The Agilent Education Program

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Abstract:

Saying "I work in education" at Agilent Technologies creates confusion, simply because the word applies to so many aspects of the company: Customer Education, University Relations and Grants, College Recruiting, Education Marketing, Employee Education, College Internships, Joint Research and others.

This paper will focus only one of these: the Agilent Education Marketing program. We will discuss the program's roots, why we got involved and what we did to create the program. In addition, we will divulge some of the mistakes we made along the way, including lessons learned in assembling the large volume of didactic material available on Agilent's website for engineering faculty, www.EducatorsCorner.com

Program Roots

The Agilent education program has its roots in Hewlett-Packard. The Computer side of the company had been running an education program for some time when the Test & Measurement education marketing program began in 1993. It started with HP's Electronic Measurements Division, an entity that would later become part of Agilent Technologies. In June 2000, Agilent separated from HP and is now a totally independent company. The Test & Measurement Education Marketing Program carried through the transition and is now the Agilent Education Marketing program. It is one of many "education" entities within the company.

Agilent is in all aspects a high-tech company whose very lifeblood depends upon close connections with engineering universities. The attitudes of engineers at Agilent closely align with the ideas behind the engineering education revolution. To Agilent engineers, concepts like mentoring, teamwork, hands-on experimentation and lifelong learning are as comfortable as a pair of old sneakers.

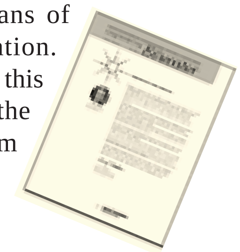
Creating the Agilent Education Program

To crystallize the program we invited several engineering professors to serve on an advisory council. It was a wonderful exchange, especially when we discovered that, from Taiwan to Budapest, engineering faculty all face similar challenges. From this original Engineering Advisory Council, these concerns came to the fore:

1) "I never have enough budget."
2) "There simply aren't enough hours in the day."
3) "I'm afraid I'll become technologically obsolete."
4) "Engineering is not staying competitive with the other disciplines."

Taking these faculty comments to heart, we attacked each in a different manner. For the "budget" problem, we doubled the educational discounts on most of our instruments and we continue to offer special promotions for academe. After some discussion about the "hours in the day" issue, it became apparent that there was one area where Agilent could contribute the most: measurement labs. We created the website www.EducatorsCorner.com to be a repository of engineering lab experiments. The "technologically obsolete" question was addressed through web-based seminars offered on a frequent basis and covering new technologies such as Bluetooth, 3G, Wireless LAN, 40G and Optical Sampling. Finally, to help engineering compete with other disciplines, we established a website for engineering students and prospective engineers: www.FutureEngineers.com .

To tie them all together, we began publishing a newsletter for engineering educators called (for want of creativity) the Engineering Educator. November 2001 was our final paper version of the newsletter; we have now incorporated its contents into the website, which has become our central means of outbound communication. In that light, the rest of this article will focus on the EducatorsCorner.com site.



Building www.EducatorsCorner.com

One frustration of our Advisory Council members was that they had inadequate time to write good lab experiments. On the surface, this didn't seem difficult to us, but as we later discovered, writing a compact lab experiment that holds students' interest while teaching something of substance can be a real challenge. To fulfill the need, we decided to create a website with free, useful lecture material and a repository of lab experiments that would help engineers and lab instructors, particularly for their freshman/sophomore classes.

Naiveté can be a great ally in the initial stages of any project, and this was no exception. Had we known how much work would be involved, we might have just gone out for pizza and stuffed ourselves until the urge passed. But we plunged ahead, first locating material currently available within our own company. This produced some good lecture notes, albeit rarely in electronic format. The most robust seminar was "Neophytes", an internal training course given to our own new-hires to get them up to

Figure 1. The site has hundreds of lab experiments, such as the speaker cone resonance lab, from University of Hartford (Prof. Walter Banzhaf)

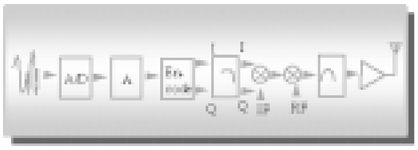


Figure 2. The collection also contains complete works, such as an 8-part series on RF from the University of Michigan (Prof. Gabriel Rebeiz)

speed on RF measurements. It is also the kernel for a course called "RF Back to the Basics", taught today in both free and for-pay versions.

Unfortunately we had to convert its Lotus Freelance format to Power Point for more widespread acceptability. We would later discover that multiple formats constituted one of the biggest time sinks in maintaining the site. This was especially true of our animated computer-based training packages, which came in all flavors: DOS, Visual Basic, Toolbook, Director, Java, Quick-Time Video, etc. We have since standardized on Java, Power Point, Word and Acrobat PDF file types.

The next step was to ask engineering educators for good lab experiments that they might be willing to share with engineering faculty worldwide via the website. The result was gratifying, not only because they came though with flying colors, but also because we established some close relationships in the process. In creating the lessons on EducatorsCorner.com, we watched the site's hit-rate data and created some feedback forms to see what people thought of the content. Here's what we learned.

A good example:

· In cooperation with Professor Emile Attala of Cal Poly San Luis Obispo, we developed several computer-based learning packages written in a DOS version of Toolbook, which we later adapted for Windows. Currently, the Agilent education website, www.EducatorsCorner.com , has the following available for classroom use:

- AM Fundamentals
- FM Fundamentals
- Logic Analyzer Fundamentals
- Transmission Line Fundamentals
- Lightwave Fundamentals

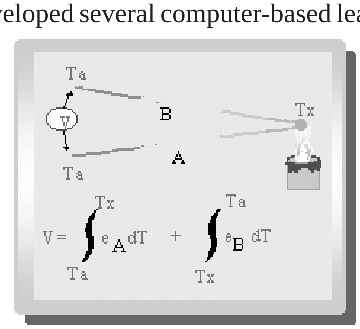


Figure 3. Application notes and lecture materials, such as this slide show on temperature measurement, are gleaned from Agilent's substantial internal resources. (Author: M. Faber)

We originally charged $200/copy for these interactive lectures, but now make them available as free downloads. We believe they are popular because the material is interactive, valuable, straightforward and not product-dependent. The lessons animate basic concepts, enhancing what a textbook can show. We're sure that having the initial supervision of a real educator also made a big difference in their value.

We recently re-created these Toolbook programs in Java format, to eliminate the need for downloading. Java is renowned for its multi-platform compatibility, but the conversion was expensive and time-consuming. It would have been much easier to start with Java in the first place.

A bad example:

· DC Circuits: A set of lessons melding lab experiments from several universities. The subjects are simple:

- Ohm's Law
- Kirchhoff's Laws
- Low Pass RC Filters
- High Pass RC Filters

This was perhaps our most expensive, valuable and disappointing lesson. We combined the best DC labs from five separate universities and hired Co-op students to go through the written lab experiments while we held a video camera over their shoulders to track each physical movement. Then we used this as a script to generate Director files that animated the instruments and the components into a set of computer-based training packages.

The result is a series of colorful panels that take the viewer through each step. We went to some trouble to make sure the lessons were engaging, adding "eye candy" like a pull-down bulletin board, as well as sound effects, periodic quizzes and "rubber-band" controls. Our third-party web provider, Viewmark, generated a great "engine" that enabled us to add more lessons that would have similar look and feel. It was a major effort.

The result? Despite our big investment, students find the lessons boring. The "cookbook" feel is a poor way to instill the principles behind the experiment. To be honest, we were enamored of the animation technology, and concentrated more on graphics than function. One mistake was giving the student too much direction—it was worse than giving them too little. It's the act of discovery that makes a lab exciting.

The lesson for us: "Interactivity" alone does not make a good lab experiment, unless the interaction involves the brain and not just the mouse finger. This was corroborated in 1999 when we hosted a Student Advisory Council, this time with engineering sophomores and juniors from around the world. They told us in no uncertain terms, "We hate cookbook labs because we don 't learn anything."

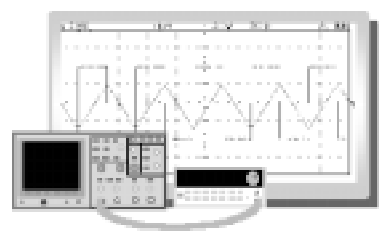


Figure 4. Using an oscilloscope with built-in math functions can add a whole new dimension to a calculus class. (Author: M. Faber)

The best example:

· Animated Smith Chart: Agilent's Blake Peterson created this animation for our Neophyte course. Viewmark converted his DOS version to Java and we wrapped a lesson around it. It's now one of the most frequently downloaded items on the site. We think its popularity stems from several factors:

- It can be added anywhere in a lecture; It is self-contained and small enough not to require force-fitting it into a curriculum.
- Students can access it after class.
- It is useful, interactive, small (quick to load), colorful and engaging, and it demonstrates things a textbook can't show.
- It does real time calculations in a highly interactive manner, to show

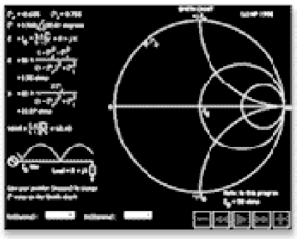


Figure 5. **The "best" example. . .One of the most popular downloads is this Java animation of a Smith Chart. It can be injected in the appropriate spot within a microwave lecture series. (Author: B. Peterson)**

several concepts.

- Most important, its free-form in teraction lets the student explore many possibilities.

Links and Content:

We surfed the Web to find free, useful didactic material for engineering educators, but what we found was rarely of high quality. Today we continue to search for good links and the results are clearly improving with time, but it still amazes us how much chaff exists on the web. We realized we could make a contribution by assembling only the highest quality lab experiments on the site. We generated some labs ourselves, then solicited university engineering educators for lab experiments, offering to do any "clean up" necessary. That brought our next lesson: We were taken aback by the disparate quality of experiments submitted by universities.

While some submissions showed untrammeled creativity, others had poor graphics, lacked objectives and had grammatical errors, nebulous instructions and occasionally errors in technical content. We corrected the obvious technical errors but we didn't have the manpower to field test every lab experiment we posted. Our assumption was, and is, that the labs have been pre-tested in the university that bears their name. As outsiders to academia, our conclusion is that universities vary considerably in the emphasis they place on the undergraduate laboratory learning experience. The good news is that recent submissions are showing significant improvement in quality. We're not sure whether this is random or it has something to do with ABET's focus on hands-on, but the change is welcome.

Why spend so much energy on undergraduate labs?

Aside from the old saw that students who are proficient at lab work can "hit the ground running", in the author's opinion there is another important aspect to labs: People who tinker make the best inventors.

Recent evidence makes the point. In preparation for the Agilent spin-off, a friend of mine—one with a prodigious cranium—was part of a team allocating thousands upon thousands of extant patents to either Agilent or HP. Suppressing an overwhelming feeling of inadequacy, I watched over his shoulder as he thumbed through the enormous stack. I immediately realized that some of the oft-repeated names were engineers whom I knew well. From my personal experience with these multiple-patent holders, I concluded that they have common traits:

1) *They never stop learning.* They read voraciously, and when their job calls for a new skill they simply pick up a textbook or surf the web. Their learning is not restricted to work. To quote one savant, "If you haven't learned one substantial new thing each year, you should be ashamed." "One new thing" could be sailboat design, welding, laser physics or conversational French.
2) *They are multi-disciplined.* They know something of both electrical and mechanical engineering, as well as chemistry or some other substantial discipline.
3) *They think several steps ahead of any one else.* One friend has memorized the sequence for every traffic light in town, and knows how many times the Walk/Don't Walk light blinks before the signal turns to yellow. He's always planning his next move, whether it's for saving commute time or for designing a new kind of antenna.
4) *They tinker.* I recall visiting the home of one engineer who held patents in AC synthesis techniques. Using standard outboard motor components, a custom manifold to act as a water jet flume and an impeller, he turned his canoe into a river sled that could run in a few inches of water.
5) *They're insanely curious about every thing.* Whether in the lab, in the cafeteria or on the beach, they're always looking for things they can improve, from a napkin holder to a reflective coating on the car windows. Then they make the defining step that per sonifies the successful inventor: they *build* it. (See 'They Tinker', above.)

It's easy to see how these characteristics track with the teaching paradigms now being emphasized by ABET: hands-on learning, lifelong learning and multiple disciplines are all characteristics common to many of Agilent's multiple-patent holders.

Where do we go from here?

The undergraduate EE labs are now well represented on EducatorsCorner. Our next step is to focus on upper division courses and non-EE coursework. "RF Corner" and "Lightwave Corner" are two examples of upper-division/graduate level material that we have added recently. We're also adding a "Projects" listing, for those interested in what other schools are doing for senior projects. All together, EducatorsCorner has thousands of pages dedicated solely for engineering educators. Most of the material is free to educators, with no copyright restrictions as long as the material is used in a classroom and not for commercial reproduction.

Of course, the website is not Agilent's only activity. For example…

The Quinn Award: In order to propel faculty members to get their students more involved in laboratory work, Agilent in 2001 introduced the Robert G. Quinn Award, a $5,000 prize for the university professor who does the most to encourage curricula integrated with college engineering labs. The award is in honor of Prof. Robert Quinn, a distinguished engineering educator from Drexel University who was instrumental in helping us get the Agilent Education Program off the ground. The inaugural winner was Prof. Angelo Perna of New Jersey Institute of Technology. The award will be given every year by the ASEE (www.ASEE.org).

GWEC: Agilent helped the Global Wireless Education Consortium (www.GWEC.org), representing nearly

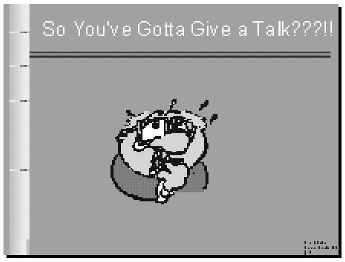


Figure 6. **The FutureEngineers.com website contains useful resources for students. One example is a short slide show on giving a speech. (Author: M. Faber)**

70 engineering institutions worldwide who are creating a curriculum for professional telecommunications engineers and technicians. A portion of the material on EducatorsCorner.com has been made available to GWEC in order to help populate their wireless curriculum.

Future Engineers: Agilent's other engineering education website is www.FutureEngineers.com. Its purpose is to encourage high school students to become engineers, and to make life easier for those who are already in an engineering curriculum.

University Relations: Agilent's University Relations organization connects with research universities around the world and offers grants and fellowships to deserving institutions. (See www.Agilent.com/univ_relation/)

Much More: Look under "Quick Links" on the EducatorsCorner website for a list of "Agilent Sites for Educators". You will find such Agilent sites as Customer Education, Bluetooth Technology portal, Agilent Labs, R&D Central, Chemical Analysis Event Center, Electronic Manufacturing Test, Metrology Forum, Educator's Corner and Future Engineers.

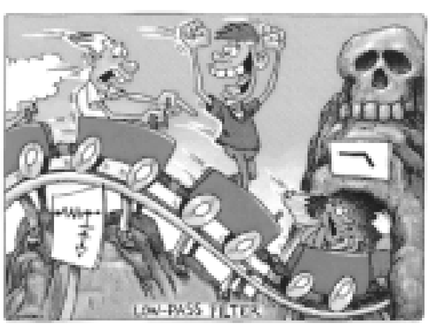


Figure 7. **Cartoons lend interest to classroom lectures. There are over 45 such cartoons on the EducatorsCorner site. (Artist: R. Kruback)**

These are just a few of Agilent's engineering education programs. We are fortunate to have a corporate leadership that believes in what we are doing, and that believes Engineering Education is a mainstay in our future. We would like to thank the hundreds of engineering professors from around the world who have contributed to this program. Above all, it is their participation that makes this program successful. In addition, many Agilent employees have given their "spare" time and effort, with special thanks to Mel Downs, John Trujillo, Joanne Kelly, Barb Bendixen and Mari Murphy for their work and to Agilent Vice Presidents Mike Gasparian and Scott Sampl for believing in us. The education program has been an education for us all and we'll keep learning as we go. After all, lifelong education applies to us too.

Marshall Faber, Jr.

In 1966, shiny BSEE degree from the University of Denver in hand, Marsh Faber joined Hewlett-Packard, evincing a temporary lapse in stringent hiring practices. As a production engineer, Marsh distinguished himself by not destroying the factory. In 1972, he moved to R&D after receiving one of the first MSTV degrees from Colorado State University's distance learning program. [Note: Actually an MSEE. "MSTV" refers to the years spent in front of a TV set, watching virtual professors.]

Throughout his 35-year career with HP and now Agilent Technologies, Marsh has kept a low profile by changing jobs frequently. He has held engineering titles related to Production, R&D, Applications, Product Marketing & Management, Product Planning, Program Management and his current role in Business Development.

In 1987, Marsh helped start a marketing center for HP's EIG in Hong Kong, where he lived with his wife Jean, son Derrek and daughter Julie. The whole family traveled the region extensively, quickly learning the three secrets to a happy life: Never sign your name in red, never give a clock to a friend, and never ask what kind of animal is in the soup. They capped their 4-year stay in Hong Kong with an 8,000-mile ride on the Trans-Siberian Express.

Marsh has been involved in startup phases of several HP/Agilent entities, including the Agilent Education Program. He publishes articles often enough to support his fly-fishing addiction.