Engineering EDUCATOR
The latest news about teaching tools, measurement technologies and innovations in engineering education

A Wake-up Call

Byron Cheung, Guest Editor

"*There can be no garden without rocks,*" the Chinese say with characteristic double entendre. They float ghostly limestone masses over a pool appointed with lily pads and tame carp, and they almost force you to relax. I'm staring at one of these gardens now as I write this note on my laptop computer in the Fragrant Hill Hotel outside of Beijing. I'm downloading it through the fiber optic link to the US. It's a far cry from the infrastructure that was here just a few years ago.

China has come a long way, and with regard to engineering education, they still have some heavy-duty travel plans. Take the "21-1" project: By the end of the 21st century, 100 Chinese universities will be on par with western schools. Imagine the leader of any other country creating a hoshin that spans a century. Of course, this is the same country whose leader Mao answered the reporter's question, "How do you think the French Revolution affected the world?" with the oh-so-Chinese reaction, "It's too early to tell."

With "21-1", China, already graduating 125,000 engineers/year, would have an overwhelming supply of modern engineers, taught by western-educated faculty. No more Asian student money for western schools. No more reliance upon the west to educate Chinese engineers or dole out technology. And China isn't alone.

All of Asia is sending a wake-up call to the rest of the academic world. All that's needed is a strong economy, a commitment, and talented people with a will to make it happen.

They have most of the ingredients. China needs to seriously overhaul the way it compensates its teachers and overcome past transgressions toward the profession, but given their track record for long-term change, my bet is that it won't take a hundred years. Come to think of it, who'll be here to collect if I'm wrong?

This issue of the Engineering Educator contains a feature story about engineering education in China. Get yourself a bowl of congee and find a nice Chinese garden so you can relax in front of the reflecting pool while you read the article. Hurry, your next 100 years are almost up.

Byron Cheung,
HP Test & Measurement
Education Program Manager for Asia

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IN THIS ISSUE

Share Your Thoughts

This newsletter and the HP Educator's Corner Website (http://www.hp.com/info/college_lab101) are intended to help you, the educators responsible for shaping students into competent engineers. But to do a good job of meeting your needs, we need your feedback. Please e-mail your comments, questions and concerns to: MARSH_FABER@hp.com.

Time-Varying Capacitance and Inductance

Vol. 1, No. 2 of the HP Engineering Educator was the first I saw....and I liked it a lot....and I read it all. You did an excellent job. I teach both basic courses and courses related to electrical power. I was interested in your student investigation of the reed relay; first, since it was a popular device when I started working at IBM in 1960; second, its investigation might "pave the way" for my power students to investigate the time-current operational and interrupt curves associated with a fuse, breaker, or ground fault device.

I learned at IBM and have used it in my teaching, that the current profile within a device like an electromechanical relay is sort of a 'fingerprint' of the operating nature of any magnetic device. As the reed relay's mechanical contacts (which also act as the coil's armature) move together, the coil inductance changes. This is never studied by EE undergraduates....that is, although Ldi/dt + idL/dt is the actual voltage across the inductor, we rarely consider that L may vary with time.

As the fixed voltage is applied to the operate coil, the current increases, but then can decrease as dL/dt really gets going, and then rises normally again when the inductance stops changing, just as it would in a normal RL circuit. So the current through the operate coil gives a good indication of when the magnetic loop is as closely ferromagnetic as it is going to be...armature (contacts) stop closing...and the current in the magnetic coil begins to rise like a normal, non-changing inductance.

I've found that time-varying capacitance and inductance are concepts not taught to undergraduates in EE; however, changing masses are considered 'fair game' in undergraduate mechanical courses. Hmmmmmm.

C. P. Callis
U. of Tennessee at Martin

Reply:

Dr. Callis,

Thanks for the practical insights. Yes, that's exactly what we were trying to show – that a device as simple as a reed relay can be used to demonstrate some fairly sophisticated engineering "opportunities". Another example is that a small current is injected into the switched circuit when the coil's current collapses.

Marsh Faber

Editor's note:

The responses to both the HP Engineering Educator Newsletter and the HP Educator's Corner website have been overwhelmingly favorable. For that, we thank you. Our only mark in the "needs improvement" category comes from a professor who thinks the first newsletter had too much commercial content. That surprises us, since we have taken great pains to insure that the HP Engineering Educator is not an "advertorial". As a result of the comment, we have redoubled our efforts to make sure that the pages of this newsletter are directly applicable to you and your efforts to teach undergraduate engineers.

Please let us know how we're doing.

Marsh Faber

Correction:

In the last edition of Engineering Educator, we incorrectly listed the URL for the HP E-Mail Mentor Program. The correct URL is:

http://mentor.external.hp.com.

We apologize for the frustration we caused those of you who tried to access the site.

Asynchronous Learning Networks and World-Wide Engineering Education

John R. Bourne, Ph.D.
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The ALN Web (http://www.aln.org),
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Vanderbilt University, Nashville, TN 37235

As instructors move from being a "sage on the stage" to being a "guide on the side," the traditional lecture can be replaced with audio, slides, simulations and video online that students can use asynchronously.

Asynchronous Learning Networks (ALNs) are networks of people who are enabled by computer and communication technology to learn anywhere and at anytime. ALNs are typically implemented using World-Wide Web sites and employ computer conferencing as a collaboration and communication vehicle among people. ALNs often combine self-study, asynchronous delivery of multimedia materials and discussion and submission of assignments. The term ALN was coined by Dr. A. Frank Mayadas of the Alfred P. Sloan Foundation, who provided the initial impetus and funding to initiate work in ALN.

Distance education has been traditionally conducted by use of mailed study materials (correspondence courses) or by synchronous broadcast of video lectures. These modes of distance learning are not ALN; by our definition, ALN requires both the ability to learn in a non-synchronous fashion and to have substantial interaction among learners.

In late 1997, ALNs have become recognized as having the potential for significant impact in higher education, both on and off campus. Off-campus, students learn without visiting campus, and on their own time. Industrial learners can utilize ALN materials at home or in the workplace. On-campus ALNs can extend the learning experience outside the classroom. Most universities have wired their dormitories for Internet access. ALNs provide a clear way to make use of these facilities.

In the previous four years, the term ALN has grown from little recognition to widespread acceptance. Schools and universities throughout the world are adopting ALN and there are many significant experiments taking place that are helping to define what works and what doesn't work in ALN. Much of this knowledge is captured in the ALN Web, an online service funded by the Alfred P. Sloan Foundation and run at Vanderbilt University. The ALN Web (http://www.aln.org) provides the following services:

- The Journal of ALN (JALN), a scholarly reviewed journal
- The ALN Magazine, a compendium of current activities in ALN
- ALN Talk, a moderated asynchronous online discussion area about ALN issues
- Workshops
- Knowledge bases about ALN

What things can be done in engineering education with ALN? First, lectures can be replaced!

As instructors move from being a "sage on the stage" to being a "guide on the side," the traditional lecture can be replaced with audio, slides, simulations and video online that students can use asynchronously.

Instructors will likely spend much more time creating materials and facilitating the use of the materials than giving "stand up" instruction. This change has the advantage of reclaiming lecture time for useful learning activities. Currently many students perceive the traditional lecture (especially in engineering education) as not having high value. By reusing the time to facilitate individual and peer-to-peer learning, both learning gains and economies of scale should occur.

Laboratories can be simulated in engineering education. Learning materials online that duplicate traditional laboratories can help prepare students for physical laboratories. For example, the Electronics Laboratory Simulator (http://www.falconsoftware.com) and the HP Basic Instrument Emulator (http://www.tmo.hp.com/tmo/iia/edcorner/English/on_test_eqpt.html)

continued on page 9

Harbin Institute of Technology Leads the Way in Chinese Educational Reform

From all over China, people flock to Harbin, a city of three million people, to participate in its annual winter carnival. Visitors brave the frigid winter temperatures to view multitudes of intricate sculptures – pagodas, bridges, lanterns, human figures and fanciful beasts – all carved from blocks of ice. The climate is cold enough to keep the spectacular statues frozen solid for several months. The local economy, however, is red hot.

"Everywhere you go there are grasshopper-like cranes putting up new buildings," said Marsh Faber, education program manager for HP's Electronic Measurements Division, after a recent visit. And no where is that more evident than at one of the city's many universities, Harbin Institute of Technology (HIT).

The architecture of the main building at HIT reflects the school's multi-cultural heritage.

The Chinese government wants to bring the entire university system, but especially engineering education, up to western standards. Their target is to have 100 schools on par with western universities by the end of the 21st century. HIT administrators are on a faster track.

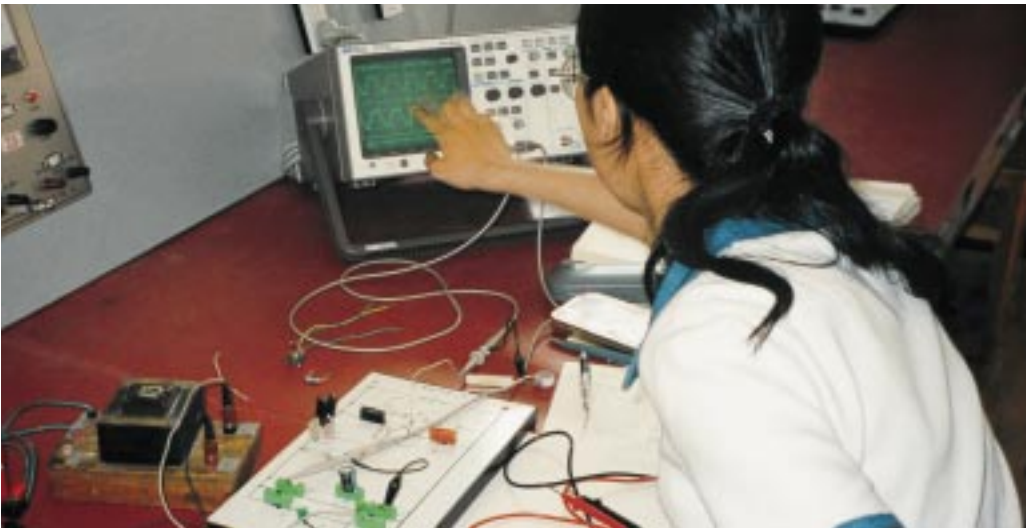
Located on a tree-lined road outside the city, HIT's sprawling campus is dotted with new buildings, with several more in various stages of completion. The stark newness of the under-construction facilities contrasts sharply with the architectural styles of the older buildings, many of them revealing the area's historical ties to Russia and Japan. The faculty exhibits a multi-cultural tradition as well, with many educators speaking fluent Japanese, Russian and, quite often, English. As if to accent this eclectic atmosphere, the outskirts of the campus are decorated with giant metallic spheres, testaments to an implosive molding technique developed by a Harbin professor.

While the architectural dissonance might give you the impression that growth has been haphazard, that's certainly not the current case. The growth and renovation at HIT are an integral part of a focused plan to redefine the Chinese education system. The Chinese government wants to bring the entire university system, but especially engineering education, up to western standards. Their target is to have 100 schools on par with western universities by the end of the 21st century. HIT administrators are on a faster track. They talk of making their school a "first-rate university in the country and a well-known university in the world" by the early part of the century. It's a lofty goal. HIT administrators are working hard to make it a reality by implementing a variety of reforms and experimental programs.

Since the late 1980's, HIT has been restructuring its curricula and investing heavily to improve the educational environment. Already a well-respected technical school, HIT has approximately 13,000 students enrolled in undergraduate, graduate and adult education programs. The university offers degrees in 65 different specializations, including electronics and electrical engineering, mechanical engineering, computer science, "mechatronics" (a hybrid discipline of electrical and mechanical engineering with some computer science), social science and science management.

Industry Partnerships

Because Harbin lies in the heart of industrial China, an area rife with heavy equipment manufacturers and steel mills, it's been natural for the university to seek industrial partners. These regional industries need employees who understand all aspects of electronics. HIT has developed several programs to meet that need. The university currently has four affili-



HIT instructors designed innovative low-cost prototype boards for students to use in the lab.

ate factories. Its College of Automotive Engineering was established jointly with the Changchun No. 1 Motor Manufacturing Group.

In addition, the university has successfully enlisted a number of foreign companies to sponsor on-campus laboratories. For a fee, company employees can use these labs to gain the skills they need on the job. When the lab is not being used by employees, students can use it for hands-on learning.

Distance Learning

To meet the needs of graduate students who work full time in area industries and can't make it to campus regularly, the university is about to implement an experimental distance learning program. And a state-of-the-art fiber optic network gives HIT students the bandwidth they need to tap into US classes, via the Internet, offered by schools like Carnegie-Mellon University, Massachusetts Institute of Technology and the University of California at Berkeley. On the European front, discussions are underway to establish an asynchronous learning program with the Berlin Technical University and a Paris technical institute.

HIT cooperates with universities in other countries in more prosaic ways as well. When HIT telecommunications students built their own PBX exchange and cell phones, they acquired cases for the phones that were designed and manufactured by students at a Japanese university. Academic exchanges with universities in the US, the UK, Japan, France, Russia and the Ukraine are increasingly common. HIT School of Management administrators have even jointly developed a foreign trade major with the Siberian Institute of Electrical Engineering.

HP Lab Equipment Provides "WOW" Factor

Hewlett-Packard has worked cooperatively with HIT to stock a lab with new test and measurement equipment including oscilloscopes, function/arbitrary waveform generators and digital multimeters. Until the installation of this new equipment last year, students used hardware designed in the 1940's.

"The students are very motivated to learn because the equipment is a 'WOW!' to them," said HP's Asia Pacific Marketing Center's education program manager Byron Cheung. The word is spreading and class enrollment is climbing. "HIT is probably using their lab equipment more efficiently than any other school on the planet – virtually around the clock by 2,000 students per week," said Cheung. Six times a day, six days a week, a new cohort of 60 students gets their 2-hour shot at the 20-station lab. In fact, the lab is used so heavily that the university now has to replace the wooden floor of the room.

Advanced Thinking

"I was really struck by all of the examples of advanced thinking I observed at HIT," said Faber. "Many schools – no matter what part of the world you're in – focus most of their resources on research, but HIT is willing to invest and improve on teaching quality. It's a good investment for the long term. The school's distance learning program and its cooperative efforts with universities in other countries, all lead me to believe that HIT will be a shining star in China's educational reform efforts."

What's Brewing in the Clinic?

Visit Rowan University in the fall and you'll find our freshmen engineering students involved in a variety of hands-on experiences. You'll see students out on the shop floor measuring the tolerances of the flashlights they've just machined. At other times, you'll find them around a campus bridge shooting an azimuth with a theodolite and then in the lab taking strain measurements from a model. Put on your safety equipment and join them as they take process measurements from the campus cogeneration plant. What's going on? In a word: Clinic.

Patterned loosely after the medical education model, the clinic is the place where students, faculty, theory, and engineering applications converge. It's the place where students learn firsthand about engineering under the guidance of engineers. They're a continuous and substantial part of our programs, totaling 24 hours and varying from two to four hours every semester over the four years. And the first year is just as important as the last – maybe more so, since a meaningful freshman engineering experience has been shown to be key to motivating, educating, and retaining students.[1]

The clinic is an ideal structure to deliver on our goals:

- Hands on - Have students use what they're learning about.
- Integrated - Show how things correlate.
- Multidisciplinary - Involve students in a community of problem solvers.
- Teamwork - Emphasize the advantage of effective teaming.
- Communication - Develop top oral and written communication skills.
- Entrepreneurial - Reinforce value-based engineering.
- Contextual - Help students understand the big picture.

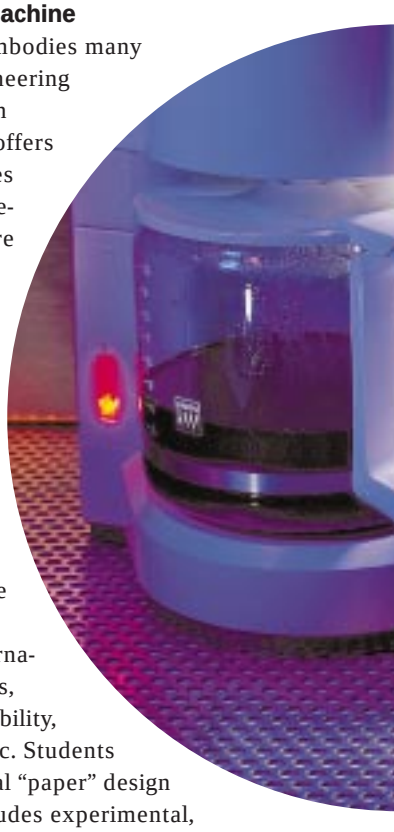
We offer four distinct programs in Chemical, Civil, Electrical, and Mechanical Engineering, but we are committed to a multidisciplinary outlook. Clinic sections include students from all four areas.

Freshman Clinic II

Freshman Clinic II is where students first experience design. But we don't rush students into it, and we steer clear of "toy" experiences like egg-drop contests, because we think they'll learn a whole lot more about engineering working with the real thing – and still learn about teamwork and have fun!

Clinic I gave students a working language of engineering units and measurements. Their second step on the path to design takes a measured look at what other engineers have done. They serve a reverse-engineering (R-E) apprenticeship using a low-cost, consumer product. These products work well and are hallmarks of the global engineering and manufacturing process we want our students to compete in. The R-E experience prepares students for the third step: we pose a modest design problem based on the product.

Design: Green Machine



A coffee maker embodies many fundamental engineering science and design principles[2] and it offers many opportunities for design improvement.[3] Students are challenged to design a coffee maker with some aspect that can be considered environmentally friendly. They can choose any aspect of "green" if it meets the core design objective. Ideas include alternative power sources, enhancing recyclability, reusable filters, etc. Students must submit a final "paper" design proposal that includes experimental, proof-of-concept work, and have to orally present their approach.

J.L. Schmalzel, A.J. Marchese, R.P. Hesketh,
Rowan University, Glassboro, NJ.

Data Acquisition is Key

A companion objective is to get students conversant in PC-based data acquisition. This introduces key instrumentation concepts and immerses students in data analysis and presentation. They use spreadsheets to analyze data from thermocouples, LVDTs, watt-meters, etc. Successful data acquisition requires a system offering high resolution, accuracy, and versatility – and it has to be rugged and easy for students to use. The HP 34970A data acquisition/ switch unit meets these requirements. The 6-1/2-digit DMM core gives effective 22-bit resolution, and eliminates signal conditioning front ends in many applications.

Coffee Maker Experiment Highlights

Data acquisition - The first lab covers data acquisition basics. Students see A/D converter resolution, visualize aliasing using over and under-sampled sine waves and cure aliasing using a first-order low-pass filter.

Materials - A beam-bending experiment shows important material properties. Modulus of elasticity is backed out from lab data using HP VEE. Thermal expansion and conductivity are explored.

Mass transfer - Effects of water temperature and coffee ground surface area on mass transfer are found using a spectrophotometer.

Heat transfer - Heat transfer in the coffee maker is investigated to determine where heat enters and leaves the system (see experiment on next page). Cooling rates of hot coffee stored in different carafes determine the most energy efficient storage method (See Figure 1).

Environmental - Water quality is explored through measurement of pH, conductivity, turbidity and chlorine residuals.

Energy and power - An energy balance is determined. Alternative sources are investigated including solar cells to charge batteries and microwave energy for heating.

Conclusions

The clinic is where we make engineering come alive. We've used a commercial coffee maker as a platform for involving students in fundamental engineering measurements and as a springboard to design.

For further reading:

1. R.G. Quinn, "Redesigned lab courses help reduce drop-out for engineering students," *HP Engineering Educator*, 1:1, 1997.

2. R.P. Hesketh, "Wake-up to engineering," *Chem. Engr. Ed.*, 30:3, 1996, p. 210.

3. A.J. Marchese, et al, "Design in the Rowan University freshman engineering clinic," Proc. ASEE Nat. Conf., Session 3225, Milwaukee, WI, June 15-18, 1997.

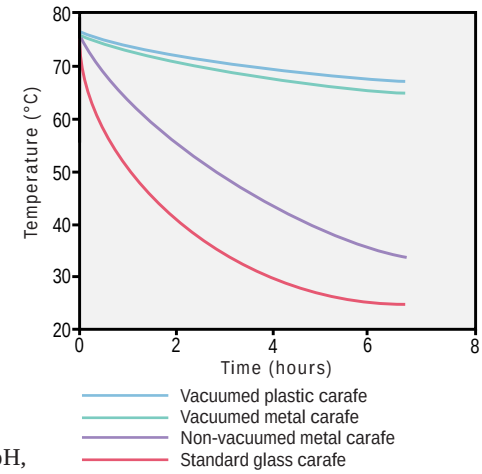


Figure 1. Performance comparison of coffee carafes.

Rowan Seeks to Change Engineering Education

Created as a result of a $100M endowment from Henry and Betty Rowan, the engineering college at Rowan University is one of only a few start-ups nationwide. The first entering class – the Class of 2000 – began in Fall 1996. The College of Engineering seeks to produce better-prepared graduates in keeping with recent calls for changes in engineering education. For example, see "Engineering for a changing world: A joint project by the Engineering Deans Council/Corporate Roundtable of the American Society for Engineering Education", http://www.asee.org/publications. Curriculum innovations from coalitions sponsored by the National Science Foundation can be found at http://www.eng.nsf.gov/eec.

Thermodynamics of Coffee Makers

A.J. Marchese, S. Mandayam, J.L. Schmalzel,
Rowan University, Glassboro, N.J.

Objectives: Multidisciplinary groups of freshmen engineering students will:

Define and measure the thermodynamic efficiency of a coffee maker.

Calculate the energy losses that occur during the brewing and heating cycles.

Estimate the amount of power consumed annually in the United States from brewing coffee.

Thermodynamic Efficiency

The thermodynamic efficiency of a device is always defined as a ratio of the desired useful energy ("energy sought") divided by the energy that actually costs money ("energy bought"). For example, an air conditioner comes with a performance rating called the Energy Efficiency Ratio. This is the amount of heat that can be removed from your house in BTU/hr, divided by the electrical power requirements of the air conditioner in Watts:

$$EER = \frac{\text{Energy Sought}}{\text{Energy Bought}} = \frac{\dot{Q}\ [BTU/hr]}{\dot{W}\ [Watts]}$$

How Do You Define Thermodynamic Efficiency for a Coffee Maker?

Energy Sought: The actual desired result of the coffee maker is to produce a good cup of hot coffee. Therefore the desired useful energy corresponds to the net change in thermal energy of the water as it travels from the reservoir to the outlet of the filter basket.

Energy Bought: A typical automatic drip coffee maker requires electrical AC power, which costs the typical consumer anywhere from 0.08 to 0.15 $/kW-hr (US Dollars).

Experiment

Equipment: The apparatus consists of a Betty Crocker Series II 12 Cup Automatic Drip Coffee Maker instrumented with 16 thermocouples (T_1 - T_{16}), a digital watt meter and a flow meter. The watt meter monitors the instantaneous energy consumption. The flow rate is measured using an Omega FTB600 ultra-low flow sensor. Data is acquired using an HP 34970A Data Acquisition Unit in conjunction with a PC. An HP E3613A powers the flow meter.

The apparatus operates over a 10-minute brewing cycle, followed by approximately 30 minutes of the heating cycle, during which the heater turns on and off to maintain temperature in the carafe. During the brewing cycle, the net rate of heat addition to the water [Watts] as it flows from the heater inlet to the outlet of the filter basket is:

$$Q_{17} = \dot{m}C_p(T_7 - T_1) = \text{The useful portion of the energy consumption}$$

where $\dot{m}$ is the mass flow rate in kg/s, Cp is the specific heat of water in J/kg-K, T_7 the filter basket outlet temperature and T_1 the water reservoir temperature in K. Since the instantaneous electrical power input to the machine, $\dot{W}$, is also measured, it is possible to calculate the instantaneous thermodynamic efficiency of the machine during the brewing cycle, from the following equation:

$$\eta = \frac{\dot{m}C_p(T_7 - T_1)}{W}$$

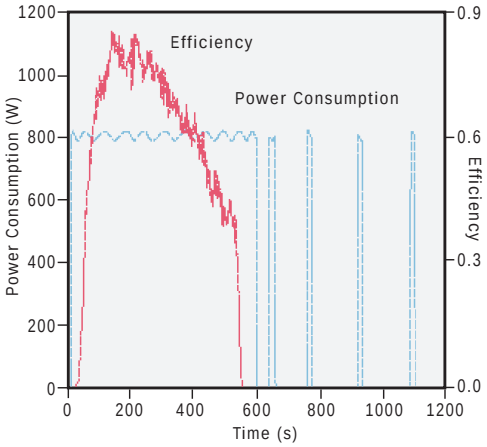


Figure 1. Instantaneous power consumption and energy efficiency for a typical coffee maker.

Figure 1 is a plot of the instantaneous power consumption during the brewing and heating cycles and the instantaneous thermodynamic efficiency during the brewing cycle.

Editor's Note:

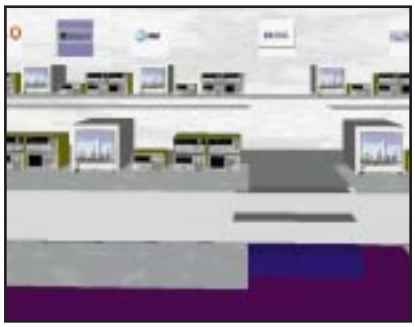
This is only the "demitasse" version of the "coffee pot" experiment. To see the full experiment log onto the HP Educator's Corner website:

http://www.hp.com/info/college_lab101

For information about Rowan the University Engineering Program visit: http://sun00.rowan.edu

Virtual Reality Lab

Take a look at the "almost-real" world of The Rensselaer Polytechnic Institute (RPI) Website. Use the right-hand mouse button to view the room from any angle. Check it out at: http://www.rpi.edu/~durlim/Elab.wrl



HP Will Support 1998 National Engineers Week

Continuing in the tradition of previous years, HP will provide financial assistance in 1998 to National Engineers Week programs which bring prospective students–kids in junior and senior high–on campus to participate in lab tours, contests and more. National Engineers Week is slated for Feb. 22-28, 1998

Asynchronous Learning Networks and World-Wide Engineering Eduction

(Continued from page 3)

are lab simulations that can be accessed over the Internet. Simulations can be useful when students need to learn about instrument operation, and when schools wish to reduce the load on physical laboratories.

ALN may help students on multiple continents integrate with ALN classes at US universities. Our current experience with an online workshop to an international audience has shown that ALN creates a simple, effective way of time shifting.

ALN has a bright future for accomplishing learning objectives in engineering education that have been previously difficult. Incorporating learners and facilitators from industry more directly into engineering courses at universities, reaching international learners, providing the ability to time- and place-shift learning on-demand and enabling student interaction among peer groups of learners that span institutions and continents are among the potential advantages of ALN.

Please join us at the ALN Web (http://www.aln.org) to participate in the excitement of this growing field!

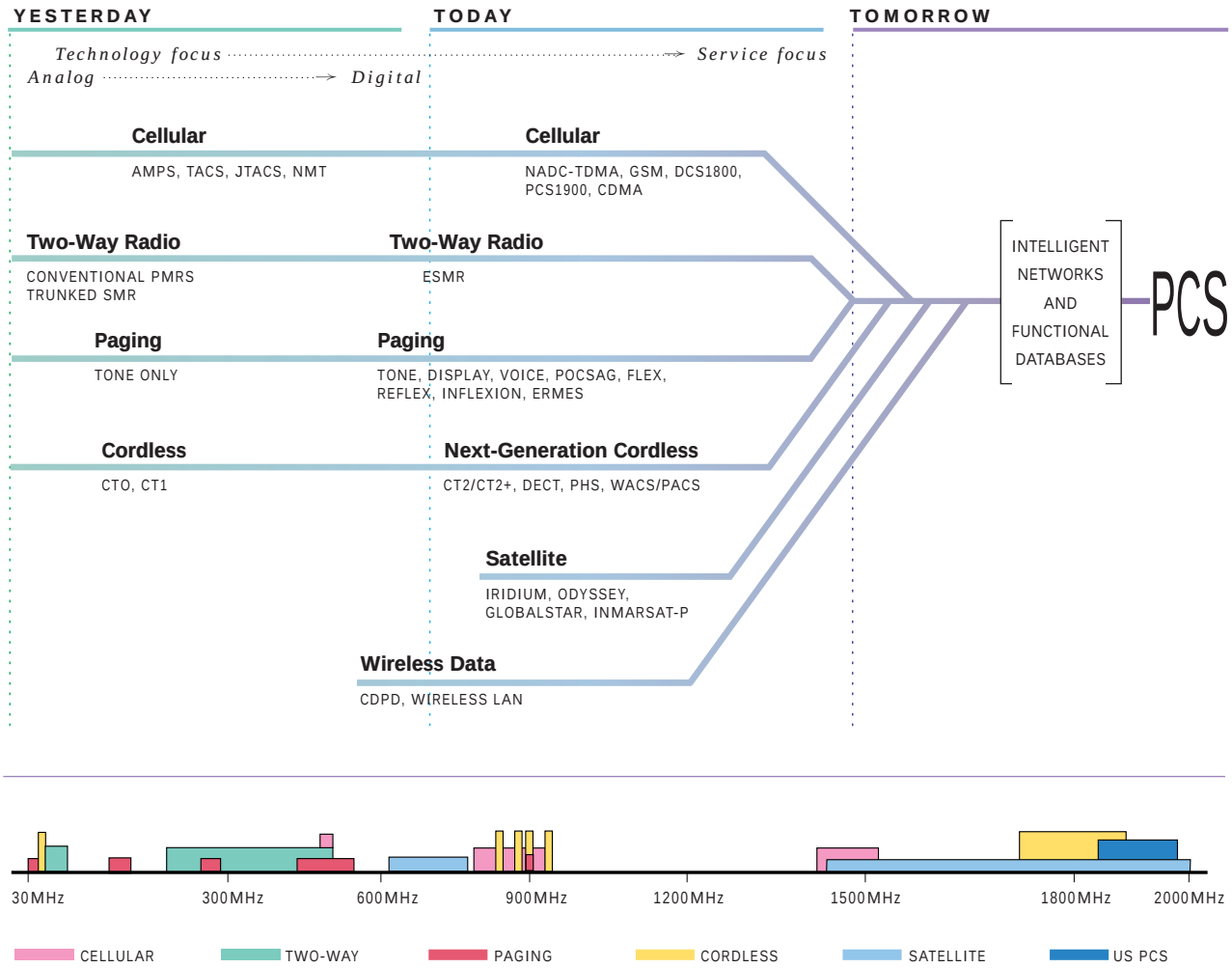
Opportunities Abound in Wireless Field

You're about to putt on the 7th green when your partner's pager rings. A nurse is calling to say one of his cardiology patients has just gone into fibrillation. Your partner pulls out his HP PalmVue computer to access the clinical information the nurse is sending him over a wireless link. After reviewing the real-time EKG waveforms and oxygen saturation data, he decides on appropriate interventions and tells his nurse to start treatment immediately. The call has ruined your day of golf, but your partner has saved a life from the edge of the 7th green.

This vignette illustrates just one of the many ways wireless technology is impacting our lives. Some people call the explosion of wireless applications a 'wireless communications revolution' and liken its importance to the invention of the telephone. Whether or not it's a revolution, the wireless market is doubling every two years.

And that means major opportunities for prospective graduates who have gained knowledge and experience in wireless-related fields while at university. For all wireless specialties, students need courses in

WIRELESS TECHNOLOGY OVERVIEW



communication theory, digital signal processing and digital modulation. To work with cellular technologies, they are likely to need an understanding of spread spectrum, multiplexing and multiple access technologies. Graduates with a good background in these areas who also have C++ programming skills are likely to command top salaries.

Evolution of Wireless Technologies

The first wireless products were based on analog technology, but that's quickly changing. These days, digital technology is where the action is. The move from analog to digital is bringing new features, better quality, and more capacity to wireless products. These benefits, along with the rapid increase in the number of users, force the once technology-driven industry to become more service-oriented.

Some examples of this evolution include: cellular radio, originally targeted at vehicular subscribers in urban areas, is now providing economical coverage of sparsely populated areas; cordless telephones have moved from the home to the street as public "telepoint" systems for pedestrians; pagers, once tone-only, can now display numeric, alphanumeric, and voice messages, or even send a reply to the caller.

Technology Convergence

The current trend blends all of these different architectures. Two-way radio is becoming more like cellular, paging services are being added to other systems such as cellular and next-generation cordless (i.e. telepoint systems). This blending of services is what some people are calling PCS, or Personal Communication Services. In its more general definition, PCS gives people wireless access to telecommunications wherever they are – on foot or in vehicles, inside buildings or outdoors, in cities or in suburbs. In this respect, PCS is really more a vision than any specific technology. In any case, it represents the exciting future of the wireless communications industry.

The evolution toward digital and smaller cell architectures, as well as the increased demand for more capacity and more services – is causing new systems to be designed and deployed at an incredible pace, and companies cannot keep up with the needs for qualified engineers and technicians. The opportunity for students looking for a career in wireless communications is NOW!

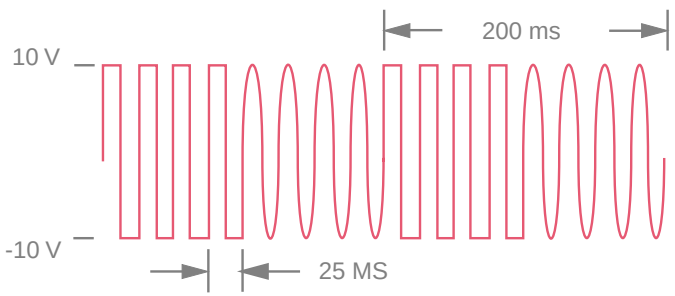
Read more about wireless technology in the next issue of the Engineering Educator!

Be sure to read the web article on the wireless lab at the University of South Florida. You can find it on the HP Educator's Corner Website at:

http://www.tmo.hp.com/tmo/iia/edcorner/English/Jan_Article.html.

BRAIN TEASER

A 12 V INCANDESCENT LAMP IS BEING DRIVEN BY A FUNCTION GENERATOR WITH THE FOLLOWING WAVEFORM:



Four sine waves, followed by four square waves, repeat themselves five times per second, with a fundamental frequency of 40Hz. The sine wave and the square wave have identical amplitudes of 20 V p-p.

Given the fact that the human eye cannot follow light changes above about 15 Hz, and the sine and square waves are of identical amplitude, how do you explain the fact that this waveform appears to make the light blink? (Hint: You can find the answer on the HP Educator's Corner Website at www.hp.com/info/college_lab101 under Static Experiments; The Brilliant Light Bulb.)

Online Resources for Engineering Educators

We know that you frequently have to stretch your time and budget to the limits, so we've built a website stocked with useful resources to help you and your students meet your daily challenges. Check out the articles, tutorials, newsletters, slide presentations, lab experiments and all the other valuable tools. You'll even find engineering cartoons to add a little humor to your lectures.

Be sure and visit the Educator's Corner often so you don't miss any of the new tools and information we post each month. Look us up today at www.hp.com/info/college_lab101.

Resources Available on the HP Educator's Corner Website

Online Encyclopedia of Lab Experiments

▷ More than 70 experiments covering:

- AC Circuits
- Analog Electronics
- DC Circuits
- Frequency-Selective Circuits
- Digital Electronics
- RF, Microwave, & Lightwave
- Instruments
- Miscellaneous
- Physical
- Pulse Circuits

▷ Interactive tutorials:

- Coupled oscillators
- Kirchhoff's Laws
- Ohm's Law
- Time Constant
- Vectors & waveforms

Discounts and Grants

▷ HP Education Discount Schedules and University Grants Program information – up-to-date and online.

Teachers' Tools

▷ EE Reference Tools: LaPlace tables, color codes, and more

▷ On Test Equipment: Tutorials & slide presentations on how to use electronic test equipment.

▷ Videos, Books, Software, Posters & Computer-Based Training: How to order these materials from HP.

▷ T&M Interactive Application Notes – so that's how a Smith Chart works!

▷ Cartoon Fun: Use these in lectures to spice things up.

About Us : How We Share HP's Resources With Engineering Educators

▷ Online journals from HP:

- Telecom News Online – products, performance testing and industry events
- Test and Measurement News Online–the newest products, services and applications from HP
- HP Journal Online – written by design engineers

▷ Case studies

▷ Other HP education websites:

- The HP Workstation University Program
- Test & Measurement Education Catalog: A listing of HP customer education courses
- HP K-12 Education Programs
- HP Worldwide University Affairs – partnerships with major universities in Europe and the United States

Products Page

▷ HP's line of Basic Instruments – product information and tutorials

What's New

▷ Updated every month – news for educators from HP

Contact HP Worldwide

▷ Have tough questions? Answers are just a phone call away.

▷ Jobs at HP – send your graduating seniors to this page.

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