Center for Atmospheric Research: Monument to Science's Old Life-Style

Scientists are individuals with special training and skills, but this does not necessarily make them an elite group to be protected from the vicissitudes of the real world.—Report of the Joint Evaluation Committee on NCAR.

Five years ago the National Center for Atmospheric Research (NCAR) at Boulder, Colorado, was generally regarded as a pleasant and intellectually exciting place to work. Today, the laboratory is still in the toils of a traumatic shake-up which has driven morale to near bottom level and would probably have caused a mass exodus of scientists had jobs been available elsewhere. Many at NCAR are still at a loss to know just what went wrong. But chief among the complex set of causes that brought the idyll to its sudden end seem to have been the pressures engendered by society's changing expectations of science, together with the management's failure to perceive that the pressures were building to a dangerous head.

Just who has managed NCAR is hard to define. The bulk of the center's budget ($24.5 million in the present fiscal year) is provided by the National Science Foundation (NSF), but the NSF has handed over responsibility for managing the center to a consortium known as the University Corporation for Atmospheric Research (UCAR), which consists of delegates from universities that have atmospheric science departments. For more than a decade the center went its own way without too much interference from either the foundation or the corporation. Last December it was pulled up short by a seven-man investigatory committee appointed jointly by NSF and UCAR and chaired by Werner A. Baum, president of the University of Rhode Island. The committee spared no one. It accused the NSF of "ambiguity, confusion, and lack of coordination" in its dealings with NCAR, and it said in so many words that UCAR had just not done its job of managing the center.

As for NCAR, the Joint Evaluation Committee (JEC) said on the one hand that NCAR was a fine laboratory which had made substantial contributions to the atmospheric sciences. It said on the other that the leadership of NCAR's scientific programs was confused and fragmentary; that management of the computers, aircraft, and other national facilities under NCAR's control could not be described as good; that the quality of the scientific staff was not as distinguished as might reasonably be expected in view of the many advantages the center enjoys; and that the management's laissez-faire attitude and expectation of preferential treatment were no longer appropriate.

Staff of 90 Scientists

NCAR accounts for less than a tenth of the national investment in atmospheric science (which in 1972 totaled $247 million) but is nevertheless among the larger individual projects the NSF had handled since Mohole. Between its foundation in 1960 and the end of this fiscal year, the center will have absorbed $192 million, $161 million of it supplied by the NSF. Housed in an elegant modern building set atop its own individual mesa, NCAR is magnificently situated between the Rockies and the town of Boulder. Some 630 people are employed at the center, of whom about 90 are academically active scientists. Other scientific and technical staff are engaged in the operation of the center's two large computers, which are used chiefly for numerical simulations of the world's atmosphere, and a fleet of five aircraft specially instrumented for the collection of meteorological data. The director of NCAR from its founding until 1967 was Walter Orr Roberts, who served simultaneously as president of UCAR. The present director, John W. Firor, took up his post in 1967; Roberts remains president of UCAR.

When the JEC report appeared 10 months ago, there were some in NCAR who took the attitude that it was nothing new. It was not indeed the first critical evaluation the center had received; according to the JEC report, management of the facilities had been criticized by the same UCAR subcommittee five times in 9 years with little tangible effect. This time, however, there was an unusual determination on the part of UCAR that some reforms should be carried through. The determination may have been kindled in part by Thomas B. Owen, the NSF assistant director responsible for NCAR, who felt that the corporation should take its management responsibilities more seriously. Another factor was that the universities had come to regard NCAR not as a purveyor of unique facilities to their own atmospheric scientists, as NCAR was intended to be, but rather as a close competitor. While funds were lush, UCAR let NCAR alone, but under the tighter budgets of recent years NCAR appeared to be siphoning off NSF money for work not dissimilar to what the universities could do themselves.

The JEC report thus provided the pretext for UCAR to demand radical reforms, as well as to express in thinly veiled terms the resentment of university scientists at the unburdened lifestyle of their NCAR colleagues. "The service NCAR staff members render," primly observed a report of the UCAR board to its members last April, "rather than being teaching as in the universities, will be in the planning and execution of projects, the development and testing of facilities, and the aiding of university scientists."

Even those at NCAR who consider that the JEC report was basically fair believe that UCAR probably overreacted to the criticisms. NCAR management, however, was not in a position to resist. Not only were many of the JEC's criticisms unanswerable but, within a few weeks of the JEC report, a second blow fell when the NSF announced that the center's budget for fiscal 1974 would be $1 million lower than expected. As for the universities, NCAR had failed to involve them sufficiently in its activities; although supposedly a national facility, NCAR scientists themselves accounted for half of the use of aircraft and, until recently, nearly 90 percent of the computer time. Thus, when the crunch came, NCAR found itself politically friendless. Nor was its scientific capability sufficiently remarkable for it to stand on its record.

The NCAR management, once having accepted that it was to be put through the hoops, entered into the ordeal in an open and wholehearted

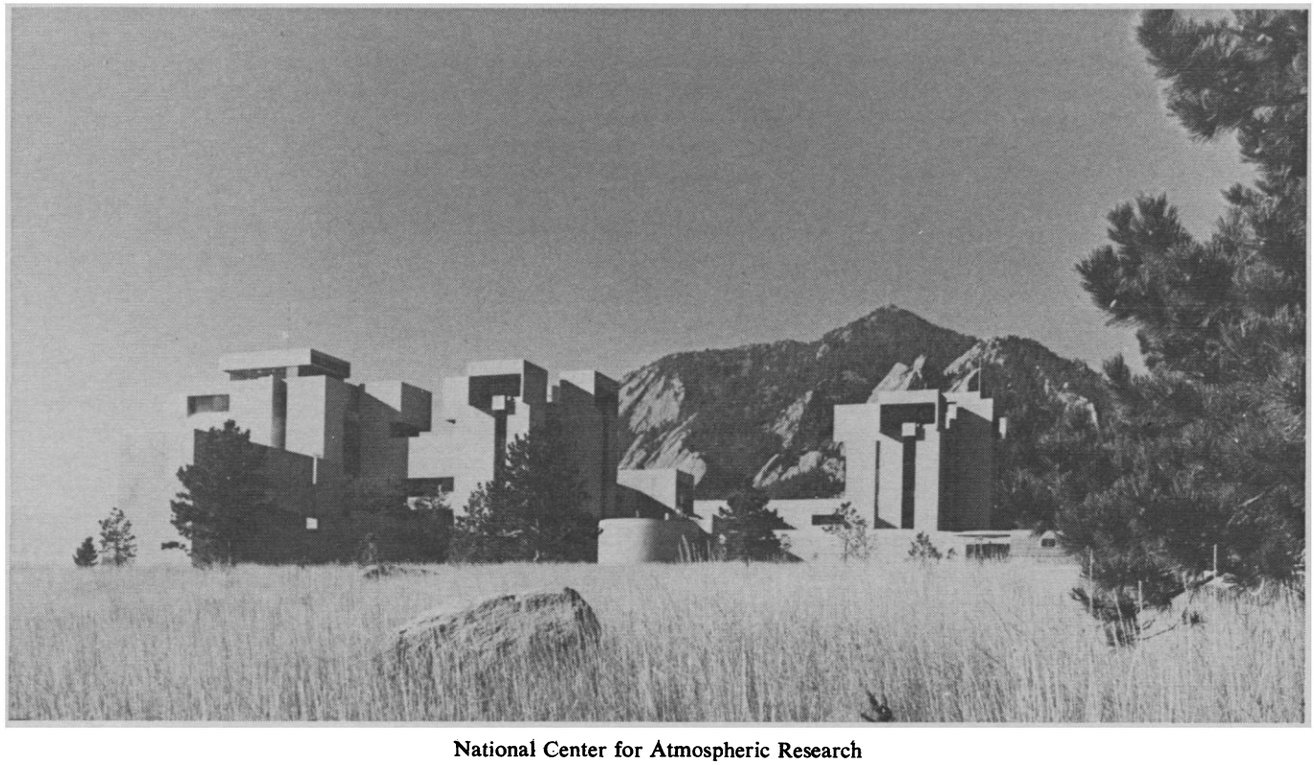
manner. As of this January, the main work of the center was organized along traditional disciplinary lines of atmospheric dynamics, physics, and chemistry, with each scientist free to do very much his own thing. As of now, everyone has been assigned to a specific, multidisciplinary project with a clearly defined goal. There has been an almost complete turnover of scientists at the middle management level, and, so far, some 12 researchers have been given notice of termination.

The reorganization has not been accomplished without other costs. The NCAR management admitted a considerable degree of participatory democracy in its decision-making but allowed the main phase of the reorganization to drag out from January to August, with many details still to be resolved. "They were trying to be good guys but they didn't do people a favor by shilly-shallying around," says a senior chemist. The prolonged uncertainty did little to improve morale, and the numerous discussion meetings ate heavily into productive time. Among the dynamicists, the best integrated group and the one least affected by the reorganization, the meetings consumed from 10 to 15 percent of people's time, according to one estimate. The chemists, a 40-man group who played a leading role in the discussions, were considerably more affected. "From January to about August very little scientific work was done," one knowledgeable staff member said of the laboratory in general.

A fairly general perception among NCAR scientists is that their troubles spring from the changing times and society's more skeptical attitude toward science. People recognize that science budgets generally are dwindling, and there is considerable sympathy for a management forced to cope simultaneously with a large budget cut and a radical change of ground rules imposed by outsiders. "It's a Greek tragedy, in the sense of its inevitability," says a senior NCAR scientist for whom the tragedy has meant loss of his job. Even among those who are critical of the management there is the feeling that NCAR's way of doing business is little different from that of university departments and that the center is being unfairly victimized. "The NSF has pressures on it to support relevant research, and it's easier to pass these on to the national centers than to individual scientists at universities who are going to do their own thing whatever NSF says," remarks a senior staff member.

Although for all these reasons NCAR may be the victim of nothing more than bad luck, there are a number of points at which, in retrospect, the management of NCAR has left itself open at least to question. One is the method of scientific leadership. From the beginning NCAR policy has been not to provide scientific direction from on top but to hire good people and let them go their own way. This would be fine —and no different from university practice—provided that the quality of research remained high. But, according to some NCAR scientists, there was no great selectivity in hiring and no strict evaluation of the existing staff. In 1971, according to the JEC report, the productivity of NCAR's 140 or so Ph.D.-level scientists was 1.3 publications per head, a tally which for individuals committed to full-time research is "not particularly striking." Making different assumptions, however, one NCAR scientist calculates productivity as 2.5 contributions per head per year. Director Firor says that in a study he made himself he found the papers of NCAR scientists were cited more often than those of an equivalent university group.

Whatever the productivity at NCAR, there seems to be agreement both within and without that the center is good but not outstanding. "The average staff at NCAR is better than the average staff at universities, though the best people in the field are at universities," says Norman A. Phillips, chairman of the meteorology department at M.I.T. The view of one of NCAR's scientific leaders is that, after the terminations, "We shall certainly be better than the average university department though not as good as the top five or seven."



National Center for Atmospheric Research

The question at issue is how good the quality of work at a $20-million-a-year national center should be. In a little-read document known as the Blue-book, which contains the proposals whereby UCAR sold itself and the concept of NCAR to the federal government, the following undertaking is given: "It is not sufficient, although quite necessary, that the Institute be characterized by superb intellectual strength." Some 13 years later the JEC report, comparing NCAR scientists against the highest standards, concludes: "There is every indication that,

One Breeder for the Price of Two?

The Atomic Energy Commission has estimated that development of a commercially attractive liquid metal fast breeder reactor (LMFBR), designated by President Nixon as the nation's "highest priority" energy R & D project, could end up costing twice the $2.5 billion the AEC said it would cost just 18 months ago. The new, unofficial price of $5.1 billion appears to reflect a more realistic calculation of expenditures—including direct subsidies to utilities—necessary to bring the breeder to a point of wide commercial acceptance by the mid-1980's. The figure may also indicate an urge in the AEC to embark on an even more ambitious R & D program now that the White House has promised to set aside a $10 billion bonanza for energy research and development over the next 5 years.

The LMFBR's tentative new price emerged recently from the Federal Power Commission's advisory task force on energy conversion R & D. The task force, in turn, is part of a larger technical advisory committee the FPC organized last December to survey broadly the "needs and consequences" of energy R & D. While this might seem a bit far afield of the FPC's duties as a regulatory agency, one of the commission's responsibilities is to encourage the development of new sources of energy, and it therefore considers such inquiries to be within its ken.

Officially, at least, the $5.1 billion cost estimate was the product of deliberations by the energy conversion task force, a heterogeneous group spanning a spectrum from federal energy authorities to utility executives, and including one environmentalist, Thomas B. Cochran, a physicist with the Natural Resources Defense Council in Washington, D.C. Cochran and other members of the task force, however, say the new cost estimate can be attributed entirely to the AEC, and thus would seem to accurately represent its intentions. Indeed, the $5.1 billion estimate was presented to the group for the first time in a 13 September briefing by the task force's chairman, Merrill J. Whitman, an AEC official. As assistant director of program analysis, Whitman is centrally involved in long-range projections of the AEC's R & D costs.

Attempts to reach Whitman by telephone, for an elaboration of his estimate, were unsuccessful. An AEC spokesman, however, while not disputing the accuracy of the figure, said that it "cannot be compared" to the $2.5 billion estimate used in a published cost-benefit analysis of the LMFBR last year* because the new number had been derived from "certain bases that were different from those used by the AEC in the past."

The 1972 estimate of $2.5 billion (which assumed commercial introduction of the LMFBR in 1986) included only those R & D costs incurred directly in the breeder program, according to the spokesman. In contrast, he said, Whitman's estimate includes another $1 billion for "general" R & D that would indirectly benefit the LMFBR. There are also additional allowances in the $5.1 billion figure for inflation and the "increased cost of hardware and high performance fuel." In short, it appears that building the breeder will cost a lot more than the AEC has previously believed or brought itself to admit.

It is worth noting at this point that the LMFBR program has already rung up some extraordinary cost overruns, particularly at the AEC's Hanford, Washington, site. Here, the total cost of a new experimental sodium-cooled reactor called the Fast Flux Test Facility (FFTF) has been rising during construction from an initial estimate (in 1968) of $87.5 million to a current estimate of around $200 million. The FFTF project has also cost another $300 million or so for related hardware and R & D, and there is reason to believe that, by the time the project is completed next year, the grand total for the FFTF may top $600 million.

Whitman's calculations of breeder program costs also allow $200 million for a second "demonstration" breeder reactor plant, although Congress and the White House have authorized construction of only one such plant—a 350- to 400-megawatt facility to be built near Oak Ridge, Tennessee, at a cost of $700 million (of which utilities have pledged to pay $240 million).

Finally, tucked away in the $5.1 billion price is $90 million that would be spent in direct assistance to utilities, to help them buy their first four commercial breeder power plants. Up until now, the AEC has not openly broached the possibility of directly subsidizing the first such plants, although the General Electric Corporation, among others, reportedly has indicated that subsidies might be essential to the ultimate commercial success of the LMFBR. In any case, the practice of paying potential customers to buy a strange new product has ample precedent. During the late 1950's and the early 1960's, the AEC spent tens of millions of dollars in direct assistance to utilities to induce them to buy the early light-water nuclear power plants. As an added inducement, General Electric, Westinghouse, and other vendors found it necessary to drastically underprice their first nuclear plants and recoup their losses by raising the prices later.

Reactor vendors, unlikely to stand still for a similar financial beating on their first breeder plants, may thus be counting on some generous assistance from the federal government, above and beyond the gift of LMFBR technology itself.—ROBERT GILLETTE

* *Cost-Benefit Analysis of the U.S. Breeder Reactor Program*, WASH-1184 (Atomic Energy Commission, Washington, D.C., January 1972).

although the personnel in NCAR are competent, they are not in general of this superb level."

There are other propositions in the Bluebook that have not been met. A major selling point—and one that NSF assistant director Owen affirms is still the policy for NCAR—was that the center should undertake large-scale, interdisciplinary projects beyond the reach of individual universities. An "important reason for its establishment is to foster the cross-fertilization of disciplines," states the Bluebook. "The degree of interaction between scientists in neighboring disciplines was small," comments the JEC report. Until the reorganization the bulk of NCAR's work was on individual projects not greatly different from those undertaken at university departments. And NCAR does not seem to have developed any particular adroitness at the development or handling of large projects. The genesis of the National Hail Research Experiment, a project to see whether hail storms can be suppressed, originated with the NSF, not NCAR, and scientists working on the program tended to be isolated within NCAR. The Fate of Air Pollutants Study was poorly thought out in its original form and has since been scrapped. As for NCAR's most important and central project, its share of the international Global Atmospheric Research Program (GARP), the JEC report found that management of the project "lies somewhere between nonexistence and disarray."

According to Firor, the reason that NCAR had to undertake university-type work instead of big projects was that in the 1960's, when there was no shortage of jobs for competent scientists, the only way to recruit good people was to offer the maximum amount of freedom and laxity. "The hope was that the good people would create large programs. That hope has been only partly fulfilled." One large effort cited by Firor, which is commonly thought of as a major NCAR achievement, is the development of a general circulation model of the world's atmosphere. The testing and operation of the model consumes more than 40 percent of NCAR's available computing time and has accounted for an investment of some $15 million to date. But insofar as there are two other comparable models, one at the Geophysical Fluid Dynamics Laboratory in Princeton and the other at the University of California, Los Angeles, it is hard to argue that this is a unique achievement. Indeed, apart from possession of a fleet of five aircraft—which can be flown together into the same storm—and what is generally regarded as an excellent computing facility, it is hard to see quite what NCAR has done that could not have been done by individual universities. Says one senior NCAR scientist, who may or may not be in a position to judge, "All of the good things here could be done just as well at universities."

Resources Spread Widely

As for contributions to the atmospheric sciences, NCAR has in the first place spread its resources quite widely. The center's scientific ballooning facility at Palestine, Texas, provides an outstanding service which is used almost exclusively by astronomers. The High Altitude Observatory (generally excluded from the strictures of the JEC report) has an international reputation for its work on solar physics, but solar physics processes have not yet proved to be of major significance in efforts to understand the earth's atmosphere. Atmospheric chemistry, the largest of the three departments in the now disbanded Laboratory of Atmospheric Science, has proved to be of some but maybe not central significance to knowledge of the atmosphere. "The chemists went off on their own thing and got out of touch," says Cecil Leith, acting director of one of NCAR's new divisions. Investment in the High Altitude Observatory and the chemistry department totaled nearly $3 million in fiscal 1973, compared with $1.5 million consumed by the other two departments of the Laboratory of Atmospheric Science.

Some might see evidence of a lack of focus in the outwardly paradoxical circumstance that NCAR has never been directed by an atmospheric scientist. Roberts is distinguished as an astronomer, Firor as a cosmic-ray physicist. (Firor, a close colleague of Roberts, succeeded him first as head of the High Altitude Observatory and subsequently as director of NCAR.) Roberts, however, explains that the founders did not want a meteorologist as the first head of NCAR; Firor says that in practical terms he has found it no handicap not to be an atmospheric scientist. Others consider that training in physics is as good a background as any for understanding the atmospheric sciences.

Over the years NCAR has developed a reputation for getting whatever it wanted from the NSF. According to the JEC report, "Funds seemed to be available without limit for new and exciting programs." The travel budget for attending scientific meetings—$238,000, or more than $2,000 per Ph.D.-level scientist in fiscal 1972—was large enough to sustain a cut of more than 50 percent in 1973, and the salary of the president of UCAR is, at $43,800, somewhat larger than even the salary paid the director of the NSF.

The writers of the Bluebook promised that NCAR would justify itself in economic terms. "We are convinced of the scientific need for a National Institute and firmly believe that the benefits that will eventually arise from a more basic understanding of our atmospheric environment more than justify the expenditure of federal funds for this purpose," wrote the chairman of the incipient UCAR in 1959 to the director of the NSF. Twelve years and $192 million later, where are the promised payoffs? According to Firor, they lie (i) in the development of numerical models of the atmosphere, which form a fundamental part of NCAR's contribution to GARP (although only in the planning stage, GARP should lead to a better understanding of the large-scale circulation); (ii) in NCAR's work on cloud physics; and (iii) in measurement of trace pollutants in the atmosphere. Other applications, according to Roberts, include the ability to predict solar disturbances of possible danger to astronauts; work on hail suppression (the $6.5 million so far invested in hail suppression has provided data which suggest, though not in a statistically significant manner, that the method will prove feasible); work on mountain waves, which may allow predictions of clear air turbulence; and calculation of the optimum number of observing stations needed for GARP.

If some of these potential payoffs are far from being realized, that is doubtless in part because the problems of atmospheric science as a whole have turned out to be much more complex than was at first thought. NCAR has of course contributed to the general progress in atmospheric science through its numerous academic accomplishments. Whether or not these equal in value the public investment required to produce them is certainly a crude, but no longer an unfashionable, question.—NICHOLAS WADE