Spot. See Spot. 
See Spot run . . . 
VIA A REAL-TIME, INTER-ACTIVE, VIRTUAL REALITY DISPLAY. AND WHILE YOU ARE AT IT, GO AHEAD AND CALCULATE SPOT'S MOMENTUM, THE DEGREE TO WHICH HE IS GENETICALLY PREDISPOSED TO HIP DYSPLASIA, AND HIS PROBABILITY OF LIVING TO AGE 10. WHEN FINISHED, PLEASE REGISTER YOUR ANSWERS ELECTRONICALLY.

☞ OH, AND CLASS, WELCOME TO FIRST GRADE!
Higher education is in a state of permanent white water,” Ruth Jones insists. “Institutions must be nimble, quick to adapt, or they will drown.” Jones is charged with ensuring that ASU President Lattie Coor’s University of the Next Century initiatives become reality.

“As a Research 1 Institution, ASU’s job is to both create and disseminate new knowledge,” Jones explains. “The only way we can accomplish this is by placing truly equal emphasis on research, teaching, and community outreach.” All three missions are critical if ASU is to prepare people for the future world—not just the world we now know. Jones estimates that at least half of ASU’s current faculty will still be here in the year 2010. Change must begin with them, she says. Perhaps that is why so many unique partnerships between Kindergarten through 12th grade, ASU and industry are already under way. These partnerships blur the lines between traditional roles and disciplines.

Visitors to ASU can see an array of projects in motion. For example, on one side of campus, artists, geologists, and engineers work side-by-side to develop three-dimensional computer images of musculoskeletal surfaces or the terrain on Mars. At another site, botanists, mathematicians, and educators help middle school teachers upgrade their math, science, and teaching skills. In still another, multimedia specialists design interactive software and Web-based courses that help global companies train employees in other lands.

There is more. In yet another area, visitors will find ASU instructors working directly with 8 to 10 year olds who take a robotics design class. “One of the president’s first visions involved refocusing ASU’s customer,” Jones says. “We’re not just serving 18-24 year olds. We’re serving K-12, our students, their teachers, our own staff and faculty, older adults, and businesses—all of whom must be taught simultaneously.”

That, she says, is because the pace of change has rendered hierarchical learning structures obsolete. All of which present some challenges in terms of time, money, and traditions.

How, for example, are faculty supposed to take time out to retrain and reach out when they already are carrying heavy loads? Few have enough time now for family after fulfilling work, teaching, research, fund raising, and other obligations. When, exactly, would one expect them to squeeze in technological retraining, related curriculum redesign, colleague collaboration, and community outreach?

“There’s no denying that we need to make changes,” Jones says. “Everything from our reward/compensation structure, to providing resources that allow our faculty and staff to better use technology, to fostering multidisciplinary relationships. The good news for us, at least,” she continues, “is that ASU is large enough to shift resources to where and when they’re needed. Our people are also wonderfully dynamic and adaptable.”

Many government agencies have helped by restructuring their grant guidelines to promote such change. The new economic weapons are information access, technological proficiency, and critical thinking skills.

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Culling forces Workforce statistical estimates indicate that children who opt out of advanced math and science classes after 7th grade may now eliminate up to 75 percent of their career choices for the next century. Girls, minorities, and children in rural communities are considered especially at risk because such groups are already severely underrepresented in math and the sciences. Technological access and lower living costs in other lands are helping even the most geographically remote peoples gain financial ground. How then are highly paid Americans supposed to survive in an evermore economy-based world?

Several government agencies stepped in by diverting resources away from pure defense projects, directing them instead toward science, mathematics, and education reform initiatives. Such efforts quickly led to the establishment of new, national math and science standards. Agency members then began aggressively directing billions of dollars in grant monies toward projects with documented multidisciplinary problem-solving strategies and applied K-12 outreach.

The reality at universities across the country is that fewer dollars are being awarded to support basic research. As the 1990s draw to a close, the really big grants are going to groups that combine leading-edge, multidisciplinary research with an aggressive plan for applying knowledge and getting it out for mainstream use.

K-12 outreach appears to be a particularly “hot” button for NSF, NASA, and corporations. Teaching the teachers, they seem to believe, is the fastest way to reach critical masses. Not surprisingly, then, millions of ASU grant dollars are earmarked for programs that purchase equipment for, then train K-12 teachers.

“Most of our efforts now reach way beyond simply buying computers and helping schools get hooked up to the Internet,” says Sam DiGangi, a College of Education professor who also manages ASU’s Information Technology Instruction Support group. “The real emphasis today is on effective content use, that is, leveraging technology so that it enriches the curriculum.”
Bolstered by a two-year, $1.2 million grant from the U.S. West Foundation, for example, DiGangi’s group has begun actively immersing 430 Arizona public school teachers in technology-based learning.

Computer novices, the teachers all were given a laptop computer, a modem, free Internet access, and several weeks of hands-on, in-person instruction. Follow-up instruction is delivered primarily via the Internet. Subject-oriented chat rooms also help teachers share suggestions and successful technology-based course curriculums. DiGangi says this format was deliberate.

“Effective modeling is an important component of good teaching,” he says. “By teaching our teachers using the very methodology we want them to use, we’re providing concrete examples of ways in which they can integrate that technology into their classrooms.”

The 430 teachers in this project alone represent 1 percent of all Arizona public school teachers. Each has committed to teaching at least 10 more teachers and one administrator from their school during the next two years. Ultimately, this project should touch 10 percent of Arizona’s public teachers.

**TECHNOLOGY FOCUS**
Ron Zambo, Ray Buss, and Keith Wetzel of ASU West have taken a more concentrated approach to teacher training. They have spent three years and nearly $1 million establishing technological competency in a single school district. In fact, most of their subject teachers come from just four schools in the Glendale Elementary District.

“Our goal was to establish a critical mass, to systematically change the culture of entire schools so that the teachers could learn from and keep motivating each other long after the funded part of this grant was complete,” says Zambo, a mathematics education professor.

The team used its grant money to purchase 50 sets of computers, printers, and software, and 25 TV/VCR and laser disc units to use with them. Zambo’s group also used grant money to pay the salaries of two teachers who were assigned full-time technology integration roles. Leonard Shanks, a recent Presidential Award winner for excellence in teaching mathematics, was one of those teachers.

“From the beginning, we focused on teaching teachers how to best integrate math, science, and technology into content teaching. We were not just helping them learn to use computers,” Shanks explains.

Software programs are set up and used just as they would be in real classrooms. Teachers then move through each exercise. A computer simulated car rolls down a ramp while teachers take measurements then enter them into a database, which graphs results. The teachers then duplicate the experiment with a real car and ramp, enter those data, and compare results. Next, they may make predictions based upon the angle of the ramp or height from which the car is dropped then they test their hypotheses.

“It’s just like anything else,” Shanks says. “People don’t know what they don’t know until they know it. Once teachers saw how computers could be used, and how much they motivated the students and helped them think more critically, most wanted to learn more.”

While these and other programs involve some initial on-site training, Gary Bitter’s Educational Media and Computers team slipped right to teaching via a “virtual classroom.”

“Multimedia is the only way to reform education,” Bitter maintains. “It allows us to reach previously unreachable audiences. It lets teachers learn by example by seeing other teachers teach. It provides first-hand experience at learning through multimedia. And, it allows people to learn wherever they are, whenever they choose, and to progress at their own pace.”

Bitter is a nationally known expert in education media. The ASU professor has produced many award-winning corporate- and education-oriented compact disc programs.

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“Understanding Teaching” is targeted at teachers who are upgrading their technology-based teaching skills. Instead of using traditional pull-down menus, it features a non-intimidating school hallway. Teachers choose what they want to study by “entering” that room.

“Books” located in each room show everything from how to write lesson plans, to establishing evaluation criteria. Bitter’s team also designed a much more technically advanced “Instructional Media Design” program for Intel.

Many of Bitter’s education programs help teach the new math standards. His “Hispanic Math Project” is designed to help sixth graders develop measurement concepts. Targeted at students, it allows users to interact in Spanish or English—and to switch languages at any time.

The ASU educator’s latest project, called “Math•ed•ology,” was funded by a $2.3 million grant from NSF. It features 30 unrehearsed math lessons, given by real teachers in real classrooms.

Users can learn about new tools and techniques, and see how each was really used and received by different students. Commentary on each lesson is available from its classroom teacher as well as from experts in three related fields. Math•ed•ology should take between 15 and 40 hours to complete.

**FIXING PHYSICS**
Educators are not the only ones involved in such programs. Researchers, administrators, and corporations are all working in partnership.

For example, ASU physics Professor David Hestenes is dedicated to reforming high school physics. National statistics show that fewer than 3 percent of this nation’s high school physics teachers have been retained to meet the National Science Education Standards.

Hestenes used funds from a $4 million NSF grant to establish a nationwide program of intensive 10-week summer workshops for physics teachers. His program helps teachers evaluate the degree to which their students make the transition from a “common sense”
Mathematics and science just aren’t what they used to be. The subjects are more complex, more center stage. They also are a whole heck of a lot more fun if you happen to be a part of Sam DiGangi’s Arizona Earth Vision project.

DiGangi’s project gives a whole new meaning to the term ‘hands-on’ research. The work places high-end computers, real-world research techniques, and technical expertise directly into the hands of students at four Arizona high schools.

DiGangi is an associate professor of special education at Arizona State University. His Earth Vision project strives to integrate sophisticated technology and sound environmental science with real world applications. Doing so will ensure that students are more motivated and better prepared for the ever-changing and increasingly technical world in which we live.

Arizona Earth Vision students use high-end computer graphics while conducting environmental research projects right in their neighborhoods. School advisors teach research techniques and direct the day-to-day aspects of each project.

DiGangi’s task is to ensure that computers help create meaningful, multidimensional graphic models of relevant data. He’s also charged with encouraging students to share that which they find.

“The biggest surprise so far is the interest in and extent to which the students have contacted us,” DiGangi explains. “They’ve really wanted to use the technology. They’ve also actively reached out to share what they’ve learned.”

His students regularly share data via student-led workshops and over the Internet. While excitement is definitely one common denominator, the schools and students involved in Earth Vision are otherwise as diverse as the projects they have chosen to pursue.

Monument Valley High School, for example, is located on the Navajo Indian reservation in remote Kayenta, Ariz. DiGangi says that while students there are extremely well-versed in tradition and nature, they eagerly embrace technology.

Monument Valley students use Earth Vision resources in research possible causes for benzene contaminants in their latest water well. Their findings, questions, and school homepage are shared on the Internet.

In Phoenix, Coronado High is located in an area designated as a federal superfund cleanup site. Coronado students are researching the rate at which the toxin trichloroethylene (TCE) diffuses through ground water in the area. Besides regularly quizzing experts on line, most Coronado project members also created detailed personal homepages.

Such diversity is not random. DiGangi is interested in exactly how well mathematics, science, and technology can be used to bridge previously significant geographic, socio-economic, and cultural differences.

“I’ve set three personal goals for Earth Vision,” DiGangi says. “Increasing awareness among students of environmental issues, providing them a skill set that includes research methods and computation, and developing their expertise at using interactive computer resources.”

Earth Vision is clearly no “learn and shelve the data” lesson. In fact, it has become a successful prototype of the interactive math/science project ASU researchers are working to create.

That project, called the Arizona Collaborative for Excellence in Preparation of Teachers (ACEPT), is geared primarily toward reforming key science and mathematics courses taken by students intending to work as teachers in kindergarten through 12th grade.

ACEPT team members are charged with preparing teachers and their students for the more complex and faster changing world in which we live. The tool is to better integrate math, science, and technology into daily life—LINDSEY MICHAILL

The Arizona Earth Vision project is supported by the National Science Foundation. For more information, contact Sam DiGangi, Ph.D., 602.965.1644. Send E-mail to: sam@asu.edu.

Technology Leverage

John C. Phillips photos

Screen views from the Hispanic Math Project CD.

Interactive controls and switchable language modes make it easy for students to immerse themselves.

Don Evans taking a turn in the student-designed interactive classroom. Teachers and subject rotate, students stay put.
DON'T PANIC

A afraid of getting lost in cyberspace? Unnerved by new technologies? Feeling like you’re being left behind? “Don’t panic!” So says Douglas Adams in his book: A Hitchhiker’s Guide to the Galaxy. Darwyn Linder thinks that Adams provides sound advice. “I sometimes get a little impatient with all this impatience surrounding the rush to embrace technology,” Linder says. Linder is a psychology professor and past president of the Faculty Senate. At ASU, he says, learning is the bottom line. “Like most businesses, we must hurry, but we can’t get so frantic that we shift our focus away from using technology to enhance the learning impact for students to just using technology.”

According to Linder, ASU can’t just “digitize” current courses any more than businesses could allow employees just to surf the Internet for fun. We must completely reformat classes and human mindsets to take advantage of the new technology. And if you’re wondering what’s happening in the library, Darwyn Linder also has some thoughts on that subject. The robo-reference world would create other issues. Think how students at MIT and the Sorbonne would feel if they shared classes with enrollees at a community college in Guam. Problems Which price should such enrollments pay? For which university does that professor work?

And Finally:

ROBOREFERENCE

W e poor librarians. In the information age? His Dewey Decimal system just got digitized. Libraries, like nearly every other entity, are being changed by technology. First there was microfiche. Then came electronic backroom tools. And, finally, the on-line title search. Though this march of technological retitling, libraries have primarily remained repositories for printed things. They are places where librarians point you toward periodicals that you can pick up to ponder. But in the Library of 2000, “point and click” will most likely outnumber “pick and ponder” by huge degrees. This is true especially among those who view the Internet as the ultimate global electronic reference tool.

“Books are ‘mark it and park it’ in library parlance,” explains Sherrie Schmidt, dean of libraries at ASU. “Their content and location rarely change, which make them relatively easy for us to track. But, people can change website data and location almost on a whim. For many people, libraries are symbols of shelter and sentiment, especially to those who enjoy the luxury of lingering while they learn. But in other ways, even modern libraries are somewhat outdated. After all, books must be purchased and maintained in sufficient quantities for each individual facility. The same is true with periodicals, which also must be saved on microfiche. Printed materials are costly, time-intensive to reshelve, and require a great deal of storage space. Then there is that pesky problem: Users must physically go to the library when it is open to get things done.

Contrast that with such a robo reference facility. “Instead of acquiring most new books, we’ll be licensing access to those books,” Schmidt says. Once a book is digitized and made available on one server, it can be accessed by nearly everyone from anywhere, anytime. “Likewise,” she says, “libraries can share the enormous costs of digitizing current books, saying, ‘I’ll do six, and you do six.’”

Accordingly, Schmidt predicts something akin to a “virtual university” for future years. She already sees teachers blending sections from several CD-ROMs and textbooks, ASU videos, external videos, and data from numerous websites to create a ‘richer course format.’ Imagine the options that become possible once an overwhelming majority of music, photos, journals, newspapers, books, and videos are available on-line. “I see people building the perfect degree course by course from all the best places,” she says. French at the Sorbonne. Technology from MIT. Anthropology and geology from ASU. Business from Wharton. All without necessarily having to ‘leave’ one’s host university.

The world’s best teachers, leaders, artists, and engineers can all be “live” on-line. “The roboreference world would create other issues. Think how students at MIT and the Sorbonne would feel if they shared classes with enrollees at a community college in Guam. Problems Which price should such enrollments pay? For which university does that professor work?”

Specific courses could also be self-customized. For example, say your marketing professor is an expert on distribution chains, but he’s not as strong in market research or pricing policies. Should he or she pick the best available “experts” from your host college for those topics? Or should he hand-pick an international retail marketing expert from Singapore, a British micro-economics professor, or perhaps even allow each student to computer-select the expert who best fulfills his or her own needs?

Of course, there is always the problem of ever-evolving technology.

The music industry has already “morphed” through the phonograph, 78s, 45s, reel-to-reels, 8-tracks, cassettes, and compact discs—each rendering its predecessors obsolete. The robo-reference world would face similar drawbacks, especially if MIT and ASU were operating in the information technology format equivalent of compact disks, while the Sorbonne used cassettes, and Guam still used reel-to-reel.

Libraries must still help organize information and help guide people to that information in the appropriate format. Schmidt says. “The good news is that if a book disintegrates, we don’t lose its intellectual content, just the artifact.”

—LINDSEY MICHAELS

For more information about innovations at ASU libraries, contact Sherrie Schmidt, dean of university libraries, 602-965-3956. Send E-mail to idsxs@asuvm.inre.asu.edu
view of physics to the ‘Newtonian’ view that has been adopted by physicists. Teachers learn how to use technology to help students transition effectively.

In science, we build imaginary worlds that help us understand the real world. We construct patterns in those worlds to represent patterns in nature,” Hestenes says. “Technology helps us represent those patterns concretely and to analyze them fully.”

Without the ability to use such patterns to make sense of real-life experience, science becomes little more than rote memorization of science fragments. Hestenes maintains.

“If all a student has is fragments, he really doesn’t know science because science is about recognizing patterns and using critical thinking skills to problem solve,” he says.

**INTERACTIVE CLASSROOMS**
Technology also lets ASU engineering professors teach Mexican engineering students directly from Tempe. Don Evans says. Those teachers can also bring some of the world’s best engineers directly to their students via videoconferencing, but technology innovation efforts do not end there. Evans is an ASU engineering professor who’s challenged his students to design an interactive classroom. Their design had to make technological integration tools easily accessible to all students, as well as suitable for teaching numerous subjects.

The Interactive Classroom features four- table student clusters with two networked computer stations per cluster. Students now receive English, physics, mathematics, and chemistry instruction in the room.

“The students stay put while the teachers rotate in,” Evans says. “All four subjects are highly interconnected, yet they’ve traditionally been taught separately. We bring them all together to show students the big picture—how mathematics is used in physics and English is used in all.”

**SEEING PATTERNS**
Nearby, at ASU’s Center for Solid State Science Research, Mike McKee is developing a software program that will allow students from around the world to fully operate a state-of-the-art microscope—located in his laboratory—directly from their classroom. McKee’s colleague and mentor, Jim Mayer, has developed a formal “Patterns in Nature” program for current educators. A “Patterns in Nature Van” outfitted with state-of-the-art equipment takes learning directly to Arizona schools.

Scientists and graduate students at the Arizona Mars K-12 Education Program use a different approach. They took science teachers to a Mars-like geological site in eastern Washington where scientists tested new tools and other equipment like those now on the surface of Mars. The group also publishes Red Planet Connection, a quarterly newsletter for K-12 classrooms, and brings teachers, students, and parents to campus for special workshops.

If you are beginning to believe that the business of education is not what it used to be, you would be correct.

For more information about ASU’s leverage for the Next Century Initiative, contact Kathy A. James, Ph.D., Office of the President, on 434, Tempe, 602/915-6400.

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