

The Caliper is
a publication
for users of
Vernier products

The Caliper

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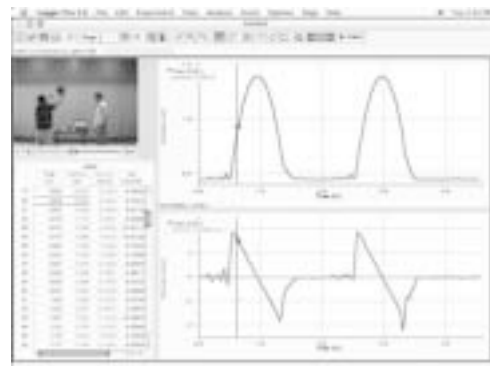
Logger Pro[®] 3

We have continued to improve *Logger Pro*, our all-in-one, award-winning data collection application. *Logger Pro* now integrates all of the features of *Graphical Analysis 3*, while offering greatly improved data collection capabilities using *LabPro*.

Connect a sensor (or four or five) to your Vernier *LabPro*[®] and start *Logger Pro*. The powerful automatic setup features mean that it doesn't matter where you connect the sensors. Click collect, and you've got data! Do some analysis such as curve fitting, statistics, integrals, and more.

Some of the new features of *Logger Pro 3* include:

- Use the mouse to draw predictions on graphs before taking data.
- Insert movies of experiments and synchronize them to the acquired data.
- Support for the new Vernier Drop Counter. No more tedious titrations!
- Save custom calibrations to your sensors for later automatic use.
- Use the built-in function generator feature of *LabPro*, controlling it from *Logger Pro*.
- Use the Vernier Digital Control Unit with *Logger Pro*.
- Collect simultaneous analog and rotary motion data.
- Collect Motion Detector data simultaneously with higher speed force data.
- Import data from Texas Instruments and Palm OS[®] handhelds.
- Do curve fits and modeling with user-entered functions.
- Spread out your graphs, tables, and text using multiple pages.
- Macintosh OS X native version, as well as OS 9.2.
- Improved USB support for Windows 2000 and Windows XP.



See page 7 for some new experiments you can do with *Logger Pro 3*. And check out the free downloadable demo of *Logger Pro* available at www.vernier.com/downloads. A *Logger Pro* site license is \$99. If you now use *Logger Pro* with your *LabPro* interfaces, you can upgrade to *Logger Pro 3* for just \$50. Our generous site license includes the home computers of both teachers and students. One copy does it all.

Logger Pro 3 Order Code LP **\$99**

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Announcing the Vernier/NSTA Technology Awards



Vernier and NSTA announced the establishment of the Vernier Technology Awards at the 2003 NSTA National Convention in Philadelphia. This award program has been established to recognize the innovative use of data-collection technology in the science classroom. Full-time science teachers from elementary to college level are eligible to apply for these awards, which are valued at \$3000 each and include a \$1000 cash award, \$1000 in Vernier equipment, and \$1000 towards travel and expenses associated with attendance at next year's NSTA National Convention in Atlanta.

For application forms, call NSTA at 703-243-7100, or visit www.nsta.org or www.vernier.com. Applications must be received by October 15, 2003. Awards will be presented at the 2004 NSTA National Convention.



No Child Left Behind and You

Vernier offers resources to help you meet NCLB requirements

The No Child Left Behind (NCLB) Act ties federal funding of education to the Adequate Yearly Progress (AYP) of students on federally mandated assessment tools. To access NCLB funds, educators must show how these funds will be used to implement activities that are supported by scientifically-based research. Vernier can help you meet this challenge! For grant-writing assistance, access to an excellent bibliography of research articles that support the use of data-collection technology in science and math education, and ideas for funding sources, visit our web site, www.vernier.com, and click on the "Teacher Resources" tab.

For more information on the No Child Left Behind Act, we suggest you visit the following web sites: www.nsta.org/nclb, www.nclb.gov, or www.nasbe.org/NCLB/NCLB.html.

Are You an AP Teacher?

Looking for new ways to do the traditional AP labs in biology, chemistry, and physics? Vernier LabPro, sensors and lab books make it easier than ever to collect data. In biology, seven of the twelve recommended labs can be done using data-collection technology. A complete correlation of the AP Biology lab objectives and our objectives can be seen at www.vernier.com/resources/ap.html. In chemistry and physics, many of the recommended labs involve the use of technology for data collection. Watch our web site for further developments in these two areas.

Stop by our booth at the AP National Conference July 18-21 in Los Angeles, CA. More information on this conference can be seen at apcentral.collegeboard.com.

New "Getting Started with Vernier" CD

Our "Getting Started with Vernier" video training CD has been updated to include new footage that shows you how to set up Vernier LabPro with Palm OS handhelds. Also included are experiments from our new Real World Math and Earth Science lab books.



Whether you want to see LabPro in action before you buy, or simply want help getting started with data collection, this CD is a great resource. For a free copy, visit our web site at <http://www.vernier.com/info.html>



Science Humor

Insultingly Stupid Movie Physics (<http://www.intuitutor.com/moviephysics/>) is a web site about the bad physics in movies. It has discussions of the common

errors in action movies, such as "the attractive force of glass," "visible laser beams," and "outerspace explosions." It rates moves as: GP = Good physics in general, PGP = Pretty good physics (just enough flaws to be fun), PGP-13 = Children under 13 might be tricked into thinking the physics was pretty good (parental guidance is suggested), and XP = Obviously physics from an unknown universe. It would probably stir up some good discussions in most physical science or physics classes.



Vernier Microstirrer

When we introduced our new Drop Counter, we decided to include a Vernier Microstirrer to enhance stirring. Since then, we have had many requests to have this as a separate product. The Microstirrer takes the place of the stirring bar that is typically used with a laboratory magnetic



stirrer. The new Vernier Microstirrer easily attaches to the end of a pH Sensor, Conductivity Probe, Dissolved Oxygen Probe or Ion-Selective Electrode. When the magnetic stirrer plate (required, but not included) is turned on, its magnetic field turns the paddle wheel of the Microstirrer, resulting in enhanced stirring near the electrode tip. The Microstirrer works with any magnetic stirrer.

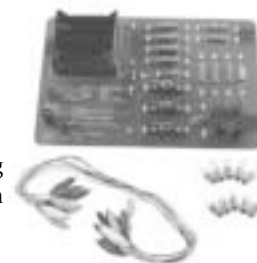
- The Microstirrer improves stirring throughout the vessel, especially in the vicinity of the electrode.
- It is especially useful with a Dissolved Oxygen Probe, because this sensor requires constant movement of solution past its membrane.

Vernier Microstirrer Order Code MSTIR \$8



Vernier Circuit Board

Make your circuits labs easy with the new Vernier Circuit Board. The board comes with a variety of resistors, capacitors, light bulbs, switches, and an LED. Use the on-board batteries or an external supply for power. It's easy to quickly connect the components using the supplied clip lead wires. Your students can study series and parallel circuits with both resistors and bulbs, try out various RC combinations, and use the function generator of LabPro to study the current-voltage behavior of a light bulb. Extra terminals allow you to add your own components.



Vernier Circuit Board Order Code VCB \$84

Vernier – Setting the Gold Standard

- **Vernier Toll-Free Number: (888) 837-6437.** Customers tell us our technical support is the best in the business. Now, you can call Vernier Technical Support staff more easily from a school telephone. You get the same great service. It's easier and it's free!
- **5-Year Warranty.** Vernier's warranty gives you the best value available. We have increased our warranty against defects in materials and workmanship from one year to five years. Data collection technology not sold by Vernier is typically covered for only one year. But, as most of you know, we have rarely charged for repairs on products that are 8, 10, or even 12 years old! Note: This warranty excludes consumables and products manufactured by Texas Instruments, Davis Instruments, and Extch.

News for Users of TI Technology

VST Apps: A New Application for TI-83 Plus Users

Users of TI calculators and LabPro or CBL 2 generally use the DataMate program for most of their data collection. DataMate is a versatile, easy-to-use, yet powerful program, that supports the vast majority of our sensors. Over the past few years, we have developed separate programs for special sensors such as our drop counter, photogates, radiation monitors, etc. and for special purposes such as distance and velocity graph matching. Each of these programs is individually available free on our web site. For users of the TI-83 Plus and TI-83 Plus Silver Edition users, we recently combined these programs into one application that can be stored in and run from the Flash memory of the calculator. Having these programs in one application makes it easier to access them. They also save RAM, which can be used for data storage. This application, called VST Apps, contains each of these programs within the single application.

- DatMatch—supports graph matching activities with the Vernier Motion Detector.
- DataGate—supports photogates and Smart Pulleys™.
- DataRad—to be used with our Radiation Monitor and Student Radiation Monitor.
- DaRotary—supports data collection with rotary motion sensors.
- DataDrop—to be used with our new Drop Counter.
- FunctGen—supports the analog out feature of the Vernier LabPro.

VST apps can be downloaded from our web site at www.vernier.com/calc/software/vstapps.

TI-83 Plus vs. the TI-83 Plus Silver Edition



Quite often we are asked to recommend a calculator for use in science and math. At the high school and introductory college level, the choice is between the TI-83 Plus and the TI-83 Plus Silver Edition. One difference between these two calculators is that the TI-83 Plus Silver Edition includes a TI-GRAPH LINK cable but the TI-83 Plus does not. In addition, the Silver Edition comes pre-loaded with



applications that are normally sold as extras. These applications include CellSheet™, Fundamental Topics in Science, GeoMaster, Organizer, and Periodic Table. The Silver Edition also has 10 times the Flash ROM as the TI-83 Plus. This extra Flash memory is very valuable because it provides extra space for all of the applications that have been and are being developed for the TI-83 Plus. The many extras of the TI-83 Plus Silver Edition give it the edge over the regular TI-83 Plus.

Vernier and Texas Instruments Collaborations

Vernier and TI are collaborating on three projects that will help you incorporate TI handheld data collection technology into your classroom.

■ Online Subscription to Science Data Collection with Vernier and TI Handhelds

TI has developed powerful online subscriptions for the use of TI technology in math, science, English, social studies and world languages. These resources let you search by topic for activities that are correlated to popular textbooks and national standards. We have been working with TI to include our lab manuals in this online subscription service. All of the following books will soon be a part of this subscription: *Biology with Calculators*, *Chemistry with Calculators*, *Physics with Calculators*, *Physical Science with Calculators*, *Earth Science with Calculators*, *Middle School Science with Calculators*, and *Water Quality with Calculators*. A subscription fee of \$85 gives you and all of the teachers at your school online access to our lab manuals. Information is available at <http://education.ti.com/us/product/explorations/overview/overview.html>.

■ Professional Development from T³ and Vernier

T³ and Vernier are developing professional development courses in middle school science and high school science. The courses include:

- Vernier/T³ Biology with Texas Instruments Handhelds
- Vernier/T³ Chemistry with Texas Instruments Handhelds
- Vernier/T³ Earth Science with Texas Instruments Handhelds
- Vernier/T³ Middle School Science with Texas Instruments Handhelds
- Vernier/T³ Physics with Texas Instruments Handhelds

Each institute allows school districts to develop local teacher leaders to serve as trainers and mentors, which in turn creates long-term systemic professional development. Information is available at <http://education.ti.com/us/t3/workshops/vernier.html>.

■ Online Training for Science Data Collection

TI and Vernier are also developing an online course to introduce teachers to data collection with CBL 2 or LabPro and TI handhelds. This course is appropriate for pre-service, middle school and secondary science teachers. It introduces ways of incorporating TI handheld data collection technology into your science curriculum to enrich instruction and extend your students' comprehension. Upon successful completion of the course, you will receive 35 hours of Continuing Education Credits. The cost is \$225 per participant. Information is available at <http://education.ti.com/us/t3/onlinecourses/onlinecourses.html>.

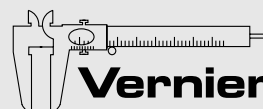
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CBL, CBL 2, TI-GRAPH LINK, and CellSheet are trademarks of Texas Instruments.

Palm is a trademark and Palm OS is a registered trademark of Palm, Inc.

Other product and company names mentioned herein may be trademarks of their respective companies.



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Dana by AlphaSmart®



Students can now collect data with Vernier LabPro and Dana by AlphaSmart. This laptop Palm OS device is popular for its wide screen, long battery life, light weight, and full-sized, integrated keyboard. The following components will have your students ready to collect data:

- **Data Pro software (version 1.2 or newer)**
Order Code DP-DANA \$50
The CD includes a site license to load it on any Palm handheld in a school, as well as students' personal Palm OS handhelds. Note: Unlike our other Data Pro Palm OS packages, the Dana does not require a special cable. The standard USB cable that comes with Dana is used to connect Dana to the Vernier LabPro interface.
- **LabPro interface**
Order code LABPRO (order one per Dana) \$220
Collect data from up to four analog or two digital sensors.
- **Vernier Sensors**
Collect data from more than 40 Vernier sensors using Data Pro with a Dana. All sensors except Rotary Motion are supported by Data Pro.
- **Science with Handhelds lab book**
Order Code SWH \$45
This Vernier lab book for handhelds has 42 experiments in chemistry, biology, Earth science, physics, and water quality.

For more information about Dana by AlphaSmart, go to www.alphasmart.com.

Data Pro 1.2 Updates (for Palm OS Handhelds)

In May, we will be releasing a new version of Data Pro for Palm OS handhelds. The latest version provides support for:

- The Vernier Drop Counter
- Radiation Monitor and Student Radiation Monitor
- Vernier Photogates
- Dana by AlphaSmart (see separate article above)
- Print driver. You can now print Data Pro data tables or other screens (graphs, for example), if your printer has IR capability, and is supported by our print driver.

If you have installed a previous version of Data Pro on your handhelds, you can update to Data Pro version 1.2 by going to www.vernier.com, and clicking on Software Updates, then Data Pro.



GLOBE Certification for Vernier Sensors!

Many of our customers participate in the GLOBE Program. This excellent, world-wide, hands-on, program gives primary- and secondary-school students the opportunity to learn science by doing science. Students participating in GLOBE take scientifically valid environmental measurements and report them to a publicly available database. Protocols and instruments are required to meet rigorous specifications in order to ensure the highest quality standards for data collection. GLOBE scientists have tested four Vernier sensors, Dissolved Oxygen Probe, pH Sensor, Stainless Steel Temperature Probe, and Conductivity Probe, and found them to be acceptable for GLOBE applications. GLOBE now plans to develop materials that detail the use of these probes to collect GLOBE data and hopes to have these available by this Fall. Stay tuned to the Vernier and GLOBE (www.globe.gov) web sites for further developments.

www.vernier.com Expands Teacher Resources

You'll find our updated web site faster to navigate and easier to use. Check out the following:

- We can help you meet the requirements of the No Child Left Behind Act at www.vernier.com/nclb.
- Need help with funding? Vernier has a free "Guide to Grant Writing."
- Correlations by state: www.vernier.com/resources/standards.
- Order online with credit card or school purchase order.
- A searchable database of answers to technical questions.
- Downloadable product manuals for every Vernier product.
- Free updates on computer, calculator, and Palm OS software programs.
- This edition and past editions of *The Caliper*.
- Idea Board, where you can exchange lab ideas with other teachers.

Workshops

Physics Modeling Workshops

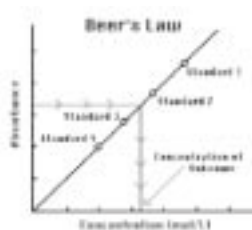
Modeling Workshops will be held this summer in many states. Most carry graduate credit, and they provide stipends and/or free tuition. Teachers are given model-centered course materials in mechanics, and they rotate through roles of student and instructor as they practice techniques of guided inquiry and cooperative learning. For more information, visit <http://modeling.asu.edu>.

Promoting Active Learning in Introductory Physics

There are spaces still available in the Chautauqua Courses in active physics learning coming up this summer. Priscilla Laws, Ron Thornton, and David Sokoloff are offering these courses June 5-7 at Dickinson College and July 24-26 at University of Oregon. For more information, see <http://darkwing.uoregon.edu/~sokoloff/physcourse.htm>.

Determining the Concentration of an Unknown Protein Solution: An Application of Beer's Law

In this experiment, you can use a Colorimeter to determine the absorbance values of five protein solutions of known concentrations (standard solutions). When a graph of absorbance *vs.* concentration is plotted for these solutions, a direct relationship should result, as shown in the figure on the right. This relationship is known as "Beer's law."



You can then determine the concentration of an unknown protein by measuring its absorbance, locating the absorbance of the unknown on the vertical axis of the graph, and finding the corresponding concentration on the horizontal axis (follow the arrows in the figure above).

Materials

You will need the following materials: Vernier LabPro or CBL 2 interface, two 10 mL pipets (or graduated cylinders), a computer, calculator, or Palm OS handheld, two 100 mL beakers, pipet or pipet bulb, Vernier Colorimeter, one cuvette, distilled water, five 20 x 150 mm test tubes, test tube rack, 30 mL of 1% albumin stock solution*, stirring rod, 5 mL of unknown albumin solution, and tissues (preferably lint-free).

* Prepare by using 1 g of albumin per 100 mL distilled water. Add 2 mL Biuret reagent to each 30 mL of albumin solution.

Procedure

1. Add about 30 mL of 1% albumin stock solution to a 100 mL beaker. Add about 30 mL of distilled water to another 100 mL beaker.
2. Label four clean, dry, Test Tubes 1-5. (The fifth solution is the beaker of 1% albumin stock solution.) Pipet 2, 4, 6, and 8 mL of 1% albumin stock solution into Test Tubes 1-4, respectively. With a second pipet, deliver 8, 6, 4, and 2 mL of distilled water into Test Tubes 1-4, respectively. Gently, but thoroughly, mix each solution with a stirring rod. Clean and dry the stirring rod between stirrings. Add about 10 mL of the 1% albumin stock solution to Test Tube 5. Test Tubes 1-5 will have concentrations of 0.2, 0.4, 0.6, 0.8, and 1.0% albumin, respectively.
3. Connect the Colorimeter to Channel 1 of the LabPro or CBL 2 interface. Start your data-collection program.
4. Set up the interface for the data collection. If you are using a computer, open an experiment file for absorbance *vs.* concentration in your data-collection program. If you are using a TI graphing calculator or Palm OS handheld, set up the data collection in the Event with Entry mode, using concentration as the x-axis entry.
5. Prepare a blank by filling an empty cuvette ³/₄ full with distilled water. Place the cuvette into the cuvette slot of the Colorimeter, and close the Colorimeter lid. If you are using a newer Colorimeter with auto-ID (see picture to the right), while still on the main graph or main screen of the program, calibrate by simply pressing the CAL button on the Colorimeter. If you are using a non-auto-ID Colorimeter, use the calibration routine of your data-collection program to calibrate with a blank cuvette at 0 and 100 percent transmittance.
6. You are now ready to collect absorbance-concentration data for the five standard solutions.
 - a. Start the data collection. (Press the Collect button or choose Start on a calculator or handheld.)
 - b. Empty the water from the cuvette. Using the solution in Test Tube 1, rinse the cuvette twice with ~1 mL amounts and then fill it ³/₄ full (3.5 mL). Wipe the outside with a tissue, place it in the Colorimeter, and close the lid.
 - c. When the value displayed on the calculator screen has stabilized, collect this data point and enter "0.2" as the concentration in %. The absorbance and concentration values have now been saved for the first solution.
 - d. Repeat this procedure for the solutions in Test Tubes 2-5 (0.4, 0.6, 0.8, and 1.0%). Note: Wait until Step 7 to do the unknown. Click or choose Stop to end the data collection.
7. Determine the absorbance value of the unknown albumin solution. To do this, rinse the cuvette with some of the unknown albumin solution, then fill it ³/₄ full with the unknown. Important: For the unknown, you will simply monitor the absorbance value (on the meter window of the computer screen, or on the Main Screen of the calculator or handheld). Record this absorbance value.
8. To determine the concentration of the unknown albumin solution, display your graph of absorbance *vs.* concentration with a linear fit displayed, then use your program to interpolate along the regression line. When the interpolation cursor reaches the absorbance value you recorded for your unknown albumin solution, the corresponding concentration will be the concentration of your albumin unknown.

New Look and Features for the Vernier Colorimeter!



One of our most popular sensors for chemistry, biology, and water quality testing is the Vernier Colorimeter. Our new Colorimeter has the following new features:

- **Automatic calibration.** Calibration is now much easier than ever before! Simply start up your data collection program, place a blank cuvette (with distilled water in most cases) into the cuvette slot, close the lid, and press the CAL button on the front of the Colorimeter. Within 10 seconds, the Colorimeter automatically performs the 0 and 100 percent transmittance calibration, and you are ready to collect data.
- **Additional wavelength value.** Due to popular demand, we have added another wavelength value on the Colorimeter: 430 nm (in addition to previous values of 470 nm, 565 nm, and 635 nm).
- **Improved performance.** The Colorimeter has a wider useful range, 10-90 percent transmittance (0.05-1.0 absorbance).

Why pay for an expensive Spectrophotometer to do absorbance *vs.* concentration (Beer's law) or absorbance *vs.* time experiments when you can do it for \$110 with the Vernier Colorimeter? With the Colorimeter, you have the advantage of computer, calculator, or Palm OS software that allows you to plot data, interpolate Beer's law plots, or do 1st and 2nd order rate law determinations.

Colorimeter Order Code COL-BTA **\$110**

Tips for Teachers from Teachers

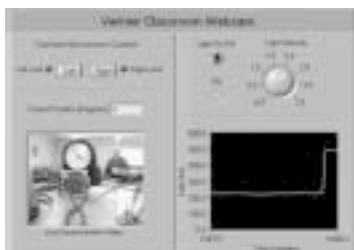
Here are some tips, tricks, and storage ideas gathered from some of our customers:

- Keep one user's guide from each sensor you order in a notebook for handy reference.
- Purchase or make at least 500 mL of pH storage solution to have on hand in case of spills.
- When you're using a pH sensor, place a nickel, or similarly sized coin, in the top of the pH storage solution and replace the cap. This will help you prevent spills.
- Store the Oxygen Gas Sensor in its Nalgene bottle to keep it upright.
- Use a Sharpie® or other indelible marker to number the probes and interfaces that students may be using over a series of days.
- Buy stackable plastic containers for storage.
- Buy a Pelican® case to store sensors and interfaces. You can customize them and do inventory at a glance.
- Use hinged, transparent boxes. Label all of the sensors in a particular box after a scientist, such as Newton. Then when Newton shows up in Einstein's box, you know exactly where it belongs. Have students check the contents of the box against a checklist to make sure all sensors are there before and after the lab period.

Do you have tips to share? If so, send them to Gretchen at gstahmer@vernier.com. Look for the complete list of tips soon on our web site, www.vernier.com.

Vernier Webcam

Check out the Webcam located in our classroom at Vernier Software & Technology in Portland, Oregon. You will need the LabVIEW Runtime Engine (free download from our web site) on your computer to view and control this demo. With a click on the panel, you can take control of this hardware from anywhere in the world with an internet connection. You can control the brightness of the small lamp (connected to the analog output line of LabPro) and see the resulting change in brightness measured by a Light Sensor. You can rotate the camera using a DCU connected to the LabPro. This project is just one example of the neat things you can do with LabPro and the Remote Panels feature of LabVIEW. Go to www.vernier.com/webcam for more information.



LabVIEW Update

We continue to develop sample programs for collecting data and controlling the outputs of LabPro using National Instruments' LabVIEW. These programs (VIs) are posted as free, open-source code on our web site at www.vernier.com/labview. Included are new VIs done in a state machine design. If you are interested in being informed about future LabVIEW workshops and developments, send an e-mail to David Vernier (dvernier@vernier.com).

Vernier Welcomes NABT to Portland!

We encourage you to attend the NABT 2003 National Convention in Portland, Oregon, October 8-11. Portland is a short drive from the Oregon Coast, Mt. Hood and the Columbia River Gorge. And, of course, Portland is the home of Vernier Software & Technology!

To celebrate your arrival, we will host a gala event in partnership with the Oregon Museum of Science and Industry (OMSI) on Wednesday, October 8, from 6-10 p.m. For more information, or to register to attend this event, visit www.nabt.org.

During the convention, be sure to visit us in the Exhibit Hall (we'll be in Booth #200), and take advantage of our free hands-on workshops all day Thursday, October 9. We look forward to seeing you!

Not Your Grandpa's Apple Cart Create a 21st century science learning center.

We are pleased that Apple Computer has chosen Vernier products to be part of the Apple Mobile Science Lab. This complete solution comes equipped with the following:

- 8 700 MHz iBooks with installed Airport cards
- AirPort Extreme Base Station
- 8 Vernier LabPro interfaces
- 8 temperature probes
- 8 conductivity probes
- 8 motion detectors
- 8 pH sensors
- Logger Pro 3
- Vernier Curriculum Binder with 73 experiments
- ProScope Digital USB Microscope and curriculum
- HP LaserJet 1200N Ethernet laser printer
- Bretford mobile cart
- Apple Professional Development Workshop



For more details, visit Apple's Education Solution page at <http://www.apple.com/education/curriculumlabs/>

Ten Years Ago in The Caliper

- We included an article on Computer Price Trends, which showed that that new computer models often were over \$3000 when first introduced, but after two or three years, they dropped to around \$1000. The top-of-the-line computers then were Mac IIsi and 486.
- We announced the first AAPT Photo Contest, sponsored by Vernier Software.

Fifteen Years Ago in The Caliper

- We announced our first program for IBM-compatible computers, Precision Timer (MS-DOS Version). It used photogates connected to the game port of the computer. It is still used in many labs today.
- We announced major upgrades of our Apple II Voltage Plotter and Temperature Plotter programs.



Innovative Uses

Two-Liter Creek

John Fischer, Ashwaubenon HS, Green Bay, WI, has created an artificial "Two Liter Creek" in his classroom for water quality studies in the middle of a Wisconsin winter. It is simply a 50-gallon aquarium with a pump that lifts water into an array of 15 two-liter bottles that have been mounted on a pegboard. This closed-loop creek has gravel in the bottles and in the aquarium. Over time, the artificial creek forms an ecosystem, as does a real creek. John's students become experts at using our sensors to monitor this creek and they are ready to tackle the outdoor water when spring comes. The students have even intentionally "polluted" the creek and monitored its recovery.



Darren Carollo's, students (Lincoln HS, Dallas, TX) learn about high-energy physics by doing hands-on experiments. Among other experiments, the students use a CO₂ fire extinguisher to shoot a piece of bubble gum through the tube and smash it inside a Plexiglas® box. The students measure the speed of the particles in this "particle accelerator" using two Vernier Photogates and LabPro.

Frances Van Dyke authored the article "Using Graphs to Introduce Functions" in the February, 2003 issue of *Mathematics Teacher*. She describes how a Motion Detector can be used to help students understand the concept of functions. She starts with qualitative graphs and progresses to quantitative graphs, then data tables, and then equations. The article contains a complete set of worksheets for this lesson.

As is usually the case, recent issues of *The Physics Teacher* have had a lot of great ideas for using data collection. Here are some examples:

January 2003: "Measuring the Damping Constant for Under-Damped Harmonic Motion," Michael C. LoPresto and Paul R. Holody, Henry Ford Community College, Dearborn, MI. They use LabPro to do a nice study of a spring-mass system.

February 2003: "Simple Uncertainty-Principle Experiment," Charles A. Sawicki, North Dakota State University, Fargo. He uses Logger Pro and a microphone to gather data and do some analysis to introduce modern physics concepts.

March 2003: "How Fast Is Your Finger? An Introduction to Photogate Use," John Gardner, Eastern Illinois University, Charleston, IL and Mattoon HS, Mattoon, IL. He offers some simple activities that you might want to try the first time you use photogates with your students.

10 Great Labs Using Logger Pro 3

These are all labs that can be done using Logger Pro 3 and LabPro.

- Power a small lamp (like the one on the Vernier Circuit Board) with a triangular wave output from the function generator built into LabPro. Place a current probe in series with the lamp. Monitor the voltage applied to the lamp and the current that flows, showing the change in resistance of the filament of the lamp as it heats up on each cycle.
- Set up a buzzer connected to a Digital Control Unit (DCU) and a LabPro to turn on when the temperature of your tea is cool enough to drink.
- Measure the speed of a moving cart using photogates and, on the same run, the impact forces during a collision.
- Power a small motor with the analog output lines of LabPro and measure the motor speed with a photogate and torque with a Dual-Range Force Sensor.
- Do Hooke's law, using a Rotary Motion Sensor to measure position, as you measure Force with a Dual-Range Force Sensor.
- Have students draw a prediction on screen of what they think the temperature vs. time graphs will look like when they cool and freeze water. Then have them do the experiment and see the resulting data.
- Use the LabPro built-in function generator to vibrate a stretched string. Investigate standing waves and harmonics.
- Use the function generator built into LabPro to vibrate a small speaker with a hook glued to it. Hang a spring and a mass from the hook and investigate this driven harmonic oscillator. See what happens at frequencies near resonance.
- Take acceleration data on an amusement park ride and have someone else take a movie of the same ride. Import the movie into the Logger Pro experiment file and synchronize the data and the movie.
- Study a collision taking hundreds of points a second with a Dual-Range Force Sensor while you use a Motion Detector sampling at a much slower rate.

Hot Biceps

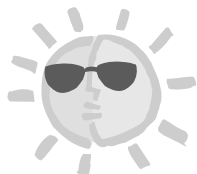
Judy Day (The Science House, Raleigh, NC) has students and workshop participants use our new Surface Temperature Sensor (STS-BTA, \$21) to examine the increase of muscle temperature as a team member lifts a 2-3 lb (1 kg) weight. The Surface Temperature Sensor is designed for use in situations in which low thermal mass and/or flexibility is required. It has an exposed thermistor that results in an extremely rapid response time; therefore, it is ideal for this experiment.



A student places the tip of the temperature against the bicep muscle for at least one minute to allow the probe to equilibrate with the skin and muscle's temperature. Meanwhile, another student sets up the data collection for a 3-minute experiment, taking one reading every second. Once the temperature has stabilized, data collection is started. After collecting muscle temperature for about 15 seconds, the student begins lifting the weight (curling the arm), while another student continues holding the Surface Temperature Sensor against the muscle.

When the data collection has ended, students are asked to explain why the muscle temperature has increased by 1.5 to 3°C. As an extension, Judy also uses Logger Pro software and our Exercise Heart Rate Monitor to track heart rate during this experiment.

Vernier Hands-On Summer Workshops



Join Vernier for a day of hands-on training. Learn how to integrate data-collection technology into your chemistry, biology, physics, math, middle school science, physical science, and Earth science curriculum.

Each hands-on workshop is six hours and includes lunch and lab handouts. You can also earn two Continuing Education or Graduate Credit hours. See our web site for details.

Affordable pricing:

- Full day of training (lunch included): \$50
- Workshop and Quick Start Package: \$250.00 (includes LabPro, Light Sensor and a Temperature Probe)
- **Best Value:** Workshop plus Training Package: \$250 (includes Vernier LabPro interface, Logger Pro software and a Temperature Probe)

Our workshops fill up fast, so sign up today to secure your spot! Sign up on-line at: www.vernier.com/workshop/index.html

Join us in one of the following locations:

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June 24	Hurst-Euleess-Bedford ISD	Bedford, TX	July 29	St. Teresa's Academy	Kansas City, MO
June 24	Salem High School	Salem, VA	July 31	Pius X High School	Lincoln, NE
June 26	Elsik High School	Houston, TX	August 5	Clay High School	South Bend, IN
June 26	Heathwood Hall Episcopal School	Columbia, SC	August 7	Benedictine University	Lisle, IL
July 8	Hume-Fogg Academic High School	Nashville, TN	August 12	Sandra Day O'Connor High School	Glendale, AZ
July 8	Dowling College	Oakdale, NY	August 14	Diamond Bar High School	Diamond Bar, CA
July 10	University of Montevallo	Montevallo, AL	August 18	Vernier Software & Technology	Portland, OR
July 10	Hackensack High School	Hackensack, NJ	August 19	Vernier Software & Technology	Portland, OR
July 15	Albany College of Pharmacy	Albany, NY	August 21	Southern Oregon University	Ashland, OR

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Logger Pro 3



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