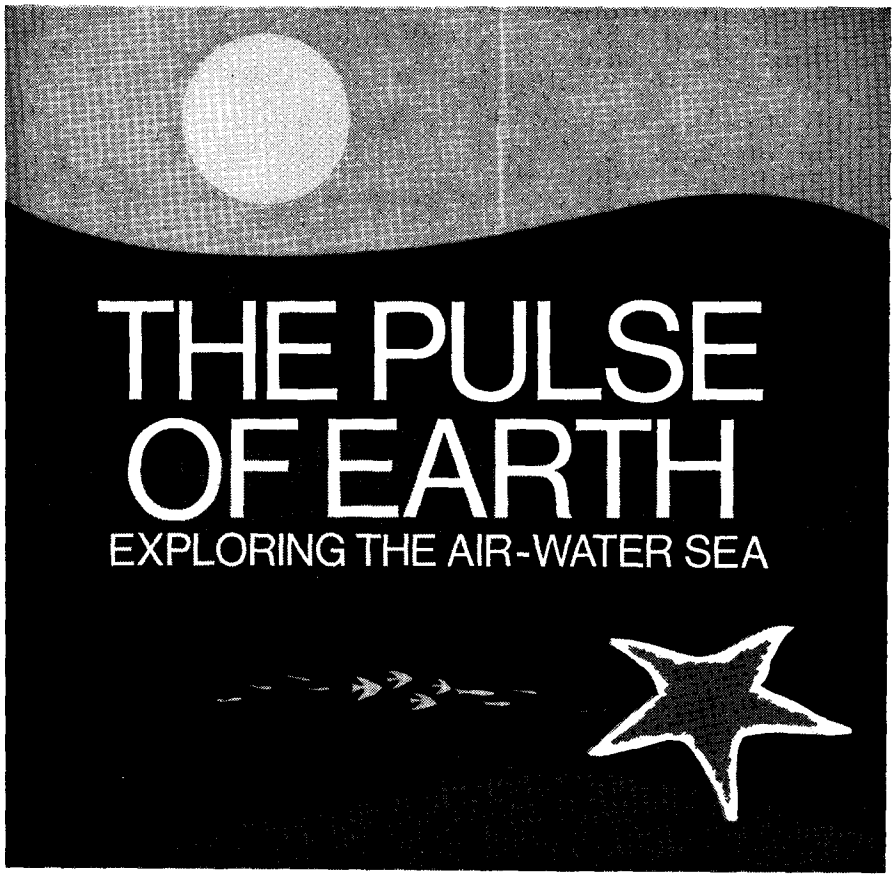
SR / Research
SCIENCE & HUMANITY



—Pageant Studios.

THE pulsebeat of planet Earth has not yet been counted. But a pulse *is* there. Several manifestations of it are regularly observed. A rhythmic throbbing in the magnetic shell enclosing the planet arises from the solar wind and has been detected by spaceships sent from Earth. Within the magnetic sheath, Earth's atmosphere expands and contracts with cyclic heating and cooling of the sun as day passes into night and into day again. Below the atmosphere, Earth's oceans rise and fall in amplitudes that must be approximated rather than measured exactly because the terrestrial crust on which the observers ride is also undulating in answer to the tidal pull of the moon.

Popular awareness of the exciting potential of a grand pattern is so narrowly confined that a political document reflecting some practical sense of the scientific reality is startling to come upon. And just that kind of rare public paper reached print during January 1969 through the initiative of former President Lyndon B. Johnson's Commission on Marine Science, Engineering, and Resources.

The commission's proposals did not explicitly extend into the magnetosphere. But they did treat Earth's oceans and atmosphere as one continuous, constantly interacting sea. The report further strained the bounds of political conventionality by advocating the creation of a new federal agency authorized to coordinate and direct peaceful exploration of the air and water from seven miles below to somewhere beyond 30 miles above the visible horizon.

The name suggested for the proposed exploration center was National Oceanic and Atmospheric Agency, or NOAA.

WAS there any premeditation about this acronym?

Was there any intent to recall another, quite similar name?

If so, the report of the Commission on Marine Science, Engineering, and Resources made no mention of it. Nevertheless, a certain parallel could hardly be escaped. Noah was the name given in the book of Genesis to the character in ancient literature (he had another name in the older Sumerian account of the same event) who was called upon to transplant selected species of earthly life after men so fouled their habitat as to make it no longer livable by the old standards of decency. And one of the responsibilities assigned to modern NOAA is to rescue modern man from his own excrement. The assignment was couched in echoes of biblical phraseology: "Today, man's damage to the environment too often is ignored because of immediate economic advantage. To maximize the present economy at the expense of the future is to perpetuate the pattern of previous generations, whose sins against the planet we have inherited."

The call for NOAA has an historical significance on that score alone. But the idea of NOAA towers even higher than that. It is the closest approach yet made to a Department of Science in the Cabinet of the President of the United States. It could be the beginning of a method to set priorities on government spending for science, a means of mating scientific discovery and its technological offspring to the seen and felt needs of society.

Consider the immediately crucial social problems NOAA would be fitted to attack:

WORLD-WIDE HUNGER. Because of the population explosion, peoples scattered around the planet—especially in lands that only now are developing as economic entities—are living at or near starvation levels. Their numbers will increase with time. The seas are a major source of the most inexpensive foods known.

DISEASE. Always a plague to man, it generates endless demand for medicines. The pharmacology of the sea is known only faintly, but that little packet of knowledge includes the fact that seagoing creatures have chemical means of fighting cancer and regulating behavior of the heart.

NATURAL DISASTER. Much of nature's havoc is wreaked in the air and on the

surface of the oceans. Together, the atmosphere and the sea hold the heat of the sun and bandy the clouds about. Surveillance of the two in a continuous spectrum will certainly lead to more accurate weather forecasts and possibly to weather modification.

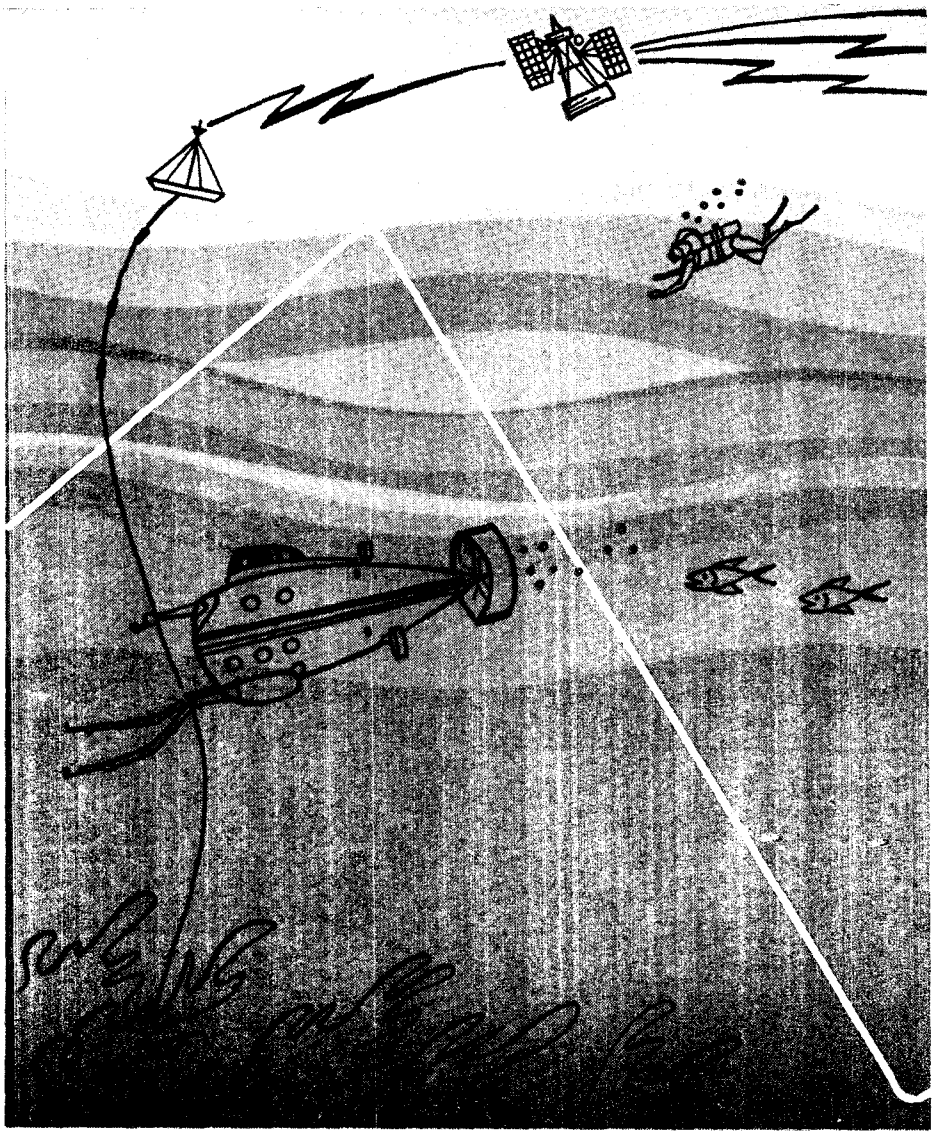
MAN'S INHUMANITY TO MAN. Whether measured in terms of power to pollute the environment or of failure to take the frailty of the human nervous system into account, this is a snakepit of problems that can be approached from the sea in a number of different directions. The waters of the Earth can work a soothing influence on overwrought nerves. Not the least promising prospects are eye-pleasing waterfront developments in coastal and lakeside cities.

WASTES. Esthetic disposal of these is an Augean job that must be done soon to accommodate the rising demand for potable water and for recreation.

GOVERNMENT REFORM. The American federal system is near breakdown. New mechanisms are urgently required to bring local, state, and national laws and regulations into harmony. Nowhere are the possibilities greater than in the nation's water and airways.

THE HOPE OF PEACE. Cooperation among the nations in exploring Earth's oceans and atmosphere can enlarge the area of non-belligerent status that was established by the international agreements governing Antarctica. A global weather-watch, for example, would hold benefits for all commensurate with the best efforts of all.

Another hoped-for consequence of NOAA ought to be noted. This would be a stimulating effect on the expanding economy that all of us have come to rely on for personal prosperity. As population expands (by the year 2000 the inhabitants of this country alone are expected to number 350 million) the need for jobs will multiply. Already, thoughtful people are worrying about a possible slump in employment and a slippage in technological capability after the Aeronautics and Space Administration lands a man on the moon. Most, if not all, of the big privately owned manufacturing complexes now profiting from rich contracts with NASA have started to interest themselves in ocean floor exploration. Essentially the same skills are required to build vehicles capable of navigating extraterrestrial space and the deep sea. Extreme pressures and temperatures must be dealt with in both environments. Working parts must be rugged, dependable, and long-lasting. Remotely controlled robots must be devised to gather information inaccessible to humans, store it for release on command, and deliver it in easily readable form. Space technology cannot simply be transferred to seafaring purposes, however; the shift opens an immense new research frontier. For it turns out to be harder to transmit reliable messages from the bottom of the Pacific Ocean to La Jolla on the coast of California than from Houston, Texas, to the moon.

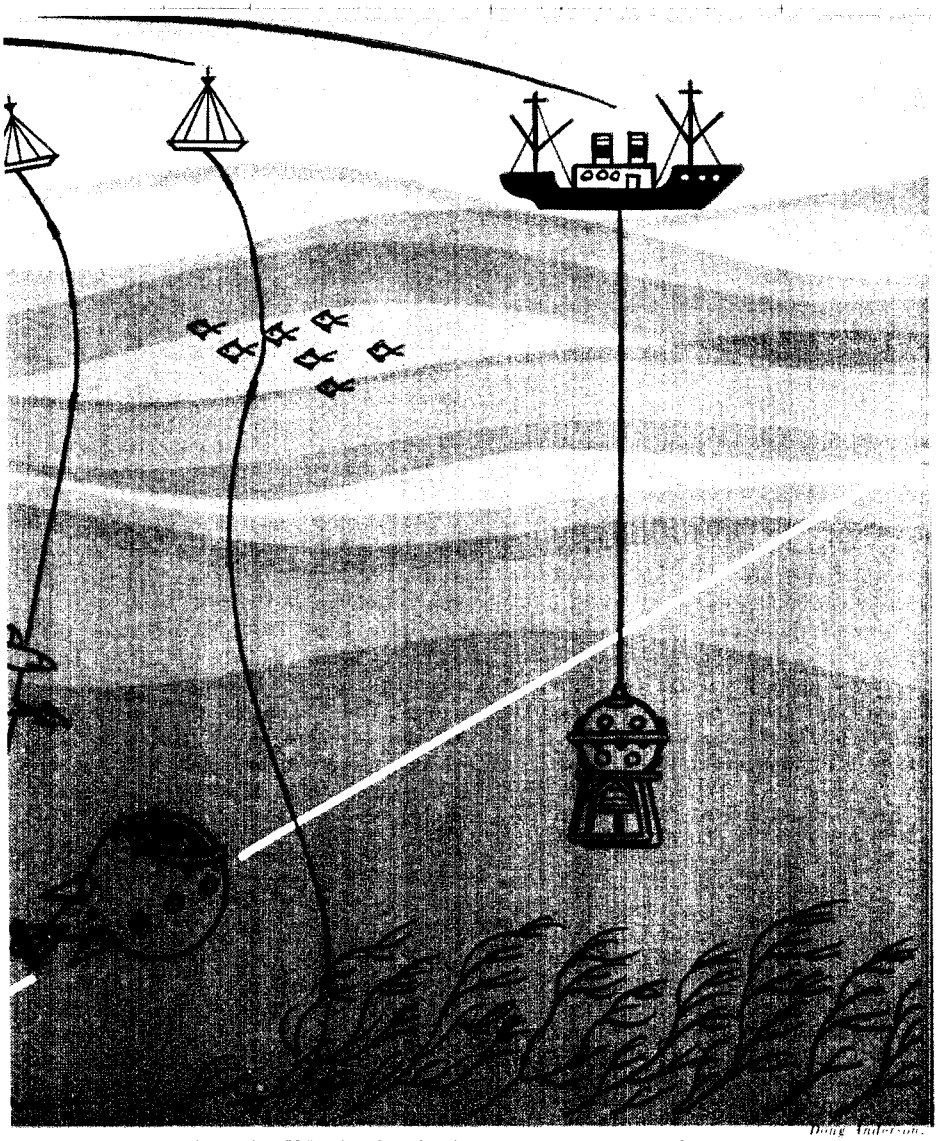


Access to ocean depths as great as 20,000 feet is one of two

After one of the early company of astronauts, U.S. Navy Commander F. Scott Carpenter, joined the aqualung crew that worked in Sealab II on a shallow sea floor several years ago, he commented bitingly on the backward state of oceanic technology in contrast to the advanced technological state represented by spaceships. The report of the Commission on Marine Science, Engineering, and Resources was, if anything, more caustic. It called oceanic research instrumentation "inefficient, unreliable, inadequate"—thus further diminishing the validity of NASA's reiterated claims of terrestrial "spin-offs" from extraterrestrial space research.

The specifications for NOAA explicitly disavow any grandiose visions. "NOAA would not be the instrument of a 'crash' program but . . . would work for orderly and revolutionary progress into the sea." the report of the Commission on Marine Science, Engineering, and Resources stated. NOAA's primary mission would be to "ensure the sure and wise use of the marine environment in the best interests of the United States"; the new agency would function as "the principal instrumentation within the federal government for administration of the civil marine, and atmospheric programs."

THE possibility that NOAA might ultimately grow into a Department of Science can be inferred from the report's observation that NOAA should be looked upon as "a step in a building process." An earlier step in the process had been the creation of ESSA (Environmental Science Services Administration) through combination of the old Weather Bureau, the Coast and Geodetic Survey, and the Central Radio Propagation Laboratory of the Bureau of Standards. NOAA would absorb ESSA (now part of the Commerce Department) along with the Coast Guard (thus removing it from the new United States Department of Transportation), the Bu-



national goals fixed for NOAA. Sketch above suggests approaches to it.

reau of Commercial Fisheries and marine and anadromous fisheries functions of the Bureau of Sport Fisheries and Wildlife (from the Department of Interior), the National Sea Grant Program (copied after the land-grant scheme through which American colleges did so much to advance agriculture) recently inaugurated by the National Science Foundation, the [Great] Lake Survey (from U.S. Army Engineers), and the National Oceanographic Data Center.

Through acquisition of the Coast Guard and ESSA, NOAA would immediately assume global proportions, with the Coast Guard Academy as a top-flight training school and with established connections to the United Nations that would also relate to the State Department. NOAA would command 320 seagoing ships, a fleet of research and observational aircraft, a set of high-speed data-recording systems, thirty eight scientific laboratories, and a staff of 55,000 people—20 per cent of them highly trained professionals, 40 per cent specially trained technicians. The activities of this sizable force would have to be meshed with the traditional activities of the Navy, the Army Engineers, the Atomic Energy Commission, NASA, and the Department of Interior—all of which now carry responsibility for one or another aspect of atmospheric and oceanic behavior. The National Science Foundation would relinquish to NOAA the funding authority NSF now holds over weather modification research, and over the National Center for Atmospheric Research at Boulder, Colorado; otherwise, NOAA would respect the present domain of NSF.

No ordinary scientist is likely to complete this intricate welding process successfully, the Commission on Marine Science, Engineering, and Resources recognized. "Only . . . a superb manager who knows the myriad problems and interrelationships of sea programs and who appreciates NOAA's potential to advance man's mastery of the seas" can do the job, the commission report said. And even a systems-management genius would fail without quick access to the White House. The report therefore recommended that NOAA be an independent agency and that its chief report directly to the President.

As quickly as this "superb manager" can be located, he should be put into office with strong legislation to protect his back. Regular reports from him to the Congress and the President would be guaranteed by a National Advisory Committee for the Oceans appointed by the President with the advice and consent of the Senate. That is the one point labeled "for immediate adoption" in the entire report on NOAA. There is no time to lose, the fifteen commission members, headed by Ford Foundation Board Chairman Julius Stratton, declared unanimously. Some of their sense of urgency came from simple observation of how much had happened during the two years of their deliberations. Offshore oil well drills were going down 640 feet below the sea floor when President Johnson appointed the commission on January 9, 1967, under the authority Congress gave him in the Marine Resources and Engineering Development Act of the previous June. When the report was issued on January 9, 1969, the oil well drills were 1,300 feet under the sea floor. Man-in-the-sea experiments were lasting for several days in 1967; now they last for several weeks. And deep sea submersibles today are able to cruise at a depth of a nautical mile.

ANOTHER source of the sense of urgency was the commission report's divergence from other recent reports predicting quick riches from the sea. The commission found no reason for rosy optimism. Man has a very long way to go before he plumbs the oceans, much less understands what he sees there—if, indeed, he can see very much. Even at depths of 1,000 feet, divers discover that mental concentration can be a major effort and that when their brains do reach decisions their muscles are slow to respond. One diver thought he was turning his body through a quarter circle; his torso did turn, but his feet stayed where they had been and his leg bones separated at the knee joints. Vocal cords are also affected by the pressures of the sea; instead of normal, clearly enunciated words, they produce squawking sounds like those Walt Disney invented for the speech of Donald Duck; communication is consequently difficult, often impossible. The cold of the dark and dirty water is so penetrating that Commander Carpenter saw fellow divers enduring body tremors with amplitudes of four inches.

Given NOAA, the Commission for Marine Science, Engineering, and Resources was ready to go slowly. It plainly wanted to avoid duplicating the offensive flamboyance of NASA. It wanted even more to prevent clashes between NOAA and the Navy. It wanted most of all to escape disturbance of the international liaison of ESSA with the U.N., and to promote universal popularity of the International Decade of

Exploration that Washington has been pushing for the 1970s.

The international motivations were dominant for excellent reasons. It was a U.N. law-of-the-sea conference in 1958 that wakened Washington to the paucity of oceanic knowledge. One of the conventions adopted at that meeting fixed the limit of sovereignty over the sea bottom at whatever line is drawn by a 600-foot depth of water. Sovereignty implies not only ownership but right to exploit. The land area of the United States was extended by one-third of its former total extent by this convention, which acquired legal force in 1964.

THE Sea Grant Program of NSF was hurried into being in reaction to the sudden appearance of this new watery wilderness. Since learning was the first challenge, NSF turned to the universities and colleges and other educational institutions of the country. State-supported schools had a natural preference because authority over the development of the continental shelf lies essentially with the thirty states which share the coast line and the Great Lakes shore line. NSF was authorized to designate Sea Grant colleges in the tradition of the old Land Grant schools. No such designation has yet been made, but NSF has issued thirty-three Sea Grants totaling just under $5,000,000 to educational institutions in eighteen states.

NOAA will assume responsibility for continuing and extending the Sea Grants and will also work with the states in establishing state Coastal Zone Authorities and university-affiliated Coastal Zone Laboratories to provide training for oceanographic and atmospheric students coming up through the Sea Grant schools.

To emphasize the seriousness of this federal-state thrust into the mysteries of the continental shelf, the Commission on Marine Science, Engineering, and Resources set one of two national goals in this domain of relatively shallow water. The goal, which has no time deadline attached to it, is that men should be able to work safely and reasonably comfortably for extensive periods of time in water up to 2,000 feet deep.

The second national goal set for American exploration of the oceans calls for whatever scientific discoveries and technological developments are required to give access to the ocean floor at depths as great as 20,000 feet. Ninety-eight per cent of all the ocean bottoms of earth fall within this limit. The sketch on pages 50 and 51 gives a rough idea of the imaginative kind of designing and building that will be required to achieve this second goal.

The most striking single experiment mentioned in the report of the Commission on Marine Science, Engineering, and Resources would be done with a sea sled probably shaped like a raindrop. The sled would take off downward from the surface of the sea, using the force of gravity by means of water ballast to glide 20,000 feet to the bottom. At the bottom, jets of a liquid chemical would blow the ballast and use the force of gravity in reverse to glide the raindrop back to the surface again.

It is estimated that each glide cycle would cover 50 miles. Fifty such cycles would completely transit an ocean and provide fifty sets of data on all of the physical and biological strata en route from the surface to the bottom, and allow fifty trips to parts of the sea floor never before visited. This still-on-the-drawing-board vehicle would carry three men on jaunts up to twenty days long.

"Use of the combinations of depth and visibility described for such a vehicle in ocean transits could be invaluable for explorations of the oceans," said the report that urged such expeditions on NOAA. But the report went on to say:

> Information from expert observers is not enough. Elaborate photographic equipment and lighting complete with pressure housings have been developed for deep sea work. Such equipment can be operated remotely from the surface in conjunction with acoustical listening devices for describing the forms and strata of life.
>
> Submersibles also can be fitted with thermistor probes to record temperature profiles continuously. This information then can be correlated with the photographic observations. Ultimately, instruments to monitor the gross chemistry of the passing sea water can be fitted to the hull. . . .
>
> Another class of devices could be self-propelled and automatically or remotely guided along programed courses. Diesel-driven, semi-submersibles could cruise the surface in trans-ocean patterns. Deep-diving torpedo hulls with battery power could dive from surface vessels, run a search course, and return for recovery. Helicopters, aircraft, drones, and rockets could cover great distances carrying sensors with or without the option of water entry.
>
> Other classes of devices, such as recording and coring equipment, are not truly instruments but they are equally important. Ultimately, unmanned coring and rock-sampling techniques may be possible from a deep submersible.

—*Lockheed Missiles & Space Co.*

What happens in the deep sea? This photo shows a plastic coffee cup before (right) and after (left) riding the outer hull of Lockheed's research submarine *Deep Quest* to a depth of 8,310 feet.

"Seasteading" may one day assume the pioneering role in underwater colonization that homesteading played in past settlement of the grasslands of the American West. The Commission on Marine Science, Engineering, and Resources ventured to hope that this would happen. But before the sea can be extensively ranched (the Russians are learning to herd fish with sound waves) or farmed (for plankton, oysters, shrimp) or mined (for a host of available minerals) sources of energy must be placed to help men carry the work load. Fuel cells are top candidates. But a major project proposed for NOAA is installation of a nuclear furnace on the continental shelf, far under the water, distant from any coastal city. An experimental complex of this sort would help to measure the extent of thermal effects on the oxygen (hence the life-supporting) content of the water as well as to test the long-time safety of large-scale nuclear power generation.

THERE is another factor that will have to be taken into account in any continuing exploration of the sea. This is the need to know the state of the sea at the time any given expedition sets forth. It is because the state of the sea is interlocked with the state of the atmosphere that NOAA's proposed jurisdiction reaches out of the water into the sky. How far above the sea surface the NOAA domain would go has not been determined. A good guess at a minimum limit would be 30 miles, that being the extent of the lower atmosphere, which shares the heat budget of the sun with the sea. Somewhere between there and the ocean bottom, Earth's surface weather is manufactured.

If NOAA comes into being in any close approximation to plan, its human and robot agents together may ultimately measure the pulse of the Earth with the help of Earth satellites which simultaneously photograph the clouds, take infrared readings of the heat reflected from the planet, and query giant buoys moored to all the ocean floors for news of the latest fluctuations in the pulsebeat.

—JOHN LEAR.

A SCIENTIFIC STUDY OF UFOs

The University of Colorado Report

— APRO.

UFOs? No. Lenticular clouds, Brazil.

By EDWARD U. CONDON

THE emphasis of this study has been on attempting to learn from UFO reports anything that could be considered as adding to scientific knowledge. Our general conclusion is that nothing has come from the study of UFOs in the past twenty-one years that has added to scientific knowledge. Careful consideration of the record as it is available to us leads us to conclude that further extensive study of UFOs probably cannot be justified in the expectation that science will be advanced thereby.

It has been argued that this lack of contribution to science is due to the fact that very little scientific effort has been put on the subject. We do not agree. We feel that the reason that there has been very little scientific study of the subject is that those scientists who are most directly concerned—astronomers, atmospheric physicists, chemists, and psychologists—having had ample opportunity to look into the matter, have individually decided that UFO phenomena do not offer a fruitful field in which to look for major scientific discoveries.

This conclusion is so important, and the public seems in general to have so little understanding of how scientists work, that some more comment on it seems desirable.

Each person who sets out to make a career of scientific research chooses a general field of broad specialization in which to acquire proficiency. Within that field he looks for specific fields in which to work. To do this, he keeps abreast of the published scientific literature, attends scientific meetings where reports on current progress are given, and energetically discusses his interests and those of his colleagues both face to face and by correspondence with them. He is motivated by an active curiosity about nature and by a personal desire to make a contribution to science. He is constantly probing for error and incompleteness in the efforts that have been made in his fields of interest, and looking for new ideas about new ways to attack new problems. From this effort he arrives at personal decisions as to where his own effort can be most fruitful. These decisions are personal in the sense that he must estimate his own intellectual limitations and the limitations inherent in the working situation in which he finds himself, including limits on the support of his work, or his involvement with other pre-existing scientific commitments. While individual errors of judgment may arise, it is generally not true that all of the scientists who are actively cultivating a given field of science are wrong for very long.

EVEN conceding that the entire body of "official" science might be in error for a time, we believe that there is no better way to correct error than to give free reign to the ideas of individual scientists to make decisions as to the directions in which scientific progress is most likely to be made. For legal work sensible people seek an attorney, and for medical treatment sensible people seek a qualified physician. The nation's surest guarantee of scientific excellence is to leave the decision-making process to the individual and collective judgment of its scientists.

Scientists are no respecters of authority. Our conclusion that study of UFO reports is not likely to advance science will not be uncritically accepted by them. Nor should it be, nor do we wish it to be. For scientists, it is our hope that the detailed analytical presentation of what we were able to do, and of what we were unable to do, will assist them in deciding whether or not they agree with our conclusions. Our hope is that the details of this report will help other scientists in seeing what the problems are and the difficulties of coping with them.

If they agree with our conclusions, they will turn their valuable attention and talents elsewhere. If they disagree it will be because our report has helped them reach a clear picture of wherein existing studies are faulty or incomplete and thereby will have stimulated ideas for more accurate studies. If they do get such ideas and can formulate them clearly, we have no doubt that support will be forthcoming to carry on with such clearly defined, specific studies. . . .

Some readers may think that we have now wandered into a contradiction. Earlier we said that we do not think study of UFO reports is likely to be a fruitful direction of scientific advance; now we have just said that persons with good ideas for specific studies in this field should be supported. This is no contradiction. Although we conclude, after nearly two years of intensive study, that we do not see any fruitful lines of advance from the study of UFO reports, we believe that any scientist with adequate training and credentials who does come up with a clearly defined, specific proposal for study should be supported.

What we are saying here was said in a more general context nearly a century ago by William Kingdon Clifford, a great English mathematical physicist. In his *Aims and Instruments of Scientific Thought* he expressed himself this way:

> Remember, then, that [scientific thought] is the guide of action; that the truth which it arrives at is not that which we can ideally contemplate without error, but that which we may act upon without fear; and you cannot fail to see that scientific thought is not an accompaniment or condition of human progress, but progress itself.

Just as individual scientists may make errors of judgment about fruitful directions for scientific effort, so also any individual administrator or committee which is charged with deciding on financial support for research proposals may also make an error of judgment. This possibility is minimized by the existence of parallel channels, for consideration by more than one group, of proposals for research projects.

In the period since 1945, the federal government has evolved flexible and ef-

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