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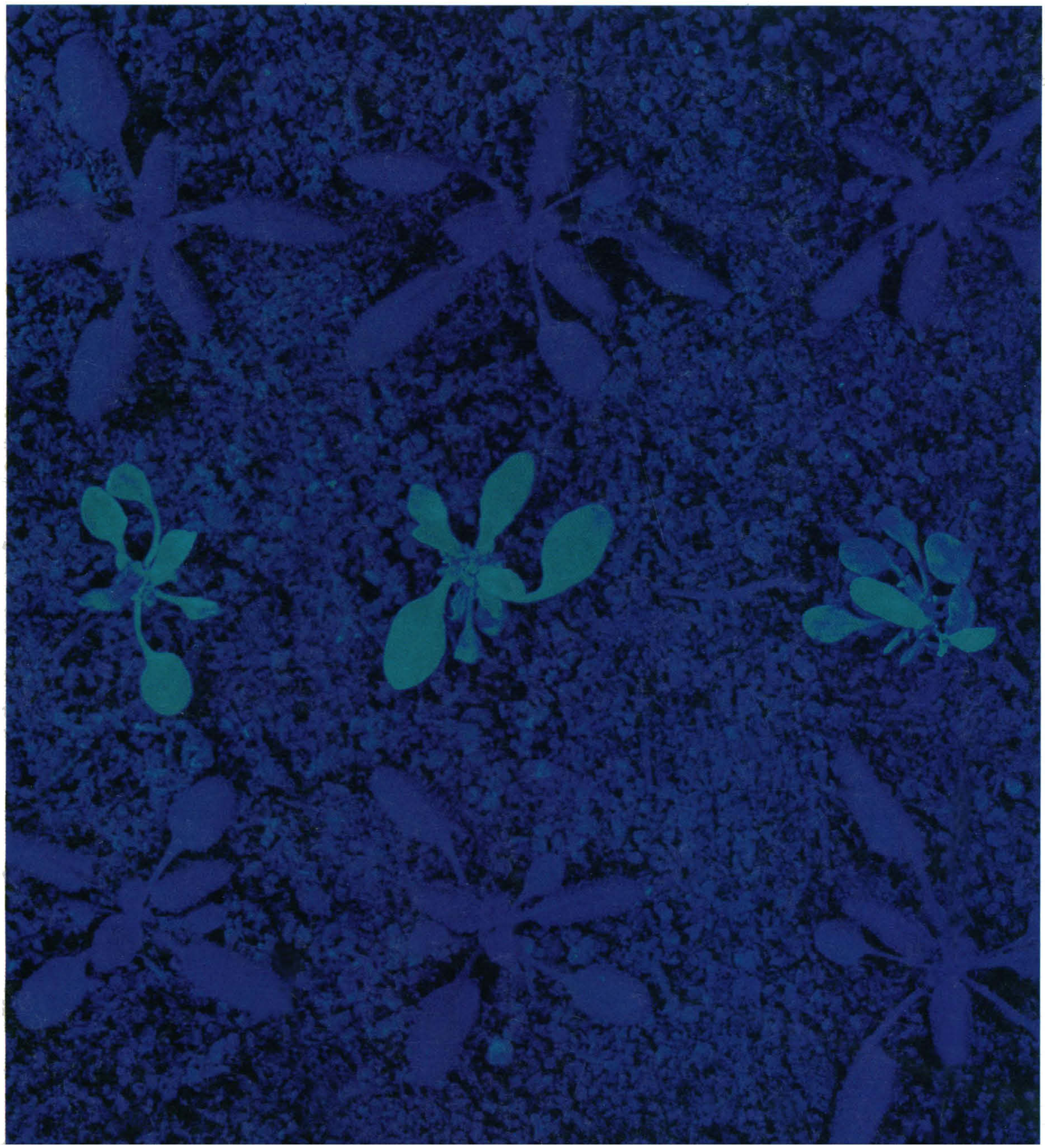

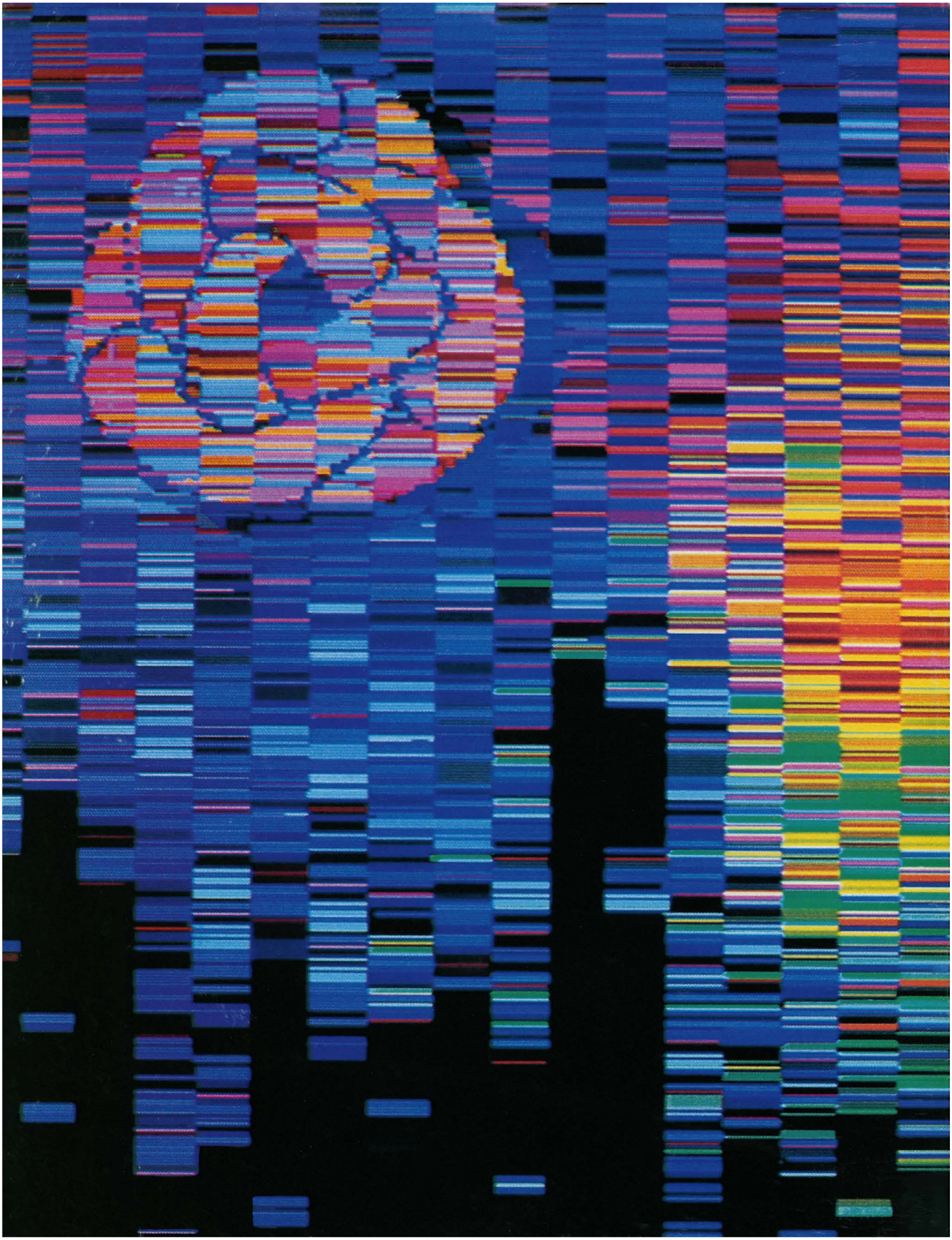

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Book Reviews

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This Week in SCIENCE

Industrial relations

How adequate is half-century-old legislation at addressing contemporary labor-management issues (page 287)? Kochan profiles industrial relations in the United States—the changing composition of the work force, the eroding trust between labor and management, and the shifting emphasis to high technology industries. The procedures established by the New Deal legislation of the 1930s have been adequate or adaptable for some negotiations involving disputes between management and blue-collar workers represented by collective bargaining agents—the groups for which it was originally intended. However, with less than 20% of nonfarm workers in the United States now represented by unions (down from a high of 35%), new guidelines are needed for most labor-management relations. By the 21st century the mismatch may be very high between the majority of new industries that will be hiring and the level of education and training of the available work force, new entrants to which will be heavily minorities, women, and immigrants. The focus of future policies must be shifted from technologic achievements to the development of human resources.

Green light for greenhouse?

THE global climate reflects the balance struck between incoming energy from the sun, chemical species in the troposphere and stratosphere, and conditions on the earth (page 293). A current concern is that a change in the earth's climate is being induced by human activities through the introduction into the atmosphere of "greenhouse" gases—carbon dioxide, methane, ozone, nitrous oxide, and a variety of synthetic chemicals such as chlorofluorocarbons. These gases absorb the terrestrial infrared radiation emitted from the warm surface of the earth, trapping some within the atmosphere (the greenhouse effect). They disturb and provide more energy for driving the climate system; then, in order for the system to reequilibrate, the troposphere must grow warmer, the stratosphere cooler, and the globe must become warmer and wetter. In reviewing the models that predict and account for a greenhouse phenomenon and the signs which indicate that it is in fact occurring, Ramanathan points out how difficult it will be to verify a continuing "greenhouse" because natural climate fluctuations that accompany changing seasons, latitudinal differences, and long-term trends make it difficult to define what the "control" climate might be.

Plant metabolic defect illuminated

PLANTS unable to make their own tryptophan (one of the essential amino acids) have been identified through adaptation of a technique that is used for isolating tryptophan-requiring bacterial mutants (page 305). On selective media, the mutants grow better than do the wild-type organisms; thus, in plants, as in bacteria, amino acid mutants—which are powerful genetic tools—are now available. Last and Fink describe the features of one *Arabidopsis thaliana* plant: the plant grew poorly, had a bushy shape, small crinkled leaves, small infertile flowers at first but fertile flowers later, and a sweet smell. All the defects were attributable to a single genetic mutation. When the plant was illuminated with ultraviolet light, it fluoresced (cover); this glow, which lasted from germination to maturity, came from an intermediate in the tryptophan pathway that was accumulating in the plant. The tryptophan deficiency is of special interest because this amino acid is thought to be a precursor of auxins (hormones). In addition, tryptophan biosynthesis in plants can now be compared with that in bacteria and fungi. Techniques used for finding the tryptophan mutants may be applicable to searches for other plant mutations resulting in alterations in amino acid biosynthetic pathways.

Oral malaria vaccine

A vaccine has been developed against mouse malaria that can protect mice from a challenge infection with malaria parasites (page 336). Bacteria unrelated to the disease (*Salmonella typhimurium*) served as Trojan horse vectors; they were attenuated (alive but not pathogenic), genetically engineered to contain the malaria parasite's circumsporozoite antigen, and given orally to mice. Sadoff *et al.* hypothesize that the effectiveness of the vaccine might have been due to the proper presentation of the antigens to the host's immune system: if liver macrophages ingested the bacteria and displayed circumsporozoite antigens on their surfaces in the right context (in association with histocompatibility antigens), effective cellular immune responses might then be induced. The success of the animal vaccine suggests that it may be possible to develop oral vaccines for human malaria and for various diseases—leprosy, leishmaniasis, schistosomiasis, AIDS, and others—in which cellular immune responses appear to confer some protection.

Boredom: rectifiable monkey business

IF there is something interesting to look at, monkeys are more attentive and neurons involved in vision give a bigger response in a more refined fashion than if the stimulus is dull (page 338). Spitzer *et al.* report that this finer discrimination ability of monkeys is not dependent on the monkeys' general state of arousal but is related to the difficulty of the problem to be solved: the harder the visual task the better is the performance of the monkey and of its firing neurons. The visual system and other perceptual systems do not always work optimally, and the take-home message from these studies is that attention is better riveted when a challenging task is presented. This work may have implications for human perception and for how the learning and teaching processes might be improved.

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Academic-Industrial Interactions

The rationale and mechanisms for public support of research in the physical sciences, mathematics, and engineering are undergoing profound and probably irreversible change. Where once the federal government was essentially the sole source of research funds for universities, the states and industry are becoming significant factors. In an earlier day, the widely held view was that federal sponsorship of basic research would automatically lead to societal benefits, including innovative applications and industrial competitiveness. The belief was more or less valid for the United States at a time when this country was the world's unchallenged leader in technology.

This nation will encounter tough global industrial competition for the foreseeable future. In this circumstance, it is the states rather than the federal government that have been highly innovative. Today, there are 500 state and local high-tech programs in 45 states aimed at improving economic competitiveness.

The recession in 1981 brought hardship and 15% unemployment to the states of the Rust Belt such as Ohio. It was good politics in the Rust Belt to create programs that used state funds to create jobs, to support innovation by small companies, and to facilitate university-industrial collaboration. At least ten different types of programs have been devised, such as research parks, incubators, and provision of venture capital, but the major activities involve university research or industrial extension services. Appropriations are usually leveraged by contributions from industry that match or exceed those from the state. An exuberant report from Pennsylvania tells that in the interval from 1983 to 1987, more than 10,500 jobs were created or retained and that $76.6 million in state funds attracted more than $280 million in private investment. Virtually all the colleges and universities (public and private) of Pennsylvania are members of a partnership that interacts with 2500 firms. More than half are small enterprises that could not afford to maintain research activities on their own.

In Ohio several programs foster start-up companies. However, the major emphasis is on future-oriented major industrial-university interactions. At nine Edison Technology Centers, academic researchers work on industrial problems especially relevant to the state. Each center is built around the problems of a single set of technologies such as advanced manufacturing, polymer innovation, or welding engineering. Each center has a number of companies and academic institutions as members. More than 500 companies and every university in the state participate.

Activities in New Jersey appear to be unusually well conceived. A $90-million state bond issue provided funds for buildings and equipment. Management of the enterprise is vested in a commission on science and technology whose members include bipartisan legislators, university presidents, and highly competent scientists and engineers. Among the various programs being supported, major emphasis is on advanced technology centers, eight of which are in operation. Among the fields covered are advanced scientific computing, industrial ceramics, biotechnology and medicine, computer aids for industrial productivity, and plastics recycling. In the future, centers for photonics and surface modification may be established.

Texas has created what amounts to a science foundation that will support local basic and applied research. Eligible fields for basic research are mainly in the physical sciences and mathematics, but biological, behavioral, and social sciences are included. The biennial appropriation for basic research is $20 million. The corresponding funds for an Advanced Technology Program are $40 million. Among the fields to be supported are aerospace, biotechnology, manufacturing technology, materials science, and micro-electronics. Proposals will be reviewed by out-of-state scientists and engineers, but final authority resides in a 12-member board whose background is predominantly science and engineering.

The states have initiated many programs aimed at improving their ability to use science and technology. Similarities among the programs abound, but all differ in detail, whether in strategy, tactics, or management. It is too early to judge what will prove best, but indications are that initiatives have been largely successful and that the efforts are expanding.

—PHILIP H. ABELSON

Letters

NIH Drug Tests

Constance Holden's article, "NIH scientists balk at random drug tests" (News & Comment, 12 Feb., p. 724), contains a series of one- and two-word quotes, attributed to me, which are presented out of context and woven into the story so that they create an inappropriate, adversarial, and inflammatory sentiment which I neither voiced nor do I hold. I have always had great respect for my scientific colleagues at the National Institutes of Health, and I can certainly understand the feelings that have been generated on this issue. The two principal points I attempted to convey in the interview were (i) that the "scientific and technical" aspects of the federal drug program are well documented (*1*) and that concerned individuals should review these materials and understand the procedures and safeguards that have been provided, and (ii) that the President's Executive Order for a Drug-Free Federal Workforce (*2*) *requires* the heads of Executive departments to implement drug-testing programs and is not discretionary.

The problem of drug abuse in America and the "appropriate" way in which to deal with this problem is a complex and emotionally charged subject. My views on the issue are well documented (*3*) and support any substance abuse policy which manifests a basic philosophy of getting the substance-abusing employee into treatment and back on the job. The membership of the AAAS would be better served by accurate information, not rhetoric, to help employers, workers, and unions continue developing and refining ideas about these difficult issues.

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Response: I am sorry Walsh did not like the things I quoted, as I certainly respect him and his commitment to carry out the President's order. However, I believe I accurately conveyed the tone of the interview in which he sounded distinctly frustrated at scientists' opposition to the drug-screening program (he did not, for example, tell me he certainly understood the negative feelings that have been generated).—CONSTANCE HOLDEN

The Windscale Legacy

I should like to amplify one crucial interpretation stressed in David Dickson's excellent article about the importance of the release of the original official papers on the 1957 Windscale nuclear accident (News & Comment, 5 Feb., p. 556). I should also like to comment on the representation in the article of the polonium-210 release.

On the latter point, although the presence of polonium-210 is not mentioned in the Penny Report, released in sanitized form in November 1957, 1 month after the accident, it is mentioned in two papers published in 1958 by U.K. Atomic Energy Authority (UKAEA) staff scientists (*1*, *2*).

What is curious is the way in which mention is made. Dunster *et al.* (*2*, p. 300) state:

> In order to give an appreciation of the magnitude of the accident which occurred it is necessary to provide estimates of both the amount and

> nature of the radioactivity released. These estimates are based on the survey measurements made in the district together with sampling of the material found in the exhaust filters subsequent to the incident.
>
> The principal fission product released was iodine-131. Smaller quantities of other fission products such as caesium-137, strontium-89 and -90, ruthenium-103 and -106, zirconium-95, niobium-95 and cerium-144 together with polonium-210 were also released.

The reference to polonium reads as though it were an appended afterthought.

Dunster, then a UKAEA scientist, later became the director of the U.K. National Radiological Protection Board (NRPB) set up in 1970. It remains a mystery as to why the importance of polonium was not emphasized in the NRPB's own reevaluation of the 1957 accident, published 13 years later in their report (*2*) of February 1983.

Another important matter to stress is why the then British Prime Minister Harold MacMillan (later Lord Stockton) judged it crucial to gain the support of the U.S. Congress for the amendments to the 1954 U.S. Atomic Energy Act. Britain wanted access to U.S. pressurized water reactor propulsion technology. It also wanted a backup testing site in addition to Australia and the Christmas Islands for its own nuclear warheads and highly enriched uranium for military use. The resultant Anglo-American Mutual Defense Agreement (MDA) on Atomic Energy Matters (*4*) provided the basis for the 1962 Nassau Polaris agreement and the 1980 Trident agreement and permitted the export from Britain to the United States of at least 7000 kilograms of plutonium of civilian origin for use in U.S. Department of Energy weapons programs. The vast proportion of this was exported between 1964 and 1969 and constituted about 96% of the total plutonium production in civil Magnox reactors over the period.

Another recent release under the "30-year rule" shows that the UKAEA Chairman Edwin Plowden actually suggested in a meeting of the U.K. cabinet defense committee on 2 August 1957 that an assessment be made to judge "the extent to which nuclear weapons programmes could be accelerated by the diversion of the fissile material devoted to civil purposes."

A year later, in June 1958, the national British electricity utility, the Central Electricity Generating Board, agreed to a request by the Ministry of Defense to modify its civil Magnox reactors to provide for military plutonium production. This came after the 5-month-long amendment hearings (*5*) (from January through May 1958) in the U.S. congressional Joint Committee on Atomic Energy to ensure that the MDA be completed.

One long-term political fallout effect of this complex atomic diplomacy of 30 years ago is that the British government still refuses to publish plutonium production figures for its civil Magnox reactors. The legacy of military secrecy pervades to the present, creating continued suspicion.

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The Militarization of Physics

Historical Studies in the Physical Sciences, vol. 8, part 1. Papers resulting from a symposium on cooperative research in government and industry organized by Robert Seidel. University of California Press, Berkeley, 1987. vi, 229 pp., illus. Paper, $9.50; to institutions, $11.50.

American physicists, when asked whether they have ever received support from the military or its nuclear weaponeer—the Atomic Energy Commission and successor agencies—will usually respond with a "yes." But when asked whether such funding has shaped their physics, they will typically respond with some kind of "no." For years, most historians of science took this conventional wisdom about the physicists' independence from their military patrons at face value. Recently, however, a growing number of historians have been taking a fresh look at the whole issue. A few have come to the position that, as Harvey Brooks succinctly put it at the 20th anniversary of the Office of Naval Research in 1966, "Even in a system of complete scientific freedom the cumulative effect of the small biases placed in the mind of the investigator by his sponsor can have a profound effect on the direction and impact of his research" (quoted on p. 214 of the present volume).

Drawn from meetings held in 1985 and 1986, this set of six papers provides an excellent introduction to recent historical work on the military-physics relationship in postwar America. Stuart Leslie analyzes how Stanford's electronic engineers and physicists used military funding to propel their university into academia's front ranks. David DeVorkin examines how a semiofficial panel promoted high-altitude research from rockets by serving as a liaison between the military and a medley of physicists. Allan Needell shows that two university-based physicists—John Simpson and James Van Allen—were nicely positioned for jumping into space research after Sputnik, thanks to prior military patronage of their work in cosmic-ray and upper-atmosphere physics. Robert Seidel describes how physicists, working at the behest of numerous military patrons, pursued the elusive goal of high-power lasers during the 1960s and 1970s. Lillian Hoddeson, in a study that at first sight does not exemplify this volume's theme (but see below), tells how physicists at Fermilab succeeded in doubling their accelerator's energy. And in a final paper that is a tour de force, Paul Forman not only assesses the military's role in the early development of quantum electronics but also develops a comprehensive framework for thinking about the relationship between military patronage and physical research in America since 1940.

After World War II, Forman reminds us, the armed forces and the AEC rapidly replaced foundations as the chief patrons of physical research in the United States. Abundant evidence indicates that the military's largess was not motivated by a disinterested enthusiasm for the advancement of physical knowledge. Many officers and bureaucrats, DeVorkin and Forman show, came away from the war convinced that the services should use research patronage as a means of maintaining contact with the physicists. They anticipated that such support would assure cooperation whenever it was needed. Although important, the desire for a cooperative clientele soon became, in Forman's view, a secondary motivation for patronage. With ONR in the lead, the military patrons began making a concerted effort to foster the development and refinement of techniques, including apparatus, having immediate or long-range relevance to service missions—atomic clocks, for example. It was this quest for techniques, Forman insists, that emerged as the military's primary motivation for supporting physical research.

If the Department of Defense and AEC wanted cooperation and techniques from the physicists, what did the physicists want from the military and its nuclear provisioner? First and foremost, as all the papers show, they wanted the wherewithal to pursue ever larger and more costly investigations. In addition some wanted, as Leslie's fine study of developments at Stanford demonstrates, resources with which to maintain or improve their institutions' standing within the academic pecking order. However, funds were not all the physicists wanted. As Forman forcefully argues and DeVorkin and Needell illustrate, they also wanted the feeling that they had scientific freedom—that they, not their military patrons, were setting research and institutional priorities. Accordingly, they had little patience for detailed relevance statements and heavy-handed security regulations.

Despite the physicists' desire for and sense of independence, DOD and AEC/ERDA/DOE patronage has, Forman maintains, deeply influenced physics in postwar America. It transformed the quality of life of