Australia: Education and Science Are Looking Up "Down Under"

As Australia has changed from a country with main economic dependence on primary products such as wheat and wool to an increasingly urbanized and industrialized country, the proper policy toward education and scientific research has become a matter of public concern and partisan controversy. In response to public pressure, a Cabinet department of education and science was created in 1966. The first Minister was J. G. Gorton, who, after the death of Harold Holt late last year, became Prime Minister. In late February, J. M. Fraser became the new Minister for Education and Science and R. Garrod, now in the Australian Embassy in Washington, was named to head the science part of the department.

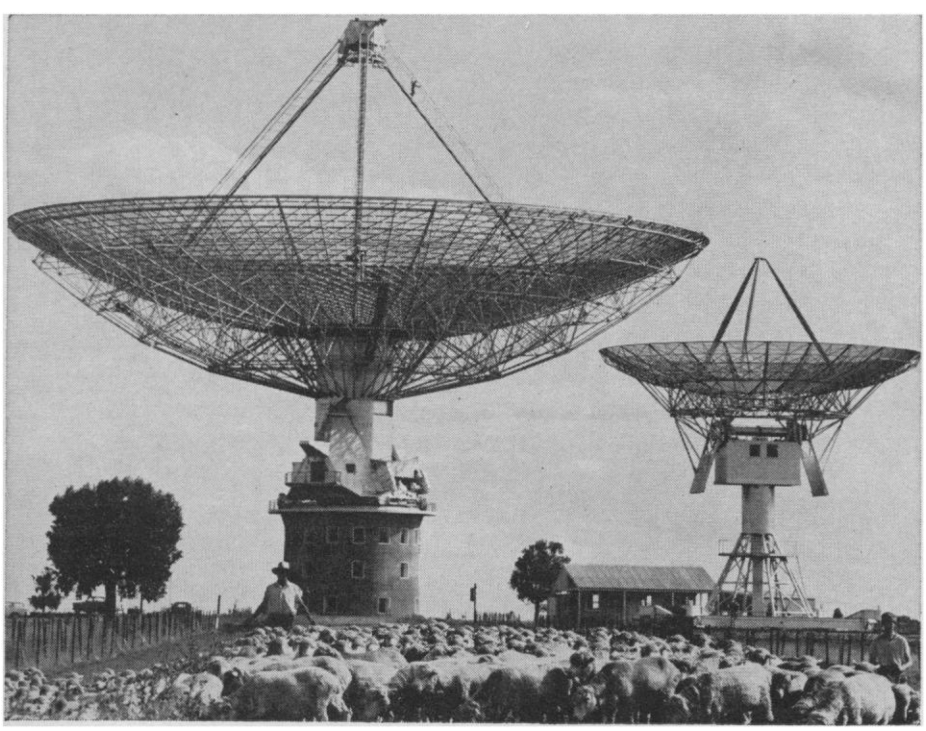
It should be remembered that Australia has only about 12 million people and does not yet have the funds for a scientific program of nearly the size, for instance, of Britain's. There seem to be no precise figures on the Australian outlay for research and development. One estimate is that Australia spends about $225 million (U.S.) on R & D; a government science administrator estimates that Australia spends about 0.75 percent of its gross national product on R & D, a figure which he compares to an expenditure of more than 2 percent by Britain and one of more than 3 percent by the United States.

Although the Australian R&D budget is not swollen by great expenditures on military and space research, Australia has evolved a respectable civilian-oriented scientific effort. As radio-physicist E. G. Bowen commented in an interview when this reporter visited Australia recently, "I make the point very strongly when I'm abroad; we have a damn good research system in Australia."

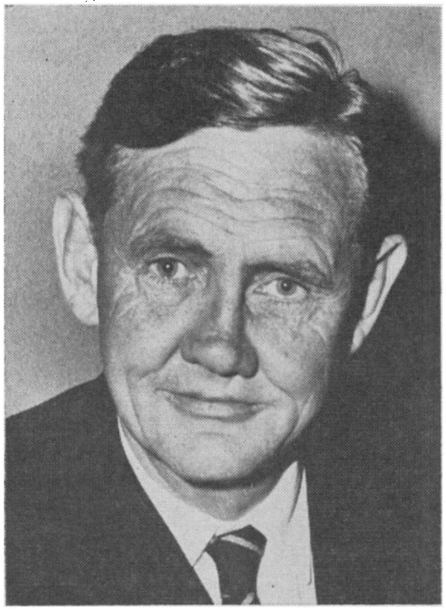
Like the research establishments in other countries, that of Australia has evolved in its own unusual manner. Most Australian scientific research is financed by government, especially the federal government. This government-sponsored research is primarily conducted in government agencies, rather than in universities or by industry. There is relatively little industry-subsidized research. "Industry doesn't go into research nearly as much as it should," Gorton commented in an interview with *Science*.

There are several reasons for the failure of Australian industry to develop substantial research facilities. One explanation is the size of Australian industry. L. W. Weickhardt, an industrial research director in Melbourne, who says that 18 percent of Australian research money is spent by industry, argues that it is impossible to have a worthwhile research group for under $200,000 annually and that there are relatively few industries in Australia which could afford that amount. Another research administrator says that only 20 to 25 firms are large enough to sustain significant research efforts. Gorton and others point out that many Australian firms are owned by the British and the Americans and that these foreign-owned companies tend to concentrate their research in the home country. "Industrial research has not developed," Bowen, director of CSIRO's division of radio physics in Sydney, comments, "and it jolly well ought to." The federal government has recently begun to make small grants to encourage industrial research.

The central and most publicized research body in Australia is the government-sponsored CSIRO—the Commonwealth Scientific and Industrial Research Organization. CSIRO has a staff of some 5000 (including 1700 graduate scientists), distributed among laboratories throughout Australia. The annual budget, which is now about $52 million (U.S.), has tripled in the last decade. About three-quarters of the budget is directly supplied by the Commonwealth government; much of the rest comes from the Wool Research Trust Fund, which was established by the wool industry. In an interview with *Science*, Sir Frederick White, chairman of the CSIRO Executive, explained the functions of his organization in a U.S. context: "CSIRO is a mixture of the regional labs of the Department of Agriculture, the Bureau of Standards, the labs of the Commerce Department, plus the Bureau of Mines."



The 210-foot steerable parabolic radio telescope and (right) the 60-foot satellite telescope, which are located north of Parkes in the Goobang Valley in southeastern Australia. The telescopes are operated by CSIRO, the government research agency.



J. G. Gorton, now Prime Minister of Australia, formerly Minister for Science and Education: "Our endeavors in applied science and pure science grow. They will continue to grow; that is the only way to maintain and improve our standard of living."

CSIRO had its beginnings during World War I, when Britain founded its Department of Scientific and Industrial Research. (Other countries, in addition to Australia, which established such departments were Canada, New Zealand, and South Africa.) CSIRO began operating on a significant scale in the late 1920's. In the late 1940's it underwent a substantial reorganization in which it was divested of all military research. It now does only unclassified research.

CSIRO enjoys wide backing. Gorton's appreciation is typical: "CSIRO is a very popular organization. They've been damn good and have had good public relations." In its first decades, CSIRO was primarily engaged in research in agriculture and biology. During this period it was able to score some successes which helped insure popular support. The organization helped control the rapid spread of the prickly pear and, through its pasture-improvement research, helped double the high-quality pasture available in Australia. CSIRO's work on myxomatosis helped reduce the number of rabbits by more than 80 percent after the disease was introduced into the Australian rabbit population in 1951.

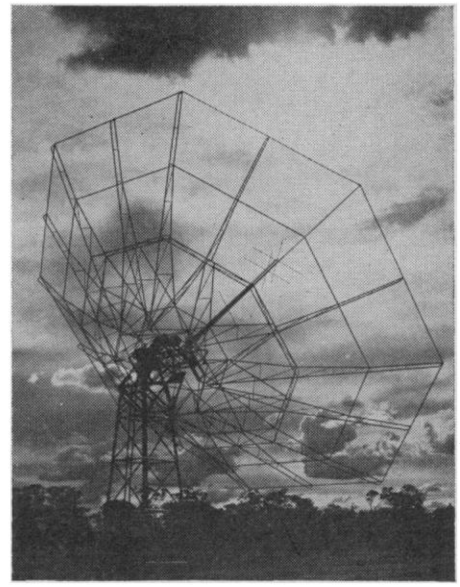
One of the explanations given for CSIRO's success is the organization's autonomous nature, despite its heavy reliance on government financing. CSIRO was created by act of Parliament, and until recently the organization reported directly to the Prime Minister. It now reports to the Minister for Science and Education, but it still seems to retain near-autonomy. CSIRO has been able to set its own employee and salary regulations and thus is free of the stultifying effect of governmental rules. CSIRO has been a salary leader for Australian science and has attracted many top-flight scientists from abroad, especially from Britain.

As might be expected, much of CSIRO's research is prompted by the unusual Australian environment. Well over half of Australia is arid, and CSIRO is putting increasing emphasis on arid-lands research, as well as on cloud seeding, meteorology, and the study of air circulation in the Southern Hemisphere. It continues to do extensive research on wool, on tropical pasture, and on the diseases of livestock. In the physical sciences, CSIRO has achieved world attention for its work in radio astronomy; it has also been active in solid state physics, in atomic absorption spectroscopy, and in mineral chemistry. CSIRO has stayed away from research in the social sciences.

CSIRO has enjoyed fairly good relations with Australian higher education and has laboratories situated at several universities. Relations have improved recently with the creation of the Australian Research Grants Commission in 1965, which now subsidizes university research at more than $3 million annually. Before the existence of the Commission, some university scientists were angered by what they regarded as CSIRO's monopolistic claim on federal research funds.

In the last few years Australian universities have grown greatly in size and number. In the last decade the enrollment at universities has almost tripled (it is now more than 95,000). Much of the expansion came about during the premiership of Sir Robert Menzies, and at several of the universities there is a building named for the former Prime Minister.

Until the 1950's, Australia had to import its Ph.D.'s from abroad. The first Australian Ph.D. degree was awarded by the University of Melbourne in 1948. As of a couple of years ago, Australian universities were reported to be awarding about 230 Ph.D.'s annually, two-thirds of which were in science and applied science. Recently, Australian universities have been able to fill an increasing number of staff positions from the ranks of their own Ph.D.'s.



One of the 96 radio aerials at the new CSIRO Culgoora Solar Observatory on a site halfway between Narrabri and Wee Waa in southeastern Australia. The aerials, each 45 feet across, are set 100 yards apart around the 6-mile perimeter of a circle. The radio heliograph was conceived and designed by J. P. Wild to fulfill the need for practically instantaneous and continuous pictures of the radio sun.

Attitudes of Australian faculty members toward research seem comparable to faculty attitudes in the United States. Sir Philip Baxter, vice-chancellor of the University of New South Wales in Sydney, commented in an interview that "the general attitude of faculty members is to do research and as little teaching as possible. Our general compromise is to have them do half teaching and half research." Unlike other Australian universities, Baxter said, his newly built university is on the M.I.T. model, with engineering as the largest faculty. Another unusual institution is the Australian National University at Canberra, which was started after World War II as a research and postgraduate institution, somewhat along the lines of Johns Hopkins University in Baltimore.

One answer to the problem of scarce university research funds was the creation of the Science Foundation for Physics, within the University of Sydney, by Harry Messel, an enterprising physicist who came originally from Canada. Messel has had great success in persuading Australian companies and foreign sources such as the U.S. Air Force and the National Science Foundation to subsidize Australian research. An astronomy center has been created which is operated jointly by Cornell University and the University of Sydney. Personnel and staff are interchangeable in this project, in which are associated, among other activities, the Mills Cross project in Australia and Cornell's large radio-telescope facility in Arecibo, Puerto Rico.

Much of the money being spent now on Australian education is being spent outside the universities. For instance, Gorton says every school in Australia will have a science laboratory within 3 or 4 years. The Australian government is now putting special emphasis on building up the nonuniversity side of the "tertiary education" system—those institutions, including technical colleges, which lie beyond secondary school level but whose admission standards are less demanding than those of the universities.

Australian scientists say they have little trouble in obtaining funds for continuing research projects. "Our funding is adequate, we're very well looked after," radio-physicist Bowen comments. "But we're badly off for big capital expenditure. Our Treasury people can't understand a million dollars in one hit. It's one hell of a job to get started. We've been entirely dependent on U.S. benevolence." Bowen said there may be signs of a change since the Australian government has agreed to match a $5-million contribution from the United

Big Science: Tight Budgets Pinch Some Major Facilities

Stringency in U.S. government budgets in the past 2 years has put a number of expensive national research facilities on short hours, but has not halted some important new projects that had been funded previously or that are relatively low in cost.

A case in point is the Cambridge Electron Accelerator (CEA), run by Harvard and M.I.T. with about $3.5 million a year in operating funds from the Atomic Energy Commission. Dedicated in 1962, the $20-million machine has operated at times around the clock—that is, for 21 shifts of 8 hours each week, including 14 shifts for experiments, four for maintenance, and the rest for improvements. Since late 1966, however, the usual number of weekly shifts for experiments has been ten, and the staff has been decreased by about 30 from its maximum of 215.

However, these cuts have not prevented the CEA staff from altering the synchrotron so that it can store large numbers of "pulses" of electrons going in one direction and positrons going in the opposite direction and then send them crashing through each other for periods up to an hour. Full-scale clashing-beam work, for which the CEA machine will serve as its own "storage ring," is expected to begin late in 1969. These experiments will be a poor man's version of much more ambitious projects proposed but not yet approved for the Stanford 2-mile accelerator (SLAC) and the CEA-type synchrotron in Hamburg, Germany.

Most of the equipment for the electron-positron storage ring project was financed from regular CEA equipment funds. One major item, a positron source costing $650,000, is being bought with fiscal-year 1968 money.

SLAC is facing similar problems. Although about half of the AEC's fiscal-1968 budget increase for high-energy accelerators throughout the country went to SLAC, the machine has been able to operate an average of only 11 to 12 shifts per week, even though SLAC's staff of 1200 includes enough people to operate the machine 15 or 16 shifts a week.

Even with a $20-million operating budget, SLAC has lacked money for needed extra electric power and for replacement of worn-out klystron tubes. SLAC hopes to get enough money to operate about 15 shifts in the coming budget year. Although such SLAC projects as an electron-positron storage ring for clashing-beam experiments will be delayed some years by tight budgets, a large liquid hydrogen bubble chamber has been moved to SLAC from Berkeley, mainly for experiments by visiting physicists rather than SLAC staff members.

Another short-time facility is the 120-foot (36-meter) radio telescope called Haystack operated by Lincoln Laboratories near Groton, Massachusetts. Haystack has been hit by a now-common problem, a sharp cutback in Defense Department funds for basic research. For lack of funds, the hours of operation have been shortened for radar work on such problems as the rotation of Venus and Mercury or the reflectivity of materials in the lunar crater Tycho. When the telescope is used for radio astronomy, a smaller crew is needed and Haystack can be operated around the clock if need be.

Like radio astronomers in many other places, the civilian users of Haystack are looking for non-Defense Department sources of support for time on the telescope.

One potential source is the National Science Foundation. But NSF is faced with requests to pick up about $1 million a year for astronomy at Arecibo, Puerto Rico, now paid for by Defense funds, and to take over the Office of Naval Research support of radio astronomy at California Institute of Technology and the universities of California, Michigan, and Illinois.

Despite such problems, workers at Haystack were able last fall to "readjust" the surface of the dish to allow its use at frequencies even higher than the 8000 megacycles (8 gigahertz) used for earlier research. This work was done at small cost and opened up important new regions for study by radar and radio-astronomy techniques.

A fourth major facility, Kitt Peak National Observatory, suffered a $1.2-million cut in its operating budget last fall, even though there was no slowdown in capital funding for a pair of 150-inch (4-meter) telescopes costing $10 million each. The two telescopes, one for the Kitt Peak Observatory and the other for the Cerro Tololo Inter-American Observatory in Chile, are expected to be operating fully in the early 1970's.

Kitt Peak's budget was slashed from $5.9 million to $4.7 million. The cut removed money for a new computer and money needed to start a research group on designing future telescopes, as well as $800,000 from Kitt Peak's rocket astronomy program. This means that Kitt Peak can schedule only one rocket flight out of a planned total of three or four—VICTOR K. MCELHENY

Kingdom to build a 150-inch optical telescope in Australia.

Several of CSIRO's large astronomy facilities have been built in part with U.S. grants. A unique radio heliograph was recently constructed partly with $630,000 from the Ford Foundation. The 210-foot steerable parabolic radio telescope at Parkes, commissioned in 1961, was built with more than $600,000 from the Carnegie Corporation of New York and from the Rockefeller Foundation and a like amount from the Australian government.

Through their close financial and personal connections, Australian scientists have become well informed about the structure of scientific research in the United States and Britain. Many first-rate Australian scientists emigrate to Britain, the United States, or Canada, often to return in later life. Despite this "brain drain" of top-flight people, sociologist S. Encel of the University of New South Wales points out, Australia imports 25 percent more Ph.D.'s than Australian universities produce. Many of these come from Britain. In disciplines in which Australia has special standing, such as radio astronomy, it reportedly has little trouble in recruiting scientists, even from the United States.

Some Australians who are close observers of scientific research occasionally maintain that Australia has no clear-cut set of priorities or articulated science policy. Encel, for example, has criticized the government for not having a science policy, for inadequate funding of the biological sciences, for lack of a policy on natural resources, and for failure to establish urban research centers. But some other Australians disagree. "I don't know what a science policy is," Gorton protested in an interview. "The critics want an overall advisory committee to allocate funds, but I don't see the need for any advisory body. These committees are only a group of individuals pushing the barrow for their own discipline."

With regard to the future, Australia plans to concentrate on those areas which, it feels, are of special economic use or in which it can make a special contribution. Gorton defines some of these areas: "radiophysics, optical astronomy, tropical study, and marine biology."

With an expanding economy and a well-educated population, Australia is a likely candidate to move, in coming decades, into the middle ranks of the scientific "powers" of the world. Already it has an excellent scientific base and popular and governmental respect for the value of research. Under present circumstances, it will be difficult for Australia to compete in full equality with the world's major nations in scientific research, but it is likely that Australia will be increasingly recognized as an important outpost of world science.—BRYCE NELSON

Rockefeller University: Seitz To Succeed Bronk as President

Announcement was made last week of changes in two of the most influential and prestigious positions in the scientific community. Detlev W. Bronk, who has reached the retirement age of 70, will step down after 15 years as president of what is now known as the Rockefeller University and will be succeeded by Frederick Seitz, who, since 1962, has been president of the National Academy of Sciences.

Both institutions have experienced rapid growth under their respective leaders, but the changes come at a time when both are evolving toward new and ambitious roles in scientific affairs. The Academy, which holds a congressional charter as scientific and technical adviser to the federal government, has, under Seitz, shed much of the passivity that had characterized its century-long history. Seitz led the way, for example, in setting up a nationwide consortium of universities to administer the 200-Bev accelerator that the Atomic Energy Commission is building at Weston, Illinois. And, during his presidency, NAS sponsored the creation of a National Academy of Engineering, as well as various other mechanisms for examining and advising upon scientific and technical issues.

The institution to which Seitz will be going was known as the Rockfeller Institute when Bronk became its president in 1953. Under his leadership it evolved into a graduate-degree-granting institution and was renamed the Rockfeller University in 1965. It now offers programs in a wide spectrum of scientific disciplines. The 150 students are outnumbered nearly three to one by the faculty, which includes four Nobel laureates and 37 NAS members; only Harvard and the statewide system of the University of California exceed Rockfeller in that last category. Located on Manhattan's east side, the University's physical plant has also expanded greatly in recent years, and, at present, a 17-story laboratory building is under construction.

To some extent there is an important element of continuity in the Seitz-Bronk succession at Rockefeller, for Seitz followed Bronk to the Academy presidency—which Bronk held from 1950 to 1962—and has maintained close relations with him in connection with Academy activities and, during the past year, as a trustee of Rockfeller. The two men established their scientific reputations in different fields, Bronk in the life sciences and Seitz as a pioneer in solid-state physics. But throughout the postwar period their paths frequently crossed as members of various government high-level science advisory bodies.

Seitz's transition to Rockefeller will be a gradual one and will briefly involve a reversion to a part-time presidency at NAS, the basis on which he first took that post in 1962. At that time he also held the position of head of the physics department at the University of Illinois, and later he was dean of the graduate college and vice president for research at Illinois while president of NAS. In 1965 the NAS presidency became a full-time position for virtually the first time in the Academy's 102-year history, and Seitz resigned from Illinois following election to a 6-year term. According to a Rockefeller announcement, Seitz will take office next 1 July, but