state & society

Corporate Associates meeting stresses industrial physics

For the first time, the annual meeting of the Corporate Associates of the American Institute of Physics took place at an industrial research laboratory, that of the General Motors Corporation in Warren, Michigan. So it was especially appropriate that the theme of the meeting, held 8–9 October, was "Physics in Industry." The meeting brought together Corporate Associates representatives, physics-department chairmen, government officials and society officers. In addition to talks on today's industrial research, applications of physics, and frontier areas of physics, the 150 participants were given a tour of the General Motors Research Laboratories and participated in informal discussion groups.

N. Bruce Hannay (Bell Laboratories) discussed innovation in industry. He noted many signs of declining industrial R&D, observing that 85% of industry-funded R&D is in just seven industries: electrical equipment, chemicals and allied products, electrical machinery (including computers), motor vehicles, aircraft and missiles, petroleum, and instruments. Only 29 companies, each spending $100 million or more on R&D in 1975, accounted for almost half the industrial total.

Basic research in industry amounts to about $600 million, he said, which represents a decline of over 30% in real spending over the last ten years. Furthermore, the last few years have seen a significant reduction of basic research in a number of companies.

Hannay's central concern is whether the capacity for fundamental innovation, which in the past has produced the transistor, synthetic fibers, the digital computer, and so on, is being adequately sustained. Much of today's innovation is,

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Coffee break at the American Institute of Physics Corporate Associates meeting, which was held at the General Motors Research Laboratories in Warren, Michigan, 8–9 October.

Bureaucracy stifles US research community, NSB says

Basic research is in trouble—such appears to be the consensus of several hundred scientific and administrative leaders of the US research community, according to statements solicited by the National Science Board. The problems and potential solutions brought up by these researchers range from the immediate and practical to the long-range and esoteric, but most respondents to the NSB survey agree that present policies, institutional structures and objectives endanger the future of American research. In particular, many perceive excessive, all-pervasive supervision and regulation of the research enterprise as a grave threat.

The NSB obtained the personal, subjective impressions of more than 600 leaders of the American research effort in order to produce *Science at the Bicentennial: A Report from the Research Community*. This latest report complements the earlier Science-Board survey *Science Indicators 1974*, a predominantly statistical examination of the state of US research in science and technology (see PHYSICS TODAY, May 1976, page 93). Both reports indicate concern about the course of basic research, but the opinion survey reveals a degree of anxiety—especially over the public's attitude toward science and scientists—not indicated in the objective study.

Causes for concern. The NSB asked top administrators, research heads and department chairmen in the nation's leading research universities, governmental and independent laboratories and industries to name the most important problems affecting US research. The Board further requested that comments deal with "circumstances in the institutional, managerial or policy environment" influencing "the productivity of working scientists and engineers," rather than financial complaints. The *allocation* of funds in a tight economy, however, remains a matter of concern. The dwindling of resources spent on basic research in industry, for example, is cited by a number of industrial research leaders. "Research and development is a highly visible overhead expenditure," according to Thomas R. Miller (Vice-President,

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Union Carbide Corp), "and is usually high on the list for reductions when profits are too low, as they are for capital-formation purposes. Generally, basic research is cut back the most." Some industrial-research leaders suggest preferential tax treatment for R&D and mechanisms to ensure the continuity of basic-research funding as needed countermeasures.

But some, like George L. Pake (Vice-President, Xerox Corp), believe that "basic science is what universities do best." The academic research leaders, too, worry over a possible waning of basic-research efforts. H. S. Gutowsky (Director, School of Chemical Sciences, University of Illinois) warns that "the amount of basic research being accomplished will be reduced in proportion to falling graduate enrollments unless other components of the enterprise are increased concurrently," and Charles E. Hathaway (Head, Department of Physics, Kansas State University at Manhattan) says an "aging static faculty" may prove the most detrimental problem in the long range. Daniel D. Perlmutter (Chairman, Department of Chemical and Biochemical Engineering, University of Pennsylvania) suggests that graduate-student support should not be tied to faculty members' research grants: "Students ought to be supported because of a commitment to science and engineering education, not dependent on the fund-raising skill of a particular adviser."

Another reason given for the perceived decline in basic science's fortunes is the quality of the researchers. For example, Hans Mark (Director, Ames Research Center, NASA) sees a drift of the most promising workers away from basic fields. The major issue is not money, according to Mark, but rather it is the need "once again to convince our very *best* young people to pursue careers in basic scientific research."

Red tape. Surely the most universally recognized problem among those consulted was the superabundance of rules, regulations and sundry requirements—most of them governmental in origin—that seek to guide and channel research but may end up stifling it. Perhaps the most vehement was Harold Agnew (Director, Los Alamos Scientific Laboratory): "Bureaucracy will eradicate creative endeavor and innovation in the long run. Bureaucracy eventually loses sight of what the real objective was and becomes only concerned in its own management and control functions. Unless this trend toward centralization is somehow reversed I predict the US will rapidly lose its lead in science and technology."

Industrial research leaders told the NSB that multiplying regulatory actions could make basic, long-term research efforts too costly for all but the largest companies. Though part of the decline in industrial support for such research, according to Lee A. Iacocca (President, Ford Motor Co), is due to a depressed economy, "another serious cause is the need for industry to commit a substantial and increasing proportion of its research resources in response to regulatory demands and goals established by the Congress and a number of Federal agencies."

At the universities, excessive supervision may be proving counterproductive, in the view of some academic research leaders. Dale R. Corson (President, Cornell University) has misgivings about a governmental trend toward the targeting of sponsored research on "short-range, high-payoff objectives." Such specifically targeted research, he says, is not well suited to university research. Allan M. Cormack (Chairman, Physics Department, Tufts University) laments the erosion of the "traditional view" of the university's function; assorted legislators and bureaucrats, he says, have "demanded that we explicitly demonstrate in our work innovations, relevance, concern for interdisciplinary matters and so on" with the result that "we have lost much of what is most valuable in solving any problem—time to think."

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Public confidence. Respondents from all sectors of the US research enterprise express doubts about society's attitude toward scientific and technological advances. Robert G. Sachs (Director, Argonne National Laboratory) refers to "an unfortunate erosion of the intellectual climate in this country. . ." of which a negative attitude toward basic research is just one aspect. Decreasing public confidence in research scientists, a distrust of technological advancements and misunderstanding of the role and function of basic research are among the problems cited by research heads. Some feel the need of a national education program to put science and its practitioners in a more favorable light with the public.

How far scientists may actually have fallen in public esteem is not easily determined, beyond these subjective impressions. The NSB report includes a brief recapitulation of what public surveys have revealed about national confidence in science and technology. In summary, the data appear to indicate that there has been a drop in general regard for public institutions since the middle 1960's, and that scientists have shared in the drop. But compared to other professionals, they have held their own or even gained. Thus some of the concern shown by the research leaders would appear from the report to be unwarranted. But if there is cause for worry, perhaps researchers themselves are a factor; David Langmuir (TRW Systems Group, Santa Monica, Calif.) says there has been a shift of motivations for researchers in the past half-century, away from "love and fame," toward wealth and power. This, he thinks, "has been more obvious to people outside the ranks of scientists than to those within."

Science at the Bicentennial (Stock No. 038-000-00280-5) is available for $2.95 from the US Government Printing Office, Washington, D.C. 20402. —FCB

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instead, incremental, and some of it amounts to little more than product differentiation. Industrial research with the potential for fundamental innovation has been declining, he feels.

He catalogued some of the forces affecting innovation: Most important are financial factors, which include the increased cost of launching new ventures and the very high rate of return required

for an innovation to pay for itself, given the discouraging financial climate of today. Industry sometimes fears that competitors will be in just as good a position as the innovator to take advantage of a new discovery. Government has had both a positive and a negative impact on innovation. Hannay believes that "Changing government policies and regulations create a climate of uncertainty, and this discourages R&D for which the payoff is in the long-term." Government-sponsored research has been effective where it itself is the customer (space, defense) and in basic science; the Federal government is now attempting to affect civilian technology through direct support of applied science, but Hannay feels this effort has largely been ineffective. He believes that Federal actions should be directed toward the encouragement of private funding of R&D and of innovation.

John S. Toll (State University of New York at Stony Brook), speaking on the relationship between university and industrial research, noted that the role of physics is broadening. Over half the industrial employment is in industries growing out of discoveries made by physicists within the 20th century. Highlights have included the development of the transistor, the maser and the laser. Superconductivity has most of its applications in the future, and it will be a challenge to develop high-temperature superconductors. Thermonuclear fusion and solar power will require new physics developments, a task that requires cooperative work between industry and universities.

Cooperation between industry and academia has been maintained over the years through common membership in the scientific community, publication in scientific journals, circulation of preprints, meetings, and research collaborations. This relationship has developed in three phases. The first was simply through common participation in the scientific community. The second was the introduction of the Federal government as the principal supporter of basic physics research. The third phase, which Toll feels we may now be entering, is one in which direct interaction of universities and industries becomes much more important.

Faculties are beginning to realize that because of the leveling off of university and government jobs, major opportunities for physics graduates in the future will be in industry. The trend is for student participation in summer programs, more collaborative research programs, new ways to develop and utilize patents, and a return to more traditional topics such as continuum physics and turbulence. However, the "glamour fields" are still important. For example, an experimental particle physicist might be an expert in pattern recognition, high-speed detection, and computer techniques—all topics that have great potential in industry.

Paul Chenea (General Motors), who discussed management of industrial R&D, noted that the General Motors Research Laboratories are working in fields such as atmospheric physics and chemistry, biomedicine, socioeconomic modeling, and even the psychology of noise. Staff recruiting, he feels, is probably management's most important duty. "We work very hard at communicating Corporate goals downward and letting the ideas for projects flow upward from the staff . . . The trick is to get them working on that subset of exciting things that are of great importance to the Corporation."

"We in the auto industry are up to our windshield wipers in regulations," he said. Meeting safety, emission and fuel-economy standards costs almost half of the General Motors R&D budget. Some of this money would be spent anyway because the company wants its vehicles to be as safe as possible and avoid harming health or environment. But some of the regulation-related research, Chenea argues, is unnecessary—that which they do "to defend ourselves against regulations based on faulty or incomplete data." As an example, he cited the sulfate question, which arose when catalytic converters were introduced on American cars in 1975. The Environmental Protection Agency began discussing establishment of sulfate standards for 1979-model cars. When the GM Labs did a massive experiment simulating rush-hour traffic, they concluded the EPA estimates of potential sulfate buildup at ground levels along busy freeways were up to 20 times too high. Because of this result and other data, he noted, EPA has announced it will not now propose a sulfate-emission standard.

Robert Stratton (Texas Instruments), speaking on the future challenge of science in education, noted that since 1930 the school population doubled while the number of employees in education quadrupled. During the last 20 years, he feels there has been a marked decrease in educational productivity. If one assumes a teacher-centered culture, one would argue that productivity cannot rise because the adult/student ratio must remain low. However, Stratton notes a trend toward student-centered learning, which allows a constantly increasing productivity. In programs being developed at the University of Pittsburgh and the University of Wisconsin, for example, the emphasis is on self-paced, self-directed instruction.

Such an approach can also be used to advantage in scientific research, where graduate students learn to become independent researchers. But excellent R&D at the teaching institution is required.

Communication in science appears to be particularly lacking between Washington and academia, he believes. University officials wonder how they can convince Congress that "fundamental research is not a discretionary societal luxury but an essential prerequisite to technological growth." A long-term solution is to revamp our educational system in law, politics and science to provide insight into the limits and powers of each procedure.

To improve communication between university and industrial groups, Stratton suggests taking a cue from the industrial techniques already developed to facilitate communication among scientific and technical people in many companies.

John Wheeler (University of Texas, Austin), speaking at the banquet, made some proposals to take into account the human factor in physics in industry. His first proposal was that management ought to spend more time with its research people, just like the Arabian king who had to be told that he must spend time with occupants of his harem if he expected to have any babies. "If a research scout never sees a general . . . never gets a chance to feed in some ideas . . . , then nothing much happens . . . Wire up your decision makers with the research people in your organization. You'll produce many healthy, happy babies."

A second proposal: "Let physics fill every ecological niche." Take a cue from Charles Darwin, who said, "Of the varieties descended from any one species, the most divergent, which differ most from their parents and each other in all respects, in the long run prevail, for they will be enabled to fill more and more widely different plaees in the polity of Nature."

Wheeler's third proposal was: "Teach to measure better." Take advantage of the latest physics-based measurement techniques. And have the laboratory people learn these techniques by teaching themselves.

The final proposal was to look at the larger implications of the problem. Wheeler cited the dangers inherent in the breeder reactor, of which he was an ardent proponent. He feels we must take a hard look at the dangers of proliferation with the breeder.

Other speakers included Alec N. Broers (IBM) on microstructure fabrication, Hans Frauenfelder (University of Illinois) on the physics of heme proteins, Nick Holonyak (University of Illinois) on solid-state light emitters, Alfred O. C. Nier (University of Minnesota) on physical measurements on Mars, Robert L. Hirsch (ERDA) on solar, geothermal and fusion energy, Charles K. Rhodes (Stanford Research Institute) on laser photochemistry, and Kip S. Thorne (California Institute of Technology) on gravitational waves.

At the banquet Jeremy Bernstein received (PHYSICS TODAY, September 1976, page 80) the AIP–US Steel Foundation Science-Writing Award in Physics and Astronomy, presented to him by AIP

director H. William Koch.

The five discussion groups were led by Robert G. Hirsch and Richard H. Tait (duPont), John K. Bragg (Singer) and Robert Adler (Zenith), Raymond Bowers (Cornell University), J. E. Goldman (Xerox) and Philip E. Seiden (IBM), Robert W. Keyes (IBM) and Lester Guttman (Journal of Applied Physics).

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in brief

The Moscow Seminar on Collective Phenomena began its 1976–77 series 12 September—these "Sunday Seminars" are held weekly and will continue through 12 June 1977. The sessions take place at Ulitsa Veshnyakovskaya, Dom 4, Korpus 2, Apt 5, Moscow, and any visitor to Moscow is welcome to attend and present a paper. Further information may be obtained from the Committee of Concerned Scientists, 9 East 40th Street, New York, N.Y. 10016.

The American Institute of Aeronautics and Astronautics has begun publication of a new bimonthly journal, *Journal of Energy*, in January 1977. Subscriptions are available from the AIAA Subscription Department, 1290 6th Avenue, New York, N.Y. 10019 at a cost of $6 per year for members and students, or $38 per year for non-members.

The Faculty Exchange Center, which helps to arrange college and university exchanges in the US and overseas where the language of instruction is English, is now preparing its roster for academic year 1976–77. Registration information may be obtained from the Center at Franklin and Marshall College, PO Box 1091, Lancaster, Penn. 17604.

The book series *Vistas in Astronomy*, edited by Arthur and Peter Beer, is now available as a review journal. Beginning with volume 19, the journal is published quarterly. Subscription price for 1977 is $56; inquiries may be addressed to Pergamon Press Ltd, Headington Hill Hall, Oxford OX3 OBW, England.

The Scientific Manpower Commission has published a study on the availability of women and minorities for professional positions. The 320-page report, *Professional Women and Minorities: A Manpower Data Resource Service*, brings together for the first time all available data on manpower at professional levels. Copies are available at $40.00 each and semi-annual supplements will be available at $20.00 per set. For information contact the Scientific Manpower Commission, 1776 Massachusetts Avenue, NW, Washington, DC 20036.

Applications are now open for 1977–78 American Vacuum Society scholarships in vacuum science and technology, vacuum metallurgy, surface physics and thin-film research. The scholarships carry a maximum grant of $4000 per year. Applications may be obtained from the AVS, 335 East 45th St., New York, N.Y. 10017 and completed forms must be returned by 31 March 1977.

Instrumentation for Environmental Monitoring (Lawrence Berkeley Laboratory Report LBL-1), a survey in five loose-leaf volumes, is available at a cost of $40 per volume from LBL Technical Information Department, University of California, Berkeley, Calif. 94720.

Wolfgang Priester, director of the Institute for Astrophysics and Space Research of Bonn University, West Germany, has been elected president of the Astronomische Gesellschaft, an international astronomical society. Founded in 1863, the society is composed largely of German-speaking astronomers from central Europe.

the physics community

OSA elects Williams as vice president

The Optical Society of America has elected Dudley Williams to the office of vice president. In this post, Williams will become president-elect in 1978 and president in 1979. The 1975 president-elect, Peter Franken (University of Arizona, Tucson), has succeeded Boris Stoicheff to the office of president, and Emil Wolf (University of Rochester) is this year's president-elect. All of these officers serve on the OSA board of directors.

Williams, who is Regents' Professor of Physics at the Kansas State University, earned his PhD in 1936 at the University of North Carolina, Chapel Hill. He was a faculty member of the University of Florida, 1936–41, and during World War II he became involved in microwave radar development at the MIT Radiation Laboratory. He was later associated with the Manhattan Project at Los Alamos, where he worked primarily on mass spectroscopy. Williams was a member of the Ohio State University physics department, 1946–63, and spent one year as the head of the department of physics at North Carolina State University before joining the faculty at Kansas State University

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where he holds his current position. His present research interest is infrared spectroscopy as applied to the study of planetary atmospheres.

OSA members have also elected three directors-at-large, who will serve two-year terms. They are Gerald B. Brandt (Westinghouse Research Laboratories), Arthur H. Guenther (Air Force Weapons Laboratory) and Lorrin A. Riggs (Brown University).

New AIP directory expands its coverage

The *1976–77 Directory of Physics and Astronomy Staff Members*, which includes listings of 22 000 staff members at some 2400 institutions, is now available. In addition to its coverage of North American colleges and universities, the directory now includes government laboratories and a complete listing of Federally funded research and development centers.

Appendices in the directory show the following: institutions by type of physics or astronomy program offered, number of faculty by rank, research areas in doctoral programs and areas of concentration in master's programs. Manpower data are also presented concerning the US institutions that granted the largest number of physics doctorates and baccalaureates in 1974–75.

The 295-page directory may be ordered at a cost of $17.50 per copy (prepaid) from AIP Marketing Services, 335 East 45th Street, New York, N.Y. 10017. □