana State University Shreveport, Shreveport, LA

ENVIRONMENTAL SCIENCE & SOFTWARE

Vernier Sponsors NABT Ecology/ Environmental Science Teaching Award

Each year, Vernier sponsors the NABT Ecology/Environmental Science Teaching Award. This award is given to a secondary school teacher who has successfully developed and demonstrated an innovative approach in the teaching of ecology/environmental science and has carried his or her commitment to the environment into the community. Vernier's sponsorship of this award includes \$1,000 toward travel to the NABT Professional Development Conference and \$1,000 of Vernier equipment. The recipient also receives a recognition plaque to be presented at the conference and a one-year complimentary NABT membership. The deadline for the 2013 Award has passed, and the winner will be announced at the NABT conference in Atlanta in November. Applications for the 2014 Award will be available soon after the conference, and the deadline for submission is March 15, 2014.

To sign up for notification of the 2014 application's availability, go to www.vernier.com/grants/nabt

ENTRY DEADLINE: MARCH 15, 2014

VERNIER AWARDS

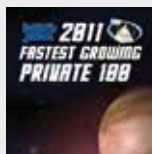
Vernier is proud to be recognized for its philanthropic commitment, steady growth, and as one of the Best 100 Companies to Work For in Oregon—for 13 years in a row.



INTERNATIONAL AWARD FOR LABQUEST



BUSINESS JOURNAL CORPORATE PHILANTHROPY AWARD



FASTEST GROWING PRIVATE COMPANIES



PLACED 16TH OF 100 BEST GREEN COMPANIES IN OREGON



2012 HEALTHIEST EMPLOYERS 5TH PLACE



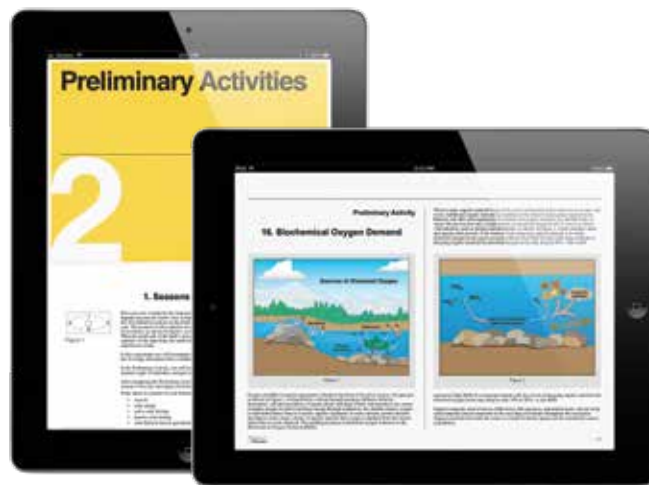
HALL OF FAME OREGON BUSINESS AWARD

Logger Pro, LabQuest, LabPro, Vernier and caliper design, Go!Link, Go!Temp, Logger Lite, Vernier EasyTemp, Vernier EasyLink, Vernier EasyData, and Connected Science System are our registered trademarks in the United States. Vernier Software & Technology, vernier.com, and Graphical Analysis are our trademarks or trade dress. All other marks not owned by us that appear herein are the property of their respective owners. iPhone, iPad, and iPod touch are trademarks of Apple Inc., registered in the U.S. and other countries.

Our First iBook

Our popular lab book, *Investigating Environmental Science through Inquiry*, is available for iPad® on the iBookstore for \$2.99. This student companion to the print version contains student instructions, a new glossary feature, and images in full color.

For more information, go to www.vernier.com/esi



View student versions of experiments in portrait or landscape, add highlights or notes with ease, and use the zoom feature to see images, figures, and tables in full screen.

Windows RT and the Microsoft Surface RT

The low-price version of the Microsoft Surface tablet runs an operating system called Windows RT. This OS does not run standard Windows applications, so it does not support Logger Pro. However, it is still possible to collect data on the tablet. The next release of Vernier Data Share web app, which is included with LabQuest 2 and Logger Pro, will be compatible with Internet Explorer 10, the browser in Windows RT.

With Vernier Data Share and 1:1 devices such as the Microsoft Surface tablet, every student in a lab group can get their own copy of the data, perform analysis, and make annotations for lab reports and informal reports. Vernier Data Share even supports offline analysis, so students can finish their lab reports at home.

Did you know?

Teachers and students love using Graphical Analysis for iPad alongside some of their favorite apps. It's easy to save annotated graphs and experimental data directly to Google Drive™ online storage service, Dropbox, Evernote®, and many other apps for easy storage and retrieval. For more info, see www.vernier.com/r1326

SOFTWARE

Software Updates

Vernier's software developers are constantly working on new versions of our software. These updates support new devices and add new features. Keeping up to date with software releases is one way to keep things running smoothly in your classroom or lab. Have you updated your Vernier applications recently?

LOGGER PRO 3.8.6.1

Logger *Pro* 3.8.6.1 was released in April 2013. This update is free to all users of any previous version of Logger *Pro* 3 and is available at www.vernier.com/lpupdates

The new version improves video analysis features, makes numeric entry more robust, and updates numerous experiment files. Google Maps export is updated for compatibility with changes at Google and exports large data sets more reliably.

Of particular note in this version is updated support for the Connected Science System. Logger *Pro* can share sensor data with Graphical Analysis for iPad. It can also share data using the Vernier Data Share web app in any device running a modern browser. Version 3.8.6.1 includes an updated version of the service, improving speed, stability, and usability.

We recommend that all users of Logger *Pro* update to this release. With an account on the Vernier web site and a purchase history of Logger *Pro*, you can download the full installer at any time—no waiting for a CD or download link. To create an account, go to www.vernier.com/account

The next planned release for Logger *Pro* is late 2013, and will update the Data Share web app.

LABQUEST 2.2

LabQuest 2.2 for LabQuest 2 was released in April 2013. Version 2.2 adds the Pivot Data feature for more flexibility in graphing while in Data Matrix mode, as well as new calculated columns for digital filtering. New drivers improve Wi-Fi connection stability, and new connections screens simplify connecting to the desired Wi-Fi network. Better power management improves battery life. The Vernier Data Share web app has been enhanced, improving speed, stability, and usability. Graph export has been substantially improved.

Note that the previous 2.1 release added support for Enterprise Wi-Fi networks, or those with username/password combinations.

We recommend that all users of LabQuest 2 update to the 2.2 release. This free update to LabQuest 2 is available at www.vernier.com/lq2updates

The next release of LabQuest App is planned for October 2013 and will include an update to the Data Share web app.

LABQUEST 1.7

LabQuest 1.7 for the original LabQuest hardware was released in October 2012. Version 1.7 adds support for newly released sensors and improves graphing for spectrometers. This free update is available at www.vernier.com/lqupdates

LOGGER LITE 1.6

Logger Lite 1.6 was released in April 2012 to support LabQuest 2. The previous release of Logger Lite added support for LabQuest Mini and Windows 7 (including 64-bit machines), as well as linear fits. The free update is available at www.vernier.com/llupdates

VIDEO PHYSICS FOR iOS

The current version of Video Physics is 1.2, updated in December 2012. This version adds the important ability to export video analysis data to Graphical Analysis for iPad. Once in Graphical Analysis, you can make selections, add annotations, perform curve fits, and create high-resolution graphs. Updates to Video Physics are always free and are available in the App Store.

Video Physics is a CODiE Awards Finalist for Best Educational Use of a Mobile Device.

GRAPHICAL ANALYSIS FOR iPad

An update to Graphical Analysis for iOS, 1.4.1, was released in June 2013. For this update, we have focused on making the app easier to use and easier to learn. A QR code scanner makes it easy to connect to a LabQuest. Improved accessibility and additional language support are also added.

Updates to Graphical Analysis for iPad are free and are available in the App Store.

APPLE VOLUME PURCHASE PROGRAM

Purchasing apps for iOS devices can be a challenge for schools. Did you know that your school or department can purchase vouchers to distribute apps such as Vernier Video Physics to multiple devices?

This is a way to distribute iOS apps to both school-owned and student devices. You can use purchase orders or credit cards. Schools receive a 50% discount when purchasing 20 or more copies of Vernier Video Physics or Vernier Graphical Analysis from the App Store. The upcoming iOS 7 release will give schools the ability to provide apps to student-owned devices, while subsequently recovering the app license as needed.

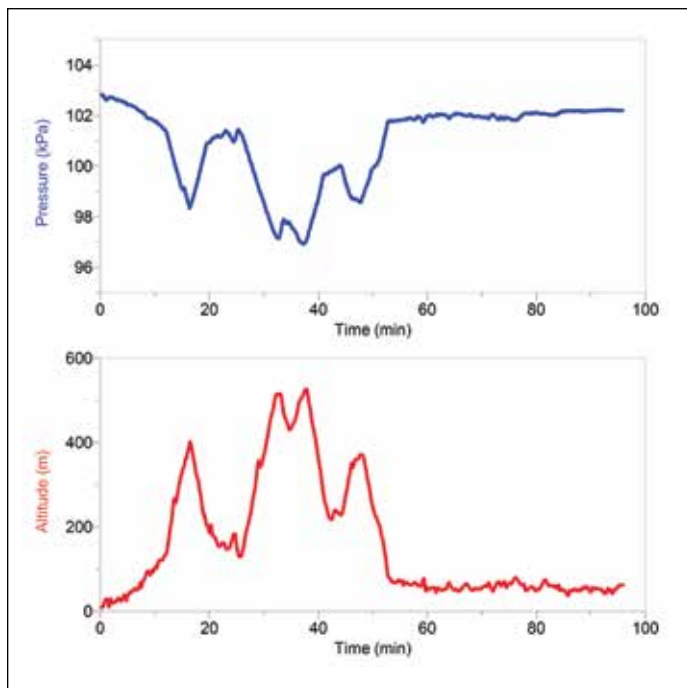
See www.apple.com/itunes/education for additional information on the Purchase Program.

Vernier International Guests Map Their Journey from the Oregon Coast

This summer, 43 international representatives from 26 countries and six continents visited Vernier headquarters in Beaverton, Oregon. The three days they were here spent learning more about Vernier products, learning how other countries market Vernier products, and traveling to Oregon's scenic coast.

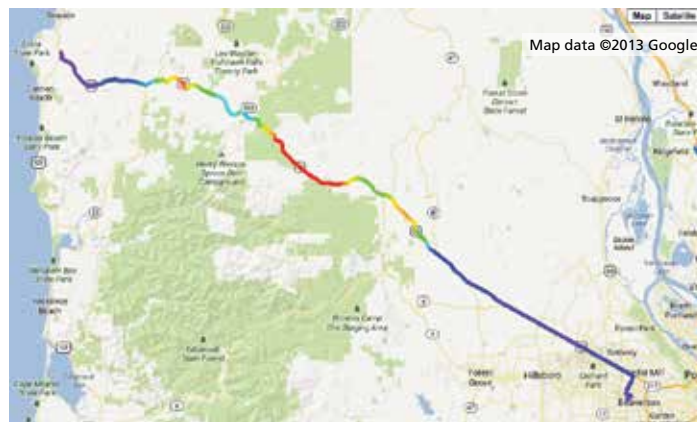


The return journey from the Oregon coast with the international guests was mapped with the built-in GPS sensor on LabQuest 2 and the Vernier Barometer. Altitude and GPS data were imported into Logger Pro 3 and then exported to Google Maps. The altitude was color-coded on the map. The color-coding feature that applies



Data collected on the journey from the Oregon coast

graduated color to your exported map can be activated during the export process. More information about showing color-coded data in Google Maps is available on our web site www.vernier.com/r1327



Color-coded altitude data

Vernier Adopts New Environmentally Friendly Packaging

In keeping with Vernier's long-standing commitment to environmental quality, we've made some recent changes to our LabQuest 2, LabQuest Mini, and sensor packaging. The boxes are now made of brown recycled materials rather than the former white, laminated cardboard. The LabQuest 2 box is made from 60% recycled materials, and the LabQuest Mini box is made from 80% recycled materials. Other boxes are made from 60–65% recycled materials. Our new boxes are locally sourced in nearby Tualatin, Oregon, from a company that follows green practices.



"I love your products and your customer service. Every chance I get, I encourage others to purchase your products, as well."

Amy Fowler Murphy, University of Montevallo, Montevallo, AL

Gently Used and Overstocked Vernier Products

Are you looking for a bargain?

Bargains galore can be found in the “Clearance” section of our web site. Most of the items in this section have been used once or twice for a workshop or for product testing. They have all been refurbished and carry our full warranty. Availability of an item may be limited. Here are some examples that are available as of the printing of this newsletter:

- Original LabQuest (with power supply and cable), LABQ-L, \$225
- Dissolved Oxygen Probe, DO-BTA-L, \$157
- Hand-Grip Heart Rate Monitor, HGH-BTA-L, \$89
- Stir Station, STIR-L, \$97
- Chloride Ion-Selective Electrode, CL-BTA-L, \$134
- Calcium Ion-Selective Electrode, CA-BTA-L, \$134
- Ammonium Ion-Selective Electrode, NH4-BTA-L, \$134
- Go!Link USB Interface, GO-LINK, \$46
- LabPro (with power supply and cable), LABPRO-L, \$165
- Original Motion Detectors with cable, MDO-BTD, \$5
(These older, blue Motion Detectors have a range of 0.5 m to 6 m and do not have a switch.)

See available items at www.vernier.com/clearance

Vernier and NGSS *(continued from cover)*

The eight Science and Engineering Practices, including Planning and Carrying Out Investigations, Analyzing and Interpreting Data, and Using Mathematics and Computational Thinking, represent the foundation of our experiments. We’ve always been a hands-on science company, and we encourage students to investigate natural phenomena and solve real-world problems.

When you look through our lab books, you will see that we have approached engineering both implicitly, through challenges such as “Keepin’ It Cool, Design Your Own Thermos™,” “Solar Homes,” or “The Pencil Car,” among others, and explicitly, in books such as our *STEM with Vernier and LEGO Mindstorms NXT*, *STEM 2 with Vernier and LEGO Mindstorms NXT*, *Engineering Projects with Vernier*, and the *Hands-on Introduction to NI LabVIEW with Vernier* lab books. We also have STEM extensions available on our web site that use sensor data, the Vernier Digital Control Unit, and Logger Pro software to create sensor-based control systems. These include “Cooling Fan,” “Eye-Controlled LED,” “Hand-Sensing Dryer,” and others.

Visit our web site to see a graphical representation of how “Keepin’ It Cool, Design Your Own Thermos™” incorporates the Performance Expectations, Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas of NGSS. www.vernier.com/ngss

For questions about this or other content inquiries, contact us at publications@vernier.com

25 years ago in the CALIPER



We announced our first book, *How to Build a Better Mousetrap and 13 Other Science Projects for the Apple II*. The description in that newsletter starts with: “If you have an Apple II+/IIe/IIIGS computer and you or your students are interested in using it for science projects, then this is the book for you.”

One reviewer of the book said, “David Vernier’s *How to Build a Better Mousetrap* is an exemplary model for the new direction in science education.”

This old book seems well aligned with the 2013 Next Generation Science Standards (NGSS), bringing project-based learning and engineering concepts into a science class. We were STEM before STEM was cool!

Applications Open for Annual Vernier/NSTA Technology Awards

Vernier Software & Technology and the National Science Teachers Association (NSTA) are now accepting applications for the annual Vernier/NSTA Technology Awards. The 2014 awards program will recognize up to seven educators—one elementary teacher, two middle school teachers, three high school teachers, and one college-level educator—who promote the innovative use of data-collection technology.

Prizes include \$1,000 in cash, \$3,000 in Vernier products, and up to \$1,500 toward expenses to attend the 2014 NSTA National Conference in Boston, Massachusetts. Award recipients will be chosen based on their application, which is judged by a panel of NSTA-appointed experts. All applications must be submitted by November 30, 2013.

The Vernier/NSTA awards program allows Vernier to recognize STEM educators who are using data-collection technology with their students in truly engaging and innovative ways. Last year’s winning entries encompassed a wide range of data-collection activities, including the investigation of the pH found in different cakes and chemical reactions, the creation of control boxes for underwater, remotely operated vehicles, the design of biological buffers for water treatment, and the exploration of environmental radiation and its effects on cellular growth.

For more information, visit www.vernier.com/grants/nsta

ENTRY DEADLINE: NOVEMBER 30, 2013

New Addition at Vernier Headquarters

We are working on a major expansion of our building, and we are very excited to have the extra space. We are doing some fun things with the expansion, including a slide from the second floor to the first floor. We will also have windows made of electrochromic glass that are electronically tintable to varying shades and controlled by a light sensor. If you make it to Portland, be sure to stop by for a visit.



Architectural renderings of Vernier's new two-story expansion

SCIENCE HUMOR

A guy walks into a bar and says "I'll have H₂O." Another guy says "I'll have H₂O, too." The second guy died.

Heisenberg and Schrödinger are driving when they are pulled over. The officer asks, "Do you know how fast you were going?" Heisenberg responds, "No, but I know exactly where I was." Figuring this odd answer is grounds for a search, the officer opens the trunk and finds a dead cat. He says, "Do you know there's a dead cat in here?" Schrödinger replies, "I do now!"

Thanks to Rick Rutland, Kris Troha, and <http://chemistry.about.com/u/ua/chemistryfunhumor/Science-Jokes.htm>

"I just wanted to say that you guys are an excellent company...Thanks for the great service."

Brad Sieve, Northern Kentucky University, Highland Heights, KY

Free Hands-On Training at Conferences

Vernier offers hands-on workshops at each of these conferences. For a full listing of our conference exhibits, check our web site at www.vernier.com/conferences

- **NSTA Area Conference**
Portland, OR, October 24–26
- **California Science Education Conference**
Palm Springs, CA, October 25–27
- **NSTA Area Conference**
Charlotte, NC, November 7–9
- **Conference for the Advancement of Science Teaching**
Houston, TX, November 7–9
- **Virginia Association of Science Teachers**
Norfolk, VA, November 14–16
- **National Association of Biology Teachers**
Atlanta, GA, November 20–23
- **NSTA Area Conference**
Denver, CO, December 12–14

New Optical DO Probe Tech Tips Video

We have started shipping our new Optical DO Probe (ODO-BTA, \$379). Teachers are using it for the following applications:

- Explore water quality in lakes, streams, watersheds, and more.
- Study cellular respiration and photosynthesis.
- Investigate primary productivity and cultural eutrophication.

This plug-and-play probe uses luminescent technology to provide fast, easy, and accurate measurements of dissolved oxygen concentrations. It requires no calibration, no filling solution, no warm-up time, and no stirring. See the Optical DO Probe in action with the new Tech Tips video, www.vernier.com/v173

For more Tech Tips and to check out our free library of videos featuring popular experiments and product demonstrations, visit www.vernier.com/videos



Chemistry Staff Scientist, Dr. Elaine Nam, measures the concentration of dissolved oxygen in the video "Optical DO Probe Tech Tips"

PROFESSIONAL DEVELOPMENT

NSTA Comes to Portland

Visit Vernier While You Are in Portland

The NSTA “Bridges to the Future” Conference on Science Education will be held in Portland, Oregon on October 24–26. We are offering workshops, hosting a booth in the exhibit hall, and sponsoring a tour of Vernier.

An NSTA field trip to our office is scheduled for Thursday, October 24, 12:00–4:30. Educators will visit our on-site technology museum, discover a bit about the company’s history, learn to ride a Segway®, see new products demonstrated, win prizes, and have a relaxing lunch. Come check out the development of our LEED-certified building expansion with cool science features, such as solar panels, electrochromic windows, a saltwater aquarium, and an indoor slide that is perfect for fun-loving science teachers. Sign up for this field trip through NSTA, www.nsta.org

You are also welcome to come out to our office and have a private tour given by one of our scientists. You can pick up a map from our booth at the conference. We will also have a limited number of passes to the Oregon Museum of Science & Industry (OMSI) available in our booth.



Downtown Portland with Mt. Hood in the distance

Webinars

Join us for a free, one-hour training online. Sessions are broadcast live on the web and recorded versions are available for download. Topics include:

- 1:1 Sensor-Based Learning in Science with Vernier LabQuest 2
- LabQuest 2 and the Connected Science System
- Biotechnology: Gel Analysis
- Physics: Video Analysis
- Chemistry: pH Titration
- Chemistry: Beer’s Law

To view recorded webinars or to request a personalized training webinar for your science team, go to www.vernier.com/webinars

Free Hands-On, Data-Collection Workshops

Calling all science educators! Join us for a four-hour exploration of the latest and greatest in Vernier probeware and data-collection technology. You will conduct hands-on experiments using various sensors with the LabQuest 2 interface.

Perfect for science educators who

- Want to evaluate our award-winning technology.
- Are new to data collection.
- Need a refresher course on Vernier equipment.
- Want to learn from an expert.

Attendees receive

- Four hours of free training
- Light lunch or dinner
- Workshop Training Manual on CD
- Savings on a workshop package

SEPTEMBER

9	Houston, TX
10	Houston, TX
11	Corpus Christi, TX
12	San Antonio, TX
18	San Antonio, TX
18	Omaha, NE
19	Austin, TX
19	Des Moines, IA
21	Dallas, TX
21	Cedar Rapids, IA
23	Dallas, TX
23	Minneapolis, MN
24	Minneapolis, MN
25	Tulsa, OK
26	Oklahoma City, OK
28	Wichita, KS
30	Kansas City, MO

OCTOBER

1	Manchester, NH
2	St. Louis, MO
2	Boston, MA
3	Boston, MA
3	La Crosse, WI
5	Providence, RI
5	Madison, WI
7	Worcester, MA
7	Rockford, IL
8	Chicago, IL
9	Albany, NY
9	Chicago, IL
16	Rochester, NY
17	Buffalo, NY
19	Erie, PA
21	Cleveland, OH
29	Louisville, KY
30	Lexington, KY

NOVEMBER

4	Cincinnati, OH
5	Dayton, OH
7	Indianapolis, IN

For more details, go to www.vernier.com/workshops



Conducting an acid-base titration in a hands-on Vernier workshop



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www.vernier.com
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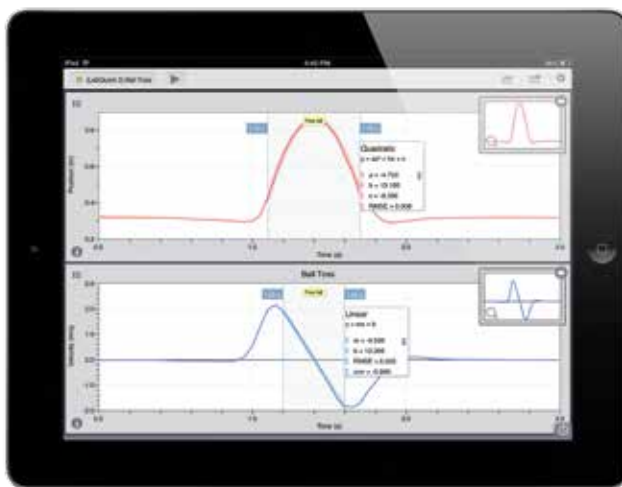


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Gear Up for iPad® Data Collection

www.vernier.com/ipad



LabQuest® 2

Collect and analyze data
with iPad and other
mobile devices.

www.vernier.com/labquest2

Graphical Analysis™ for iPad

Download this iPad app
to collect, analyze, and
annotate data.

www.vernier.com/ga-ipad

Video Physics

Record video and
analyze motion frame
by frame.

www.vernier.com/videophysics



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on or recycle it again.