Physics Bachelors on the Rise After 10-Year Decline

A new study issued by the American Institute of Physics (AIP) reports that, for the first time in nearly a decade, the production of physics bachelor’s degrees in the U.S. is on the rise. The graduating class of 2000 produced a total of 3,849 bachelor’s degrees in physics, an increase of 7% over the class of 1999, and that number is expected to continue to rise at least for the next two years. The report also found that there has been a slight increase in recent years in the proportion of new degree recipients entering directly into physics graduate study.

According to Patrick Mulvey in APS Statistical Research Center, the data in the report are based on responses from 2,721 physics seniors from 763 degree-granting US physics departments, who were surveyed during their final year of undergraduate physics study. The center has been collecting data on senior-level physics and astronomy majors from both students and departments for more than 30 years. For every 1000 bachelor’s degrees awarded in the U.S. in 2000, about 3.3 are awarded in physics, and during the 1990s, physics bachelor’s degree production declined sharply by 27%. “In a sense, physics lost some of its market share,” says Mulvey. Especially hard hit were the larger departments that included graduate as well as undergraduate programs, and it is these departments which are now largely responsible for the recovery in degree production.

The report found that the like-minded of an individual receiving a physics bachelor’s degree is much higher if he or she has taken a high school physics course, 92% of physics bachelor’s said they had taken at least one physics class in high school. Based on this finding, “With the increasing student enrollments seen in high school physics in recent years, one can be optimistic in thinking that more students may choose to continue with physics at the undergraduate level in the future,” says Mulvey. Most respondents said that their choice of major in physics was because they were intrigued by the subject matter, followed closely by the influence of the high school teacher or college professor who taught their first physics course. Ironically, very few students cited long-term employment goals as their primary influencing factor in choosing a major in physics.

Friedman Tests in Washington on NSF Doubling Bill

Former APS President Jerome Friedman, a Nobel laureate and professor of physics at the Massachusetts Institute of Technology, testified before the House Science Subcommittee in early May in support of proposed legislation authorizing 15% increases in the budget of the National Science Foundation in each of the next three years. H.R. 4664, currently known as the “Investing in America’s Future Act,” was authored by subcommittee chairman Nick Smith (R-MI), who said that part of the rationale behind the legislation was the subcommittee’s concern that the NSF may be rejecting too many grant applications because of its financial constraints. Increasing the NSF budget would allow it to increase the number, size and duration of research grants, and reduce the backlog of research facilities upgrades, says Smith.

Friedman devoted much of his testimony to the issue of major research equipment and facilities construction. “The NSF currently does not provide the scientific community with a prioritized list of approved projects,” he said, commenting on NSF’s decision-making process for construction and operation of major facilities. “The lack of transparency has prevented orderly planning by the research community. As a result, science has suffered and international research partners have been left dangling.” He cited the lack of an NSF funding request for the Rare Symmetry Project.

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Highlights

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...Lee and his family, a multi-million Round-the-clock surveillance of Ames, Hanssen, and most of the 

...So Penzias and Wilson began looking for evidence to...
One in five APS members cur- rently lives and works outside of the United States; international collaborations are vital for large research efforts; and few things stimulate scientific progress more than the free flow of information across borders and cultures. These are just a few of the many reasons that the APS has inter- ests in events and conditions in the world beyond American shores. In fact, the APS’s International Affairs Committee is specifically dedicated to monitoring and influencing international affairs.

The Committee on Interna- tional Freedom of Scientists (CIFS) began as a subcommittee under the APS Panel on Public Affairs (POPA) in the 1970s, and blossomed into a full-bladed APS committee in the 1980s. The Committee on Interna- tional Scientific Affairs (CISA) followed a similar progression in the 1980s and early 1990s. The cold war era that set the stage for the creation of the committees in the first place is rapidly fading into history Nevertheless, the injustices that motivate CIFS and the issues that trouble CISA remain as serious today as they were a generation ago.

CIFS: Working for Freedom

Even in the era of enlightened glob- alization, free speech is still a crime in many countries. Peaceful assem- bly and other fundamental freedoms are restricted in some corners, and unheard of in others. Because scientists are often at the forefront of the wonderful, and we want everybody to be able carry it on freely — to fol- low their imaginations and creativity. It’s a universal concept, independent of where you are in the world.

Such lofty goals require patience and persistence. “We are dealing with closed regimes, with regimes where information flows are tightly controlled as soon as you get past one hurdle, laws change and you start all over again,” Koller remembers. So CIFS has focused on the individual before we get them out of jail or out of trouble. We’ve achieved some success in several cases, but it has been slow.

Ironically, one of the difficulties that CIFS has faced in recent years resulted from the fall of the Soviet Union. During the cold war period, Soviet dissidents included physicists Andrei Sakharov and Natan Sharansky, and biologist Yuri Orlov. While countries less restrictive than the Soviet Union no longer use the death penalty, dissidents suffered as well, the big three achieved enough notoriety that a growing chorus of scientists in the US joined the struggle against Soviet re- pression under the moniker Scientists for Sakharov, Orlov, and Sharansky or S.O.S for short. It’s likely that few people these days rec- ognize the names Yuri Yundt, hide for eight Stuhr, or Valerian Dumin — three physicists included on the CIFS list of current cases. Raising awareness for com- mittees and for the individuals is a significant challenge.

In light of the events of the past year, CIFS must adjust again. “We are entering new terri- tory,” says Koller. “September 11 changed the parameters.” Sessions at APS meetings, which once served as the primary vehicle for dissemin- ation of CIFS information, are drawing fewer partici- pants. The committee is considering using newsletters to take up the slack in communication. Another issue of increasing importance is communica- tion with scientists in Islamic communities. Koller points out that CIFS has well developed relations with countries such as Russia, China, and Belarus, but little experience with the Near East. “We have to in- crease our awareness of the scientific climate and opportunities in Near Eastern countries and open chan- nels of communication.”

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CISA’s role, as defined in the APS bylaws, consists of encouraging the society’s efforts to strengthen inter- action among researchers and scientists in different regions of the world and to furthermore extend worldwide access of physicists to scientific information and its exchange. “To these ends,” Koller notes, “the committee’s focus is on the free flow of information and scientific personnel across borders, and to bolster science programs and facilities in underdeveloped countries.

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Focus on Committees

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New Mexico Yields New Senior Editors for PRD and PFE

Following a year long search process, committees for Physi- cal Review C and Physical Review E have found new edi- tors. Benjamin Gibson of Los Alamos National Laboratory will take the senior position at PRC and Gary Cest of Sandia National Laboratory will be PFE’s senior editor.

Gibson has been involved off and on (mostly on) on the PRC. Editorial Board as a PRC Asso- ciate Editor since 1978. His long association with the Divi- sion of Nuclear Physics is another of his assets. Gibson will replace Sam Austin, who has been at PRC’s helm since 1988. Gibson is a recent Divisional Asso- ciate Editor for PRL and has been a very active au- thor and referee for the journal.

Benjamin Gibson

Gary Cest

Great takes over from Irwin Oppenheim, PRL’s original senior editor.

Peter Bond (BNL) chaired the PRC search committee and Herman Chumins (City College) lead the PFE committee.

The committee responded strongly to the call for nominations and candidates, which appeared in a number of dom- estic and international publications. Each committee had over 40 names to consider. Electronic communication (not to mention the high percentage of interna- tional authors and subscribers) allowed the search committees to consider international candi- dates, and seventy of these reached the short list.

Panel Probes, from page 1

Community

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We are very pleased to see that in the April 2002 issue of APS News, there is an article by John Womersley entitled “Wigner and Symmetries” (on page 3) describes the recent successes of particle physics, the discovery of the top quark. This is not correct, and the article itself makes this clear. In 1993, the first evidence for top quark started to come in, and the actual discovery was made in 1995. This is important because the 1995 results were the independent work of two groups and was actually down by 10% because of the needs in physics. 

The time you have to do the next job is the capital letter (and we get K kelvin or kelvins. With- correcting more women to physics also, actively recruiting? I thought APS News

In the let...
There's been a lot of talk re- cently about professional master's degree programs (PMDPs) in applied physics. We've heard the rationale for and benefits of these initiatives: students who graduate from these programs have more career options and unique skills ranging from the highly technical to business acumen in communi- cations, teamwork, and project management. Industry benefits because they get students who are specifically educated for industry and are ready and fully capable of contributing to the success and bottom-line of companies and or- ganizations. Of course, physics departments benefit because PMDPs can foster new or rein- force existing partnerships with industry, cultivate connections with alumni, and ingrate depart- ments by attracting a new crop of talented physics students who oth- erwise might not have considered graduate school.

So the word is out: PMDPs can do a lot of good for physics depart- ments and the constituents they serve. But just because a PMDP is appropriate for one department, does this mean that every depart- ment should or even is able to jump on the PMDP bandwagon?

It is obvious that every physics department is unique and has its own individual needs and goals which must be adequately scruti- nized before solidifying the decision to institute a PMDP. Since every situation is different, it would be impossible to provide a singular model program which other physics depart- ments can emulate. However, one can examine a case study of a successful program, in which the sponsoring department, in this case the Princeton Plasma Physics Laboratory, made a decision to institute a PMDP.

For Lumiere, it was the first time anyone had, atom-splitting career that his has come across anything more than the normal protons, gluons, and quarks. “I know that over at MIT Hendrickson has amassed an entire collection of little goggews—spinning tops, decoder rings, stickers,” he said. “He’s so lucky, I hate him.”

And well he should. Atomic prizes are so rare as to drive scien- tists to unravel much of the greatest mystery facing phys- ics today. Who, they still wonder, put the prizes there?

Many have proposed theories. Meanwhile, there’s a real and increasing demand in industry for people who bring the unique skills and perspectives of physics to bear on solving problems that arise in the development and manufacture of various goods and services. So, in the spirit of adapt or die, we explored ways in which we could take the initiative and provide a service to both students and indus- try while of course benefiting ourselves at the same time,” Stein said.

The University of Arizona’s (UA) launched its professional masters degree program in 2000, spon- sored by the Sloan Foundation’s nationwide initiative. The program was created in response to the re- ten-repeat complaint that physics professors typically train Ph.D.s to be carbon copies of themselves,” said Daniel J. Stein, Head of the UA Physics Depart- ment.

“Meanwhile, there’s a real and increasing demand in industry for people who bring the unique skills and perspectives of physics to bear on solving problems that arise in the development and manufacture of various goods and services. So, in the spirit of adapt or die, we explored ways in which we could take the initiative and provide a service to both students and indus- try while of course benefiting ourselves at the same time,” Stein said.

The UA’s program was orga- nized around a series of learning outcomes designed to give stu- dents proficiency in teamwork, chang- ing roles, computational techniques, communication, and basic business and legal issues associated with scientific projects. The components of the program consist of a core curriculum in graduate-level physics, specialty electives in any related subfield, two courses in business founda- tions and project management, a colloquium series with speakers from industry ranging from CEOs to intellectual property attorneys to lab directors, an internship, and a final project or thesis. The final project, which takes into account the learning outcomes and unites the physics with the industrial as- pects of the degree, often is a culmination of research con- ducted or applied problems solved in the internship.

The challenges and keys to suc- cess:

- The challenges of orchestrating a PMDP at the UA seem simple and straightforward, but many of them still exist. One issue the depart- ment realized early on is that it cannot assume that potential stu- dents will fully understand the uniqueness and more importantly the value of the PMDP in their ca- reer plans. Similarly, target companies for internships or perma- nent positions also did not comprehend the benefit of hiring students from our program. The depart- ment realized that these possible problems could be solved through public relations efforts and a lot of one-on-one discussions with students and industry partners.

- However, it is a slow process, and since Lumiere’s concept, the department regularly seeks advice from other PMDPs on how to effectively recruit stu- dents and industry partners, most notably with other Sloan-funded schools, such as Michigan State University and Rice University. One of the main reasons the department has had success in its program is because it continually reevaluates the program and its goals, fine-tuning any aspect that has that devilish the ultimate mis- sion of the PMDP. Self-assessment, and constant and thorough consultation with industry, faculty, and students are certainly keys to success how the program continues to grow and prosper. In addition, great pains have been taken to ensure that the actual physics has not been compromised for the sake of the “professional” aspect of the degree. Yet, the flexibility, allowing students to spe- cialize in any subdiscipline of physics or related area (such as optics or satellite circuit design). Students constantly interact with industry leaders and have the opportunity to attend special indus- try conferences, conferences, trade shows, seminars, and skill- building workshops.

- By building a PMDP around not only the research strengths of the department and other units at the UA, but also the industrial strengths of the region, and by instill- ing in the program an inherent and perpetual alliance with indus- try, this PMDP has been able to effectively serve and benefit all of its constituents. Physics students receive excellent educational ex- periences uniquely preparing them for industrial careers, par- ticularly geared towards regional enterprise. Industry benefits from a new workforce with strong tech- nical skills, knowledge of business fundamentals, and consequen- tially, the connection between science and business in industry.

Alaina G. Levine is Director of Spe- cial Programs at the University of Arizona. She currently oversees the University of Arizona’s Professional Master’s Degree Program in Applied and Industrial Physics, the Undergraduate and Graduate Economics, and Applied Biosciences, and as well as public, media, and industrial relations for the College of Science and the College of Agriculture, Human, and Industrial Eco- nomics. She can be contacted at alaina@u.arizona.edu or 520-621-3374. More information on the UA PMD Program can be obtained at http://pmdp.arizona.edu/.
2002 APS General Election Preview — Members to Elect New Officers, Councillors from 2002 Slate of Candidates

Election notices and invitations to vote electronically were sent to APS members with valid e-mail addresses in June. Members without e-mail or invalid e-mail addresses were sent paper ballots. Web votes and paper ballots must be received by Survey and Ballot Systems by noon CDT, September 1, 2002 to be counted. Paper ballots can also be requested by calling 301-209-3288 or e-mailing governance@aps.org. Editors Note: Complete biographical information and candidate statements can be found at: http://www.aps.org/elec/election2002/

FOR VICE-PRESIDENT

MARVIN L. COHEN
University of California, Berkeley

Born in Montreal, Cohen was an undergraduate at Berkeley and completed graduate studies at the University of Chicago in 1963 (PhD 1969). After a year postdoctoral position with the Theory Group at Bell Laboratories (1963-64), he joined the Berkeley Physics Faculty, becoming University Professor in 1999. He has also been a Senior Faculty Scientist at the Lawrence Berkeley National Laboratory since 1995. Cohen’s current and past research work covers a broad spectrum of subjects in theoretical condensed matter physics. He is best known for his work with pseudospins with applications to electronic, optical, and structural properties of materials, superconductivity, semiconductor physics, and nanoscience. Cohen is the recipient of the APS Oliver E. Buckley Prize for Solid State Physics and the APS Julius Edgar Lilienfeld Prize. In 2002 Cohen will receive the National Medal of Science.

Cohen has served as a member and then chair of the Executive Council of the Division of Condensed Matter Physics of the APS, as the US representative on the IUPAP Semiconductor Commission, and as a member of the National Academy of Sciences-Government-Industry Research Roundtable.

Cohen serves on a number of national and international boards and committees as an advisor and advocate for science education. He was Vice Chair of the NASA-GUIR Working Group on Science and Engineering Talent, emphasizing the recruitment of women and minorities. He was a featured speaker for the Electron Birthday Project (distributed to high schools) and is currently active in lecturing to lay groups, K-12 students, and industrial groups.

FOR CHAIR-ELECT, NOMINATING COMMITTEE

JOHN PEOPLES
Fermilab

Peoples is a senior scientist in the Fermilab Experimental Astrophysics Group and Director of the Sloan Digital Sky Survey (SDSS). He received his Ph.D. in Physics in 1966 from Columbia University. He was an Assistant Professor in Physics at Columbia from 1966 to 1969 and at Cornell University from 1969 to 1972. He joined Fermilab in 1972 and during the next sixteen years he was engaged in the construction and management of experimental facilities and high-energy physics. He served Fermilab as Deputy Director in 1988 and Director from 1990 to 1999. He was appointed Director Emeritus in 1999. He was the chair of the Division of Particles and Fields in 1984 and the chair of the Division of Physics of Beams in 1999, and is currently a member of the APS Advisory Committee of International Scientific Affairs. He was a member of the High Energy Physics Advisory Panel from 1976 until 1980 and again from 1984 through 1985.

FOR GENERAL COUNCILLOR

JANET M. CONRAD
Columbia University

Conrad received her Ph.D. from Harvard University in 1993. Since that time, she has been associated with Columbia University and is presently an Associate Professor. At present, Conrad’s research focuses on using neutrinos as tools to search for beyond-the-standard-model physics signatures. She was given the Marie Goeppelet-Meyer Award from APS in 2001 for her leadership in the search for neutral heavy leptons at the NuTeV deep inelastic neutrino scattering experiment at Fermilab. Conrad has been active in the APS since she was a graduate student, and is a member of EPS, APS DPP and APSN. She has been a member of the EPS Executive Committee since 2000. She has served on the Tanaka Prize Committee and is presently on the Selection Committee for the Maria Goeppelet Meyer Award. She has been active in organizing symposia and giving public lectures, describing neutrino physics on NPR’s Earth & Sky, and serving on a number of panels focused on outreach to educators and the larger community.

STEVEN G. LOUIE
University of California, Berkeley

Louie received his Ph.D. in physics in 1976, both from the University of California at Berkeley. He was a postdoctoral fellow at the IBM Watson Research Center, a visiting member of the technical staff at AT&T Bell Laboratories, and Assistant Professor of Physics at the University of Pennsylvania before returning to UCB in 1980. He is concurrently a Senior Faculty Scientist in the Materials Sciences Division of the Lawrence Berkeley National Laboratory. His research interests are in theoretical condensed matter physics and nanoscience. He was awarded the APS Anserus Rahman Prize for Computational Physics in 1998, and the APS Davidson-Germer Prize in 1999. Within the APS, he has served on the Anserus Rahman Prize Selection Committee, the Davidson-Germer Prize Selection Committee, the Nicholas Metropolis Award Selection Committee, and the Nominating Committee, Fellowship Committee, and Executive Committee of the Division of Computational Physics.

FOR VICE-PRESIDENT

NEAL LANE
Rice University

Lane was born in Oklahoma City, Oklahoma, and obtained his B.S., M.S. and PhD degrees from the University of Oklahoma. From 1993 to 2001, Neal served in the Clinton Administration, first as Director of the NSF, from 1993-98, and later as Presidential Science Advisor and Director of the White House Office of Science and Technology Policy. From 1998-2001. At the NSF Neal emphasized the integrity of peer review, balance of funding among fields, NSF-wide support of all large constructions projects, such as LIGO, quality science and math education for all, staff morale, electronic proposal processing, good relations with the White House and Congress, and other matters. While at the White House, he stressed the importance of research funding for the physical sciences, a point emphasized by President Clinton in his FY2001 budget request, which included the new National Nanotechnology Initiative.

Prior to going to Washington, Lane enjoyed a successful academic career in teaching, research, and administration. He was Provost of Rice University from 1986-93, and Professor of Physics, from 1972, serving one term as chair. He also has served as Chancellor of the University of Colorado at Colorado Springs (1984-86), and Director of the NSF Division of Physics (1979-80).

Neal’s field of research is AMO physics, specializing in electronic and atomic collision theory. He serves on several boards and advisory committees and has received a number of fellowships, honorary degrees, and awards, including the AAS/AMAP’s Public Service Award. He has served at various times on APS Council and Executive Board, PORS (chair 1983), and other APS committees. He currently serves on the APS Physics Policy Committee.

FOR CHAIR-ELECT, NOMINATING COMMITTEE

SUNIL SINHA
University of California, San Diego

Sinha obtained his Ph.D. in physics from Cambridge University in 1984. He has held positions at universities (Iowa State University, 1985-1973), industrial research laboratories (Exxon Corporate Research Laboratories, 1983-1995), and government research laboratories (Argonne National Laboratory, 1975-1983 and 1995-2001). He is currently professor of physics at the University of California San Diego. He has worked to stress the achievements and dynamics of Condensed Matter using neutron and X-ray scattering techniques. He has spent several periods as a visiting fellow and visiting scientist in Japan, France, Germany, Denmark and India. He has served on the Executive Committees of the APS Division of Condensed Matter Physics and the APS International Physics Group, and on numerous advisory and review committees of several materials science and physics departments and neutron and synchrotron radiation facilities around the world.

FOR GENERAL COUNCILLOR

LAURA SMOLIAR
Lighwave Electronics

Born in New York City, Smolar earned her Ph.D. from the University of California, Berkeley in 1993. As a graduate student, she spent seven months in Taiwan at the Institute of Atomic and Molecular Sciences (IAMS), an institute of the Academia Sinica founded by Professor Lee and spent an additional year as a postdoc working at IAMS and the Synchrotron Radiation Research Center (SRRC). Smolar has worked in Silicon Valley since September, 1996. Initially she worked in the data storage industry at Seagate Technology, and in 1998 co-founded a start-up working on three-dimensional laser-based displays. She was then recruited by Lighwave Electronics, a small privately-held photonics company in Silicon Valley, to lead a development program aimed at the display industry. At Lighwave, she manages a multi-disciplinary group of engineers and support staff, and development partners in Asia and Europe. She has been very active in the APS Forum on Industrial and Applied Physics, serving on the Executive Committee and as Chair in 2001-02.

KATEPALLI SREENIVASAN
Institute for Physical Science & Technology, University of Maryland

Sreenivasan was educated in India, Australia and Johns Hopkins and was a faculty member at Yale University from 1979 until this year. He is currently the Distinguished University Professor and Director of the Institute for Physical Science and Technology at the University of Maryland. His research is devoted to experimental and theoretical studies of wide-ranging problems in fluid dynamics, with a major focus on the turbulent state. Within the APS, Sreenivasan has served as the Chairman of the Division of Fluid Dynamics, Chairman of the Topical Group on Statistical and Nonlinear Physics which he helped create, Associate Editor of Physical Review E (1994-97), and Divisional Associate Editor of Physical Review Letters. He is also a member of the APS Publications Oversight Committee. Sreenivasan was awarded a Guggenheim Fellowship in 1989 and the APS Otto Loarte Award in 1995.
We hope you will join us. If you are interested in joining, please go to [http://www.cur.org/membership.html](http://www.cur.org/membership.html) or contact us at cur@cur.org or info@cur.org.

WEN HO LEE, from page 4


dollar government investigation, and Lee’s nine months of solitary confinement culminated when Lee pled guilty to one of the provison of the Espionage Act charges. On September 13, 2000, US District Judge James Parker apologized to Lee for the government’s abuses during the investigation and prosecution, and subsequently sentenced Lee to time served for mishandling sensitive material.

Repercussions stemming from the Lee espionage case continue to shake up high level law enforcement agencies and the National Laboratories. A Government Accounting Office report requested by House Representatives David Wu (D-OR) and Eddie Bernice Johnson (D-TX) in response to Lee’s case was released in April. The report entitled “Actions Needed to Strengthen Equal Employment Opportunity Oversight,” revealed a pattern of discriminatory employment practices toward women and minorities at three national weapons labs, including LANL. Also in April, Ray Jaussit, bid for the top position at Lawrence Livermore National Laboratory was derailed in part because of his comparatively remote supervisory connection to Los Alamos. Also in April, Ray Jaussit, bid for the top position at Lawrence Livermore National Laboratory was derailed in part because of his comparatively remote supervisory connection to Los Alamos.


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September 11th terrorist attacks, and performance and results will continue to be of high interest in scientific research. Rep. Gil Gutknecht (R-MN) said that Congress recognizes the challenges of building bigger machines, to our exciting results from the nonni- science. FOCUS, from page 3

all, the world’s current political and social volatility presents at least as much challenge to CSA and CER as to China and the precarious balances of the cold war era. However they ap

ampire. What we offer: Our Undergraduate Minority Scientists Network (MiSciNet).

AP News: Based on your experience, would you advise foreign scientists to enter the US not to accept employ

Ween Ho Lee and his wife Sylvia Lee are deeply saddened. “It’s hard for me to even imagine what it might be like to have someone in your family who is in solitary confinement.”


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LAND MINES: An Explosive Issue Requiring Physicists’ Help

By Richard Craig

I have to confess that I am not an expert on land mines. This issue marks my third anniversary of work- ing in this area. What I’ve learned has been gleaned primarily from research on how to deal with them. The mines I’ve met have had the detonators removed—and I’m just as happy to keep them the way they are. However, present an issue that won’t go away on its own and provide opportun- ities for physicists to apply their peculiar skills in address- ing life-and-death issue.

Some refer to land mines as the perfect soldiers. They are inexpensive—a few dollars each to buy and deploy. They don’t eat; they don’t fall asleep on duty; they don’t require maintenance. Land mines are selective in the sense that they don’t, generally, detonate spontaneously or when encountered by someone other than their target. By design, land mines aren’t shock-sensitive so they’re difficult and expensive to destroy.

Most field soldiers with whom I’ve spoken don’t like them at all. They view land mines as an evil compo- nent of the battlefield. To them, land mines are indiscriminate weapons that kill and maim friends and foe alike.

Yet another perspective is that of concerns over land mine-free zones. For these people, land mines are a part of their everyday life. Land mines render their living and working areas dangerous. This is especially true in the case of civil wars for which the purpose of the land mine is, of- ten, genocidal. Bosnia/Herzegovina and Croatia are one such example. Land mines, laid as part of ethnic cleansing activities, continue to contaminate land and farming areas of noncombatant populations.

Low tech, High numbers

The numbers are overwhelming. The United Nations estimates that more than 100 million land mines are in place, creating an environment contaminated by a million land mines that randomly explode. At certain times of day, a land mine may be warmer or cooler than its surrounding. This is the physical basis of infrared tech- niques for mine detection. When IR detection works, it can work very well—minutely mines can show up very clearly from an airborne platform. The issue with IR is that it may not work at all. This isn’t a confi- dence factor in the technology.

High-tech options

In the near future, the land mine community already has invested considerable R&D to find, remove, and dispose of land mines. Various approaches are being developed, each with advantages and disadvantages including: some are electronic; some are mechanical; some are the result of new and innovative techniques.

As a community, how can physi- cists help? The physics community has repeatedly demonstrated the talent, creativity and attitude needed in the pursuit of feasible, reliable solutions to real-world challenges, including those of land mine detection.

The Future: our challenge

Where can physics help? The oppor- tunities are manifold—first, identify a phys- ical probe or suite of probes that is accepted by the local popula- tion, second, find a way to improve the performance of the ex- isting probes, and third, engineer the probe so that it is a device that is patently acceptable to a community that is comfortable with mechanical probes. The powers- ing infrastructure, which is the lifeblood of demining communities, have a dream date. Mine detection at a distance with a minimum standoff of 10 meters. Others are specifying aircraft standoff. Most of the present land probes are limited by applicable phys- ics to much shorter distances.

The demining community can ac- cept higher-cost devices; it will not accept a device that is perceived to reduce the reliability, compared to a mechanical probe, regardless of speed or other advantages. Perhaps the low- field magnetic resonance spectroscopy approach that Berkeley recently can provide a basis for low-power, low-field resonance chemical probing akin to NQR. The need for field cooling would re- strict the application only slightly. Another variation on the dielectric probe theme, (not yet considered for land-mine detection), to my knowl- edge, although it has been successful in examining storage tanks for leaks, is electrical-resistance tomography; this would require that the soil have some reasonable conductivity. Neutr- ion-scanning land-mine detection could be improved substantially if a small, truly inexpensive neutron gener- ator became available. This would also provide a source that might be used in the developing world for other purposes, such as the detection of land mines.

Finally, there is an interesting so- cioeconomic issue for humanitarian demining in developing countries. Presently, mine clearance is often a closed shop. Those doing the work are foreign soldi- ers in their countries. They are loath to see outsiders come in to replace them or to allow others to do so. Any technology to be used in these areas must be engineered to be adaptable to the existing infrastructure.

As a community, how can physi- cists help? The physics community has repeatedly demonstrated the talent, creativity and attitude needed in the pursuit of feasible, reliable solutions to real-world challenges, including those of land mine detection. The bottom line is that this problem isn’t solved and it’s not as simple as a technical chal- lenge. We can develop technologies that will be used to save lives, but the cost is often too high to clear mine fields.

Richard Craig is a physicist at Pac- ific Northwest National Laboratory in Richland, WA. He is the recipient of the 2001 Christopher Columbus Foundation award for his development of a timed explosive that will allow access to mines.

Editor’s Note: A longer version of this article can be found on line at www.aps.org/news/