

The Joy of tinkering

Dramatic technological advances in electronics have had the unintended consequence of making electronics less accessible to curious young minds. Engineering students are now rediscovering the value of hands-on learning. *Story, page 12*

Tool 'engages' EE students

By Dylan McGrath

Why have American students been losing interest in electrical engineering? One theory is that dramatic technological advances in electronics have had the unintended consequence of making electronics less accessible to curious young minds. According to that argument, while generations of EEs who came of age in the 1960s, '70s and '80s spent their teen years cracking open electronic gadgets to discover a world of interesting components within, today's kids are deprived of that experience by electronic products that are too complex and too integrated. Simple circuit boards that stimulated the imagination with their discrete components and space for soldering and tinkering have given way to multi-layered boards with complex ICs and circuitry too small to see.

Incoming college freshmen lack "the background intuition that kids used to get from just playing with stuff, tinkering with stuff," said Don Millard, a professor at Rensselaer Polytechnic Institute (RPI, Troy, N.Y.). Today's students may have cracked open a videogame console to solder a mod chip onto the motherboard that lets them play games for free. But more often, Millard said, inquisitive minds find components that are so small they can't be tinkered with or gadgets that are so tightly packed they can't be pulled apart.

Thus, Millard and others believe, students who might once have been attracted to electrical engineering because of the ability to observe cause-and-effect relationships in circuits and components are instead gravitating toward other fields.

"I have friends who went into mechanical engineering for that very reason," said Carolyn Rudak, a student and EE teaching assistant at RPI. In electronics, Rudak said, "everything is hidden away in small microchips. That's one reason electrical engineering is a turnoff; it seems too complicated."

Millard has spent years trying to engage a generation of students that lacks the tinkering experience so valuable to previous generations. For the past three years, he has worked closely with Jason Coutermarsh, now an RPI grad student, on a project that arms students with a way to perform experiments that otherwise might require a lab full of benchtop equipment, like oscilloscopes and function generators.

Called the Mobile Studio project, it is based on a relatively inexpensive (around \$100) combination of hardware and software that gives students functionality similar to that of a lab full of test equipment, in a package they can carry with them.

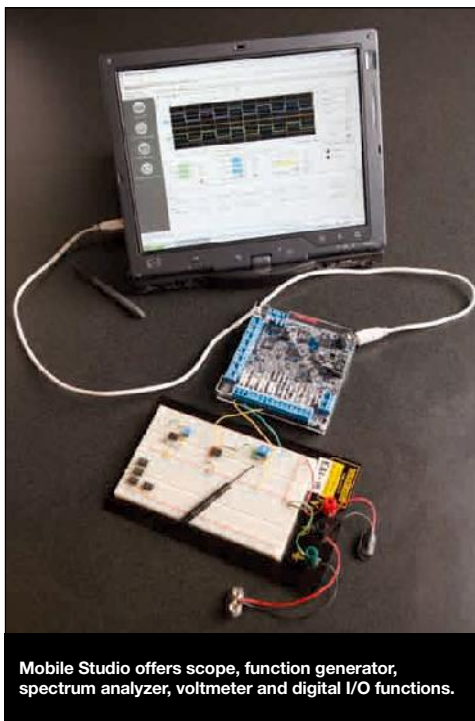
The hardware is a pc board containing the components needed to implement a scope,

function generator, spectrum analyzer, voltmeter and digital I/O. The software, which runs on a standard PC, provides an output display to mimic the physical counterparts on the board.

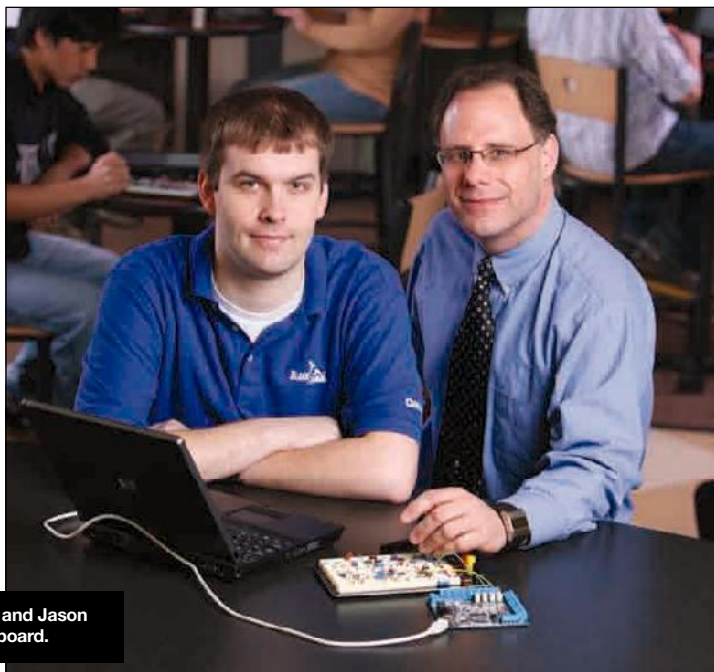
According to Millard, Mobile Studio helps students visualize abstract engineering concepts. He said last semester's

students, availing themselves of the mobile tool, had outperformed previous classes on design projects.

Millard said he often uses Mobile Studio to illustrate concepts from his lectures and pencil-and-paper exercises. He described one experiment in which students were able to observe the waveforms of music as it was pumped from an iPod through the Mobile Studio board.



Mobile Studio offers scope, function generator, spectrum analyzer, voltmeter and digital I/O functions.



Mobile Studio inventors Don Millard (right) and Jason Coutermarsh with their portable lab-on-a-board.

Millard said he can tell students are paying close attention to the Mobile Studio experiments because whenever he runs them, his students stop instant messaging and e-mailing one another to focus on the work. "They are engaged. They are seeing the kind of thing that made them want to become engineers in the first place," he said.

The project boasts a handful of prominent sponsors, including Hewlett-Packard Co. and Analog Devices Inc. It has undergone pilot testing at several institutions, including RPI and Howard University (Washington). Outreach activities have also been conducted with an elementary school district and some high schools in upstate New York, as well as Adirondack Community College.

Coutermarsh said Mobile Studio has applications beyond electrical engineering. Because of the similarities between equipment used in electrical engineering and that used in physics, he said, RPI's physics department is showing interest in Mobile Studio.

Doug Mercer, an Analog Devices fellow who had a role in the development of Mobile Studio, estimates the Norwood, Mass., company has supported the project with more than \$200,000 in cash and component donations. (The newer Mobile Studio board features the company's Blackfin

DSP.) He said ADI representatives had been "blown away" by a presentation in which Millard and Coutermarsh offered a status report on the project.

Hands-on

Mobile Studio is just one weapon in educators' prolonged battle to help students understand complicated concepts by having them roll up their sleeves.

Rochit Rajsuman, Pinson Chair EE professor at San Jose (Calif.) State University, said his students become instantly more engaged when he walks them through exercises using circuit simulators

When Millard runs Mobile Studio experiments, students quit texting each other and focus on the work.

in real-time. "It's like a new world opens up to them," he said. "The light bulbs go on, and their eyes just brighten."

Rajsuman noted that circuit simulators are available to students at no charge on a limited-use basis from companies such as Cadence Design Systems Inc. He said he believes use of circuit simulators in high schools and junior high schools could do a great deal to stimulate interest in engineering.

"Right now, as a society, we are missing that component," Rajsuman said. ■

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