formance, academic R&D, and industry in the global marketplace. Some of those trends are as follows:

▶ In US elementary and secondary education, student performance in math and science has improved "somewhat" during the past three decades across all racial and ethnic subgroups. A National Assessment of Educational Progress study shows that among high-school seniors, 74% of white students and 80% of Asian/Pacific Islander students scored at or above a level deemed basic by a national panel of experts. Only 31% of black, 44% of Hispanic, and 57% of American Indian/Alaskan Native students attained that level.

▶ Achievement gaps between males and females have largely disappeared, especially in mathematics (in a study of 15-year-old students). But US students are performing "at or below the levels attained by students in other countries in the developed world."

▶ In higher education, interest in S&E study is high among freshmen, and their coursework preparation to study S&E is as good as in the past. However, 20% need remedial help in math and 10% in science.

▶ Graduate S&E enrollments from 1994 to 2001 reflect a decline of 10% in enrollment by US citizens and permanent residents, balanced by an increase of nearly 35% in foreign-graduate enrollment.

▶ Universities and colleges performed an estimated $36 billion of R&D in 2002, or 13% of the national total.

▶ Foreign-owned firms conducting R&D in the US accounted for $26.1 billion, or 13%, of the $199.5 billion total US industrial R&D expenditures in 2000.

▶ Since 1980, the number of nonacademic S&E jobs has grown at more than four times the rate of the US labor force as a whole. But barring changes in degree production or in immigration, the S&E labor force will grow at a slower rate, and the average age of scientists and engineers will increase.

▶ The total number of retirements among S&E-degreed workers will increase dramatically over the next 20 years. More than half of S&E-degreed workers are aged 40 or older.

Jim Dawson

Particle Tracking Tunes Up Music

Thanks to particle physics, creaky old musical recordings can now be restored to pristine condition. The restoration technique, developed by physicists Vitaliy Fadeyev and Carl Haber of Lawrence Berkeley National Laboratory, is a modification of a method used to measure the alignment of silicon detectors on CERN's upcoming ATLAS experiment. "We heard about the problem of audio preservation from a report on National Public Radio. So we thought first, why not use the same optical methods with which we were familiar?" says Haber. "The concept is groundbreaking and we believe it will have a major impact on sound archiving and preservation," says Mark Roosa, director for preservation at the Library of Congress.

Traditional remastering involves playing records with a stylus or a laser. In both cases, the audio is degraded by the record's rotating on a turntable. The Berkeley technique avoids the problem by placing the record in an $80 000 optical metrology system that takes images while moving a camera in a spiral pattern

LAWRENCE BERKELEY NATIONAL LAB.

A snapshot like this one contains data for restoring roughly 2 milliseconds of music.

following the path of the groove. A single 78 rpm record results in thousands of two-dimensional snapshots—100 to 1000 gigabytes of data. The snapshots are cleaned up to compensate for scratches, dirt, and warping, and then converted to a pure audio signal. The method draws on decades of experience in finding elementary particle tracks buried in large noisy data sets from high-energy experiments. "We thought these methods, which demand pattern recognition and noise suppression, could also analyze the grooved shapes in mechanical recordings," says Haber.

The restoration technique works with vinyl, shellac, wax, acetate, and metal. "It also has the potential to digitally reassemble broken discs," says Fadeyev. Examples of restored music are available at http://www.cdf.lbl.gov/~av.

Last year, Haber and Fadeyev contacted the Library of Congress and discovered that archivists were particularly concerned about how to save deteriorating and damaged phonographic wax or metal "Edison" cylinders—the earliest form of grooved recordings. The library asked Haber to develop a three-dimensional technique to save those recordings, a request that turned into a research grant. "The Library of Congress really took the initiative to engage with us on this," says Haber.

Early this year, by processing images from a confocal scanning probe, the Berkeley-led team restored a 1910 Edison cylinder recording of George F. Root's "Just Before the Battle, Mother." According to Roosa, the library's holdings include more than 2.5 million music and spoken-word recordings. "A substantial portion of these are grooved media, which could potentially benefit from this new copying technology," he says.

The current prototypes take 40 minutes to scan 1 second of recorded sound. Haber and Fadeyev say that with a customized scanning machine they could reduce the time taken to copy and process a 3-minute recording to between 8 and 20 minutes; 3D imaging of Edison cylinders takes longer. "What we have done so far are just small experiments to prove that modern optical methods have sufficient precision and sensitivity to do that job and then show that image analysis methods can extract sound and improve the quality and reduce the clicks and pops," says Haber. "It's a good example of how basic research in the physical sciences can benefit other fields of science and culture."

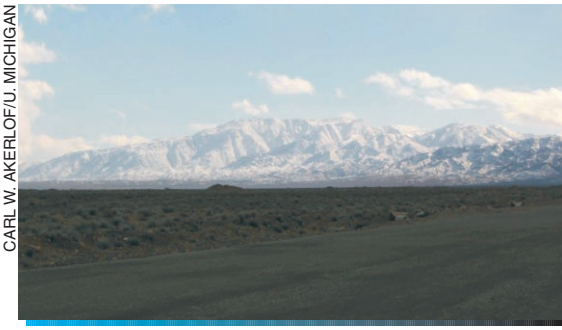
Paul Guinnessy

Iran Invests in Astronomy

The Iranian government has committed 150 billion rials (roughly $17.5 million) for a telescope, an observatory, and a training program, all part of a plan to build up the country's astronomy base. Iran wants to collaborate internationally and to become internationally competitive in astronomy, says the University of Michigan's Carl Akerlof, an adviser to the Iranian project. "For a government that is usually characterized as wary of foreigners, that's an important development."

A 2-meter-class telescope will be the Iranian National Observatory's first facility. "As far as I know, there has never been such a large purely scientific project in Iran," says Sepehr Arbabi Bidgoli, the project's assistant manager and an astrophysicist at the Institute for Studies in Theoretical Physics and Mathematics in Tehran. "The biggest telescope we have now is a 60-centimeter refractor. We can't compete with the Hubble or Keck or the VLT [Very Large Telescope], but we can do real science with [a 2-meter] telescope." Running a facility as a multi-university collaboration is also new for Iranians, Arbabi adds.

"Iran will have the only major telescope at that longitude," says project adviser Edward Guinan, an astronomer at Villanova University in Pennsylvania. "With a first-class modern telescope at a great site, it will be possible to swap time with other telescopes internationally."



CARL W. AKERLOF/U. MICHIGAN

The Karkas mountains in central Iran is one of four candidate sites for the country's new 2-meter-class telescope.

Measurements of light pollution, seismicity, wind, dust, and cloud cover have narrowed the site possibilities to four candidates. Testing for atmospheric turbulence, or seeing, at those sites begins this summer. A site is scheduled to be chosen within about four years, and the ready-made, robotically operable telescope could be installed and running in 2009.

Meanwhile, Iran's astronomy community, which consists of about 30 professionals and as many students, wants to train about 50 people in observational astronomy over the next five or so years. Last fall, the first class in a new master's program got under way. Students will learn theory and "get their first acquaintance with astronomical gadgetry on one of the few small observatories" in Iran, and then go abroad to gain experience on larger and newer instruments, says Yousef Sobouti of the Institute for Advanced Studies in Basic Sciences in Zanjan. "We do have enough friends and contacts in India, Europe, and elsewhere to give us a helping hand."

"Fortunately, Iran has an immense pool of youth very much interested to make careers in all branches of science," adds Sobouti, who spearheaded the telescope project. "This includes astronomy, though it may not seem to provide a lavish life for the individual."

Toni Feder

Feds Set Priorities Based on "Quarks" Report

A federal government science group has issued recommendations based on the National Research Council's 2002 report *Connecting Quarks With the Cosmos: Eleven Science Questions for the New Century*, and dark-energy research projects have