informed about medical physics, but they should also be made aware of certain other aspects of the field.

One important aspect is being able to work with the sick and dying—from the very old to the very young.

Another is knowing how medical physicists pursue solutions. In both the medical setting and the basic physics laboratory, that pursuit requires intelligence and training. If failure occurs in basic physics, the experimenter replaces the burned-out components in the circuit, introduces new discrimination in the electronics, places a new operator in the Hamiltonian or revises the model from which the prediction arose. In medical physics, however, the solution is literally pursued with a life-or-death consequence. The safety of the tried and tested is not only preferred, but required. Incorrect solutions can jeopardize the success of treatment, and errors are likely to occur if the individual's dedication to quality assurance falters. (Prior to my present employment, I caused a man to lose vision in one eye when I bypassed quality-control procedures. That error still haunts me.) Medical physicists must have malpractice insurance to protect themselves or their employers against such possibilities, but the human toll on both the patient and medical physicist is not so easily disposed of.

Yet another aspect is to understand how medical physics has changed over the past two or three decades. When I came into medical physics in 1971 from basic physics, an individual with a PhD could get up to speed with one year of on-the-job training. At that time there were no accredited medical physics training programs. Now there are seven. A quarter of a century ago, one could sufficiently master all areas of medical physics—radiation oncology, diagnostic imaging and nuclear medicine—in a year of concerted effort. Today one cannot.

Another aspect is realizing the risks involved when individuals try to practice medical physics without the benefit of training programs and apprenticeships. Incidents have occurred, such as numerous patients being overexposed to radiation—and hospitals and physicists thereby being exposed to legal action.

Finally, I urge interested physics students to contact the headquarters of the American Association of Physicists in Medicine (301-209-3350) for information about training programs in medical physics.

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Spirited Debate on the Role of Science

In "The Role of Science in Our Society" (September 1995, page 43), Burton Richter has done a fine job of emphasizing the importance of continued funding for basic and applied science at a time of major changes in Washington, DC. I agree with him completely on such issues as the need to continue funding basic science for national security and economic reasons, and to have industry, government and universities work together.

However, there are a couple of changes in emphasis that I would make. First, funding of basic and applied science must continue both for individual investigators and for megaprojects. The megaprojects must be prioritized by the scientific community. Prioritization would be a natural role for the National Academy of Sciences, National Academy of Engineering and the National Research Council, and you can be certain that if it is not done by the scientific community, it will be done for it. The long-term payoff from these projects needs to be carefully communicated to the Administration and Congress, and also to the general public—but without overstating results and making hollow promises.

Second, the problem in the US has not been with commercializing technology. We have a very active venture capital community, and funding companies to commercialize new technologies is not a problem. Rather the problem lies in the improved design and low-cost manufacturing of technologies that meet mass-market needs. We must emphasize the importance of good design, quick introduction into manufacture, determining what customer requirements are, and closing that loop with changing designs to meet global market needs. This capability is much stronger outside the US, and seems to be at its best in the Pacific Rim countries. Most foreign competitors can introduce dozens of new products while US companies struggle to introduce a single new design.

The future leadership of the US will depend on supporting the points made in Richter's article, and the ability of the scientific community to infect our lawmakers with the excitement and promise of science and technology.

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Burton Richter argues for continued massive government funding of sci-

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LETTERS *(continued from page 15)*

ence. He offers a rational argument: Science is an investment that pays practical dividends. And he makes an emotional appeal: Science fulfills "needs of the spirit."

The emotional appeal might be appropriate for soliciting voluntary contributions to the funding of science. Surely it is quite beyond the pale to suggest, however, that people's spiritual needs are the responsibility of government, a responsibility to be met through the expenditure of funds extracted from them by the IRS.

The investment argument has at least two serious problems. First, the length of time between discovery and application of pure-science results is not inconsequential. It is entirely plausible that government funding artificially stimulates premature research. That is, the resources could have been used more directly to build a wealthier, technologically more competent society, in which industrial or philanthropically funded research could have achieved the same results later, but still in time to apply them. The burden of argument in this regard clearly lies with those who, like Richter, advocate that the government take money from taxi drivers, mill workers, and waitresses and give it to scientists.

The second problem is that politics inevitably distorts government spending priorities. If government is in the business of funding science long-term, then there will be earmarking of research funds for use in the districts of influential politicians. There will be manned space spectaculars, misguided wars on cancer, 50-mile-long particle accelerators (perhaps only half finished before political winds shift) and so on.

If government funding produces boondoggles and premature basic research, the cost is not merely in dollars. The intellectual resources involved are priceless far, far beyond the financial cost of salaries and equipment (which is one reason why economic studies of rates of return from scientific research can be very misleading). How else might those brains have been employed?

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RICHTER REPLIES: Allan Walstad does not like my comments on "the needs of the spirit." I thought I made a pretty good case, but he disagrees. So be it.

He is concerned that funds used for research could have been better directed to benefit society. The only way to address that concern is to look at outcomes. In my article, I cited several economists who estimate large positive economic returns to society from the investment in R&D.

Perhaps there are investments with a still greater return, but the investment in science does appear to benefit "the taxi drivers, mill workers and waitresses" as well as the scientists.

Walstad and I agree that there are distortions and inefficiencies introduced by politics and earmarking. I would try to fix them. He seems to want to withdraw.

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Human Rights Issues Aired at Meeting in China

The 19th International Conference on Statistical Physics took place on the campus of Xiamen University, in China, between 31 July and 5 August 1995. Some 700 scientists (about half from overseas) participated in the conference, which was sponsored by the International Union of Pure and Applied Physics, the Chinese Academy of Sciences, and other organizations in China.

As with all IUPAP-sponsored conferences, the organizers had agreed that StatPhys 19 would comply with the general guidelines contained in the *Handbook of ICSU's Standing Committee on the Free Circulation of Scientists* whereby no bona fide scientist would be excluded, and they had gotten assurances to this effect from their government. To the best of our knowledge, every foreign scientist who wished to participate obtained a visa in timely fashion.

During the conference, some of the individuals presenting scientific papers began by dedicating their presentations to free speech and to support of peaceful pro-democracy movements in all countries, including China. They also appealed to the Chinese government to release those punished for having taken part in the pro-democracy demonstrations in Beijing's Tienanmen Square in 1989 and in other peaceful protests.

These matters also were the subject of an informal session convened during a conference lunch break by four StatPhys 19 participants: Joel L. Lebowitz, Joseph L. Birman, Bernard Derrida and Eytan Domany. About a hundred other participants attended the session, and several of them offered comments on this issue.

At that lunch session a petition directed to the Chinese authorities was circulated for signature. It specifically asked for the release of three young physics students currently incarcerated for having spoken or put up posters in favor of the pro-democracy movement. The three are Lu Yanghua, a graduate student in physics at Lanzhou University; Zhang Lin, a student in nuclear physics, now in Nanhu Labor Camp; and Zhu Xiang Zhong, a physics graduate of Xiamen University. The petition also asked the government to respect the provisions of the Chinese constitution (section 35) that guarantee individuals the right of free speech and free assembly.

About 120 participants (but none from China, or with relatives in China) from 22 countries signed the petition, which was then sent to the Chinese authorities. In addition, many of the signers were planning to send copies of the petition to their governments, asking them to intervene directly with the Chinese government on behalf of the three prisoners.

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Write to Reply, Briefly

Jack Sandweiss, the editor of *Physical Review Letters*, insists that an author's reply to criticism be subject to peer review, whereas Duncan Bryant, Robert Bingham, and Umberto de Angeles press for an author's "guaranteed right of reply" (October 1995, page 106). Given that scientific issues are not decided by majority vote and that peer reviewers (and editors) can turn out to be wrong, I suggest a constructive compromise: Allow the criticized author to publish a non-peer-reviewed and very brief (up to 100 words) reply in the same journal.

In some cases such a reply may not address the issue in full, but at least it will establish that the author has a criticism to put forward. It also will give the author a chance to offer to provide readers directly with an extended version of the reply.

Such a compromise would not severely burden a journal's format, but could prove to be useful to the scientific community.

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