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RESEARCH REVIEWS

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Two Navy scientists manning a STRATO-LAB plastic balloon rise toward a cumulus cloud above Mt. Withington in west-central New Mexico.

Balloon Flight into a Cumulus Cloud

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In order to learn more about the events which occur inside a cumulus cloud as it progresses in development from a relatively inactive stage to the active thunderstorm stage, a STRATO-LAB (Research Reviews, Sept. 1956) manned plastic balloon was flown by the authors recently into the edge of a cumulus cloud growing over 10,300-foot Mt. Withington in west-central New Mexico. The flight was made in connection with a summer-long series of studies being conducted from the mountain top by scientists of Arthur D. Little, Inc., Cambridge, Mass., under a contract jointly supported by the Office of Naval Research and the Bureau of Aeronautics. Dr. Bernard Vonnegut and one of us (Moore) are endeavoring to determine which comes first in thunderstorms, the generation of electricity or the formation of rain. This important question has never been satisfactorily answered, and there is no generally accepted explanation of how a thunderstorm can generate electricity at such a prodigious rate that sparks several miles long are created.

Although our balloon flight was brief, it was unique in several respects. It was the first relatively large plastic balloon to be launched from a high mountain top, and it was probably the first manned balloon of any type to be so launched. It was also quite likely the first manned balloon flight made for cloud-physics studies since Meissinger's flights in the 1920's. The instrument flight plan filed with the Civil Aeronautics Administration for a cloud flight was also undoubtedly a ballooning "first."

The balloon used for the flight was 39,000 cubic feet in volume and 44 feet in diameter. It was made of two-mil polyethylene by Raven Industries of Sioux Falls, S. Dak., and has a large manually operated helium valve installed at its top. The balloon and gondola were close coupled, the shroud lines being fastened to the upper suspension rigging of the gondola at its connection with the balloon's main load ring. A special "open basket" type gondola was built by Richard Miles, PRC, USNR, and M. S. Atwell, AGC, USN, both of the Naval Air Station, Minneapolis, Minn. This gondola was made of lightweight parachute nylon and had a plywood floor 48 inches wide and 61 inches long. Six 1,800-pound-test nylon webbings were sewed around the gondola, brought to a central fitting at the top, and attached to the balloon. A simple "spreader bar" was attached to the balloon load-ring with nylon line supports to opposite ends of the gondola to keep the balloon and gondola from rotating independently of each other. To protect us from lightning that might strike nearby, a crude, but effective, Faraday cage was constructed with five lengths of copper tubing. These were attached to the aluminum spreader bar and bent around the gondola to permit lightning to bypass the occupants. As an ultimate safeguard, a cargo parachute was attached in an open position to a D-ring fastened at the equator of the balloon.

On flight day—June 24th—the top of Mt. Withington bustled with activity as last-minute adjustments were made to scientific equipment, and preparations were made for getting the balloon into the air. The chief instruments carried aloft included four electric-field intensity meters, by means of which duplicate measurements were made vertically and horizontally. These were supplemented with two time-lapse cameras that functioned automatically. With the latter it was hoped to obtain cloud-particle photographs coincident with measurements of electrification. Hand cameras were also carried for over-all photographic coverage. In addition, each of the pilots had an instrument console which contained 5-liter liquid-oxygen converters, oxygen regulators, and meters indicating the oxygen supply and pressure. A clock, altimeter, and rate-of-climb indicator completed the flight instrumentation.

Ground equipment included a large Navy helium trailer, two Navy trucks which had been converted into field laboratories by contractor personnel, power generators, winches (for tethered balloon flights to be made later), a GMD radiosonde ground station installed by Army personnel from White Sands Proving Ground, and various electric-field measuring devices to record the cloud electrification. At the New Mexico Institute of Mining and Technology, in Socorro, Dr. Marx Brook, of the Institute, and electronics personnel of Arthur D. Little, Inc., were readying two radar sets for subsequent use in the program to measure the radar echoes and precipitation associated with thunderstorms passing overhead.

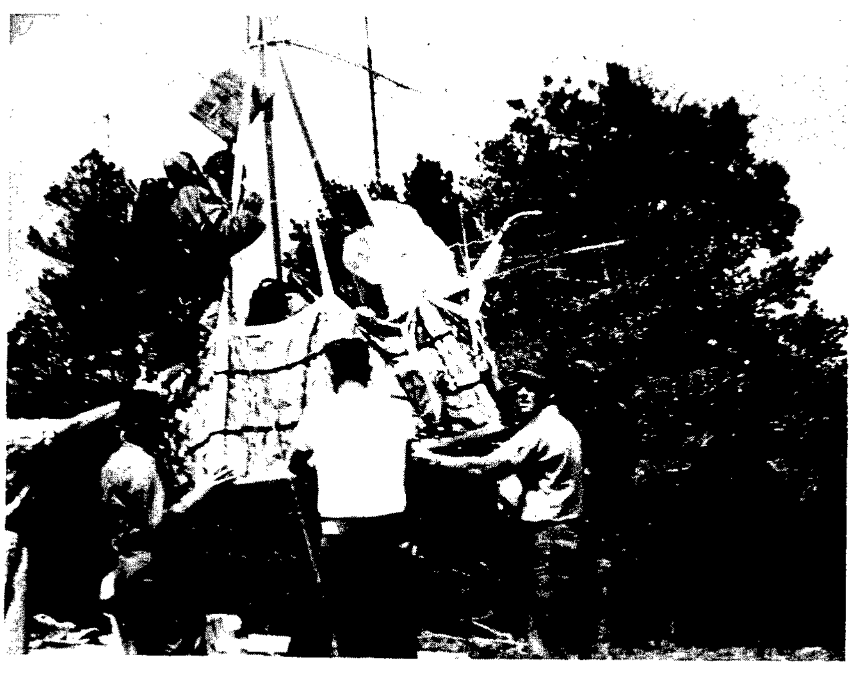
In addition to the flight crew, technicians from Arthur D. Little, Inc., Chiefs Miles and Atwell (who teamed as principals of the launch crew), CAPT Norman L. Barr, MC, USN, and personnel of his Project RAM (Research in Aviation Medicine) team from the Naval Medical Research Institute, Bethesda, Md., were also present. The latter group provided in-flight communications, assisted with safety aspects, and collected aeromedical data which it has been accumulating from flight personnel engaged in the STRATO-LAB program.

Clothing worn was the standard garb for intermediate-altitude STRATO-LAB flights developed by the Navy's Clothing Supply Office, Brooklyn, N. Y. It consisted of waffleweave underwear, an inner suit of intermediate weight, a relatively heavy outer suit, especially heavy cold-weather boots, and helmet innerliner with oxygen mask. Crash helmets were taken along for protection at landing. As this clothing was designed for temperatures as low as -70° F, and those encountered were only slightly below zero, less clothing should have been worn. Each occupant of the gondola also wore a relatively large backpack parachute, equipped with an aneroid system for automatic opening at 16,000 feet, and a complete bail-out oxygen system arranged in a seat pan. The parachute and bail-out oxygen supply weighed 34 pounds per person.

On flight day clouds did not form over the mountain quite as early as they do normally. Therefore, the take-off had to be delayed until about 2:00 p.m. Throughout the morning CAA was kept advised of the

The two balloonists make final adjustments in preparation for launching.

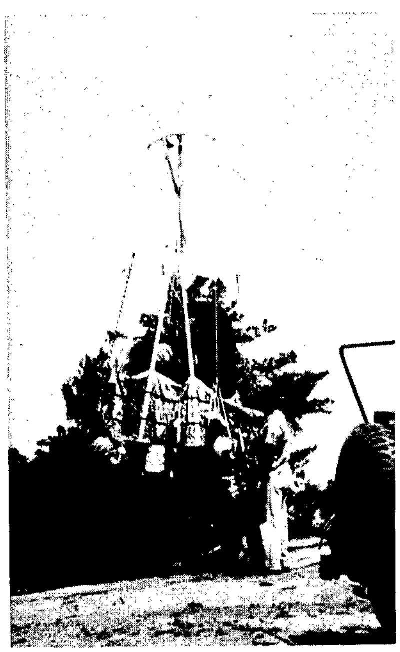
Ground crew gets set to move gondola and balloon to launching site.

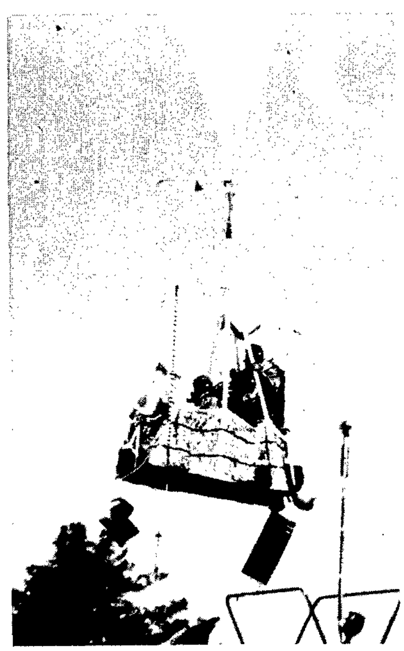


delays and of the revised estimated time of launch. Chief Warrant Officer Gustafson, USN, of Dr. Barr's group, was the CAA contact man. By means of the U. S. Forest Service radio at the lookout station on Mt. Withington, messages were relayed to the Forest Service regional headquarters at Magdalena, N. M., where Dr. Barr's primary ground receiver-recorder station was set up. Mr. Gustafson then contacted the CAA station at Truth or Consequences, N. M., directly by telephone, and CAA, in turn, passed the information on to the in-flight controller. Because the flight plan filed was an instrument flight plan which would change in the air to VFR after leaving the cloud, CAA requested that the flight plan be closed after the flight was terminated.

Layout and inflation of the balloon was accomplished quite easily, despite the fact that very few experienced plastic-balloon personnel were present. By the time the ballast, instruments, Dr. Barr's aeromedical sensing and transmitting instruments, and other equipment had been rigged, a relatively large cumulus cloud had formed over the mountain. At 2:00 p.m., when all was in readiness, a "weigh-off" was made. The ground crew walked the gondola shoulder-high to a designated spot, then, at our signal, merely let go.

As the surface winds were very light and had a reverse "drainage effect" as a result of a general upslope motion around the peak, the take-off was quite smooth. Ross, as pilot, stood to observe the altimeter and clock (for rate of climb). Moore, co-pilot and scientific investigator, sat before a waterproof packaged console of electric-field meters. Within





Ground crew walks gondola, shoulder high, to launching site, then, at signal from balloonists, lets go.

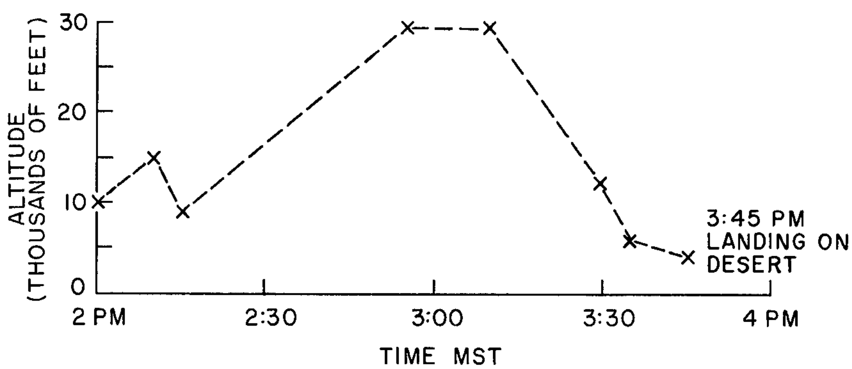
the first minute after take-off it was noted that the rate of rise was a little high, so Ross pulled the valve cord, thus releasing helium and slowing the rate of ascent to about 800 feet per minute.

Within a few minutes the balloon reached an altitude of about 15,000 feet. Here, the flight profile changed abruptly, for the balloon entered the downdraft portion of the cumulus cloud overhead. We then began to descend at a rapid rate into a canyon between Mt. Withington and an adjacent peak. Both of us were now on our feet throwing out ballast (iron shot pre-packaged for this purpose in polyethylene sacks). About 32 pounds was discharged. From the clock and altimeter a quick, crude determination of our rate of descent was made (the rate-of-climb indicator was not functioning). Apparently, we were falling at a rate of about 2,000 feet per minute. Although we were engaged primarily in attempts to slow our descent, we caught occasional glimpses of the canyon bottom. What appeared to be bushes one moment, transformed into trees the next. In a very short time we had been carried below the summits of Mt. Withington and its adjacent peak. But, after sinking to an altitude of about 9,000 feet, the balloon was blown out of the downdraft circulation, and the descent was suddenly arrested.

Once more we began to climb. This time we entered a portion of the growing cumulus cloud near its base. We didn't remain long, but Moore was able to make several readings with his electric-field meters. We then rose outside and just alongside the growing cloud turret without being drawn in. At about 20,000 feet the cloud bulged out in a giant ring and we reentered the cloud briefly. Here Ross observed countless ice crystals, which had the appearance of brilliant diamonds in the sky reflecting the sunlight. The cloud surface was also observed literally rolling down as a waterfall. Moore read the meters without pause and transmitted the observations by radio to the ground recorder. The stay was all too brief as the balloon seemed to thread its way through the breaks and emerged from the cloud into free air, then ascended between the growing cumulus cloud and a mature thunderstorm several miles away. The mature storm, which had an anvil top, was obviously producing much rain, and its thunder could be heard quite distinctly. Helium was valved several times more, but the balloon continued to rise, finally reaching its floating altitude of about 29,000 feet.

While the balloon approached and then hovered at this height, we photographed the surrounding clouds, which were most impressive against a background of crystal-clear blue sky. As beautiful as the scene was, however, it could not be fully appreciated because of apprehension we felt concerning the well-developed thunderstorm, which was now only a few miles to the north of us. We concluded that our horizontal motion was somewhat cyclonic and that we were being drawn into the expanding thunderstorm which towered high above us. As this cloud extended to an estimated altitude of 45,000 feet and was far too mature for internal investigation, we decided that the prudent course of action was to descend. The time was then about 3:10 p.m.

Because of slow valve characteristics and high stability of the air into which we had penetrated, several minutes of valving were required to establish a satisfactory rate of descent—between 400 and 500 feet per



Time-altitude chart of flight.

minute. The balloon was now drifting southeastward toward the intersection of State Highway 107 and U. S. 85, beyond which lay the Rio Grande. Except for the fact that we were again being drawn into the circulation of the first cumulus congestus, which had grown considerably in size by this time, the descent was quite routine, and it appeared that landing would offer no problem.

Familiar landmarks were now looming on the desert floor. The large lava flow on the east side of the Rio Grande was quickly identified by Moore, who called out on the radio, "Val Verde"; this bit of information, one of the last we transmitted by radio, let the ground party know the general area in which we would land.

At an altitude of about 16,500 feet, Moore took off his oxygen mask and indicated he had been sick at altitude but had been afraid to remove the mask sooner because of his need for oxygen. He was also too hot and removed his parachute, took off his outer coat, then struggled back into his parachute. The combination of heat, fatigue, and his earlier sickness struck with delayed effect. For the next few minutes he was completely miserable.

At about this time a new problem began to present itself. Cumulus cloud No. 1 had become a full thunderstorm by now. Soon we were again in its downdraft and moving earthward at a rate that probably exceeded 1,000 feet per minute. In preparation for the landing, Ross started dismantling his side of the lightning-rod Faraday cage and requested Moore to do the same. After observing that nothing but barren desert lay below, the rods were dropped over the side. The pilot now stood at the "bow" calculating the rate of descent at 15-second intervals. Between calculations he ripped open ballast bags with his knife and discharged them to slow the descent. Moore transferred his polyethylene shot ballast bags to the pilot's side of the gondola for use, then readied a long-handled "pruning" knife to sever the main load line at landing. Both of us now donned crash helmets.

About 1,000 feet above the ground our rate of descent slowed to about 400 feet per minute, which, we believed, would allow the balloon to "coast in" for a landing. About 500 feet above the ground Ross began valving at the maximum rate. The first impact was a gliding jolt, the balloon bouncing back into the air. Moore then asked Ross (who was still manipulating the valve line) to inform him when the gondola was about to touch the next time, so he could cut the load line. The second ground impact occurred about an eighth of a mile from the first. Because the balloon seemed to be hugging the ground, Ross told Moore to cut the load line. A few seconds later there was a sudden snap, a rustle of polyethylene, and we were aware that the load line had apparently been severed, as planned, but that something else had "held." The pilot, who was still tugging on the valve line at this moment and facing the direction of travel, fleetingly observed Moore tumble out of the gondola. In another split second, he, too, rolled out.

After picking ourselves up and noting that there were no injuries, we looked around for the balloon. To our surprise, it was heading skyward again. The parachute, which had been pulled from its ring at the balloon equator, now served as a drag in an inverted position as the balloon and gondola ascended. The realization now dawned that the two small anchor lines—used to keep the balloon and gondola from rotating independently—were still intact and were, therefore, serving as a suspension harness for the gondola. In a short time the balloon disappeared in the thundercloud overhead. The time was 3:45 p.m.

Five minutes after landing, the storm's torrential rain and gusty surface winds hit us. A preliminary survey was made of the area to recover pieces of equipment which had dropped out of the gondola with us. We then began walking toward the highway. Three hours later—at 7:15 p.m.—we reached the highway, where we were picked up by a passing motorist and driven into Socorro.

The balloon and gondola were located the following day on the southeast side of the Rio Grande, southeast of Val Verde, about 5 miles from the point where we had landed. A jeep loaned by Battery "C" of the New Mexico National Guard, was used to recover the equipment. The appearance of the balloon gave a good clue as to what had happened to it. Quite obviously it had been torn to shreds in the thunderstorm and had then fallen free onto the desert. The parachute, which was still attached, had been fouled and apparently did not serve to lessen the gondola's impact shock. Some equipment was smashed beyond repair. Clothing, the parachute, the gondola, the radioactive sources used as probes for the electric-field meters, and other items, however, were recovered in good condition.

The flight served as a good check-out of equipment used and procedures followed for studying cumulus clouds at close range from a low-velocity platform. When all of the data are evaluated it is quite likely they will be an important supplement to the ground measurements, tethered-balloon information, and other STRATO-LAB flights which may be made during the summer on Mt. Withington in this new approach to understanding the origin of electricity in thunderstorms.

The by-product aeromedical data obtained by Dr. Barr and his group appear to indicate that both of us experienced unusual stress during the flight. In the words of Dr. Barr, "The tape record of voice, respiration, and heart action is spectacular. This data will be useful in helping establish physiological stress tolerances for Naval personnel, particularly those engaged in aviation activities."

Research Productivity in an Organizational Setting*

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Office of Naval Research

A scientist is skeptical of generalizations, no matter how widely held, until they have been subjected to rigorous testing. He observes, analyzes, classifies and systematizes, hypothesizes, experiments, and confirms or rejects—that is, he does these things when he is pursuing some scientific end. When he supervises, or is supervised, he tends to lose this scientific detachment. If he is a highly emotional person, he tends to be emotional in his supervisory relations. If he is a frustrated person, he may develop an aggressive attitude on the job, or behave childishly, or become apathetic, just as other people do. If he has supervisory problems, he tends to deal with them in an intuitive manner rather than apply a more scientific procedure.

The sheer quantity of research now being done and the amount of money that is being spent on research programs have made the administration of research groups an important occupational category. The 1956 edition of Industrial Research Laboratories of the United States lists 4,834 research and development laboratories in 4,060 companies. In a recent article in the Harvard Business Review ("Setting Criteria for Research and Development"), Albert H. Rubenstein says that 10 years ago a large portion of these 4,834 laboratories did not exist; 15 years ago a majority did not exist.

Because research administration is new, so new that we still have no specifications for it, it is both natural and desirable that there should be many points of view as to how research groups are to be administered. The complaint has been made that we are too quick to generalize about this new area. But the philosopher Alfred North Whitehead has generalized, "Without generalization there is no meaning, and without concreteness there is no significance." In spite of the newness of research administration, some cautious generalizations can be made concerning it.

THE NEEDS OF ORGANIZATIONS VERSUS THE NEEDS OF EMPLOYEES

Most modern research is done through an organization of some kind, and the tendency is more and more toward large projects involving many research workers.

An organization must have some control over its personnel. Traditionally oriented organizations tend to believe that when the word trickles down from above, employees will conform to the message. Such organizations want most of their employees to be dependent, subordinate, and

*Adapted from a presentation made at a seminar on R and D Management Development held at the Pennsylvania State University, July 7-12, 1957.

passive to the leader. Yet, emotionally mature employees are motivated toward greater freedom of action and more participation in matters that concern them.

In a highly formal organization, every person acts according to a specific set of instructions. There is an appearance of choice of interaction, but in reality there is little or none. If the people involved know the standard operating procedures, they can predict the actions of other persons—any persons—in a particular position. Such an organization can be likened to a material structure. Individuals can be thought of as building blocks—some more important than others because of their position, but all of them replaceable.

While this picture of a rationally oriented organization seems to offer a neat mathematical solution to the problem of employee management and looks good on paper, it is by no means the only answer. When the "building blocks" are human beings, it may be wiser in the long run to pay some attention to the differences as well as the similarities in individual units comprising the whole.

Herbert Simon of the Carnegie Institute of Technology, in his recent book Models of Man, says there are two categories of theories about human behavior—those which are advanced principally by economists and which are based upon the rationality of behavior, and those that are primarily psychological and that are concerned with the emotional and nonrational aspects of behavior. In a democratic society, we need, Simon says, a new theory of human behavior based upon both rational and nonrational aspects of behavior. Organizations set up with the utmost skill insofar as economics and reason are concerned are now finding it necessary to pay attention to the nonrational aspect of man.

One way in which management attempts to bring about higher productivity is to improve the physical surroundings of the worker; another way is to try to make the worker satisfied on the job. Some psychologists maintain that productivity and high morale go hand in hand and that job satisfaction leads to productivity. There are others, however, who believe that a pleasant country-club atmosphere does not necessarily carry with it high productivity.

Generally speaking, a scientist's productivity can be increased by improving his equipment and facilities. But the best-equipped laboratory cannot make him productive if his motivation is low. Unfortunately, we seem to know more ways to decrease motivation than to increase it. One of the best ways to decrease the motivation of some people, for instance, is to ignore them completely. Yet, as anyone who supervises large groups of researchers knows, there are creative people who seem to want to be left alone. This, however, does not necessarily mean that they do not want to be perceived. Albert Einstein may have been a person who worked alone. One psychologist reports that he had an office several doors from Einstein's for a whole year. He says he had the feeling that during that time Einstein may have seen him once or twice, but he made no more impression on Einstein than the door of his office. People who knew Einstein well also say that he had a strange way of suddenly cutting off contact with anybody with whom he might be carrying on a conversation. Yet his friends say that he very much wanted to be perceived as a person.

Dr. Warren C. Lothrop of Arthur D. Little, Inc., has listed a number of ways in which research people can be mishandled. Ignoring their needs as persons is high on the list. Treating them all alike is another way.

INTERPERSONAL PERCEPTION AS A FACTOR IN PRODUCTIVITY

Someone said of Christopher Columbus that he didn't know where he was going, when he got there he didn't know where he was, and when he got back he didn't know where he had been. Yet he discovered America.

It is a good deal that way about our perception of people. Quite often we do not set out with the intention of perceiving people; we are not aware just when we pick up important clues about them; we are not sure that our perception of them is accurate; and if our perception proves to be accurate, we cannot explain why. Yet the perception of people and their needs is a skill that may be crucial in the management of people, and particularly in the management of research personnel.

It is commonly believed that all people will perceive an event or a person in exactly the same way provided they take great pains to observe very carefully. Yet this is far from the truth. For instance, when a person likes another person, he usually thinks that the other person likes him. Yet, quite often this is not true.

First, each individual does not passively perceive all the events that are going on around him. At every moment he "tunes in" on certain of his attitudes, and expectations. The second step in the perceiving process is the receipt and impact of information—that is, the events generated lead to activity in and around the person. The third step is the checking phase—that is, confirmation or lack of confirmation of the original hypotheses takes place. If the original hypotheses are confirmed, they are reinforced; if they are not confirmed, they are weakened, and changing forces are set up to revise the old hypotheses or develop new ones.

The perception of people is important in the influence process. If a supervisor wants production increased and he wants to influence a certain employee, he can best do so if he can perceive this employee's needs and do something about them. The person to be influenced must be viewed as a complex whole, differing in his needs from other individuals. Mild punishment may induce one person to be more productive, and it may have no bad consequences. Such punishment may induce a second person to be more productive, but it may have bad side effects. And in a third person, punishment may set up certain resisting forces which actually make that person less productive.

These differences may lie in the person's perception of the situation, and in the way his perception relates to his values. For instance, in studies made some years ago a curious condition was demonstrated.

As expected by both management and employees, productivity went up among a group of workers when physical conditions, such as lighting, were improved. The curious and unexpected part was that productivity kept going up when conditions were deliberately made worse. This unexpected result could be explained if it was assumed that the studies being made by management were perceived by workers as an interest in their welfare, to which they responded by an increase in output.

Herbert A. Shepard has done some interesting work with research groups at the Massachusetts Institute of Technology. In one experiment, he attempted to study the value system of a university research group. Although this particular group, as Shepard says, "shared the sentiment that pay and status should be commensurate with social contribution, and looked forward to higher income and status in the future," they "denied its applicability in the laboratory." What the research workers valued most was the opportunity to learn more and prepare for more responsible and technical work. The need that the research administrator met in this case was opportunity to progress technically.

In a study done at Ohio State University, Donald Pelz has shown that the influence of a supervisor on employees depends upon how the employees perceive the location of power. If the employee thinks authority is vested entirely in the boss (that is, the man above the supervisor), then the supervisor, even an employee-centered supervisor, is not effective in achieving high productivity.

In an article entitled "Authority in Research in Industrial Human Relations" (1957), Herbert Simon says "an employer . . . . is likely to be successful to the extent that the several parties to the employment contract perceive their goals to be more or less parallel." Thus, for instance, "cohesiveness," or solidarity, is a sword that can cut in either of two directions. A cohesive group is more productive only when its goals are consistent with those of management. If management's only concern is productivity, but the concern of the supervisor and employees is the achievement of job satisfaction and good human relations, cohesiveness may lead to lower productivity.

Jack Gibb of the University of Delaware has been working on a related problem of defensive behavior and productivity. Defensive behavior is here seen as behavior which an individual directs toward defense and support of his own ego rather than toward the accomplishment of the group task. Gibb hypothesizes that as a group gets larger, two counter-opposing functions are set up: an increase in potential creativity resulting from the increase in the number of contributors, and an increase in potential defensiveness as a result of such conditions as less opportunity for participation and more competition. The interpersonal defensiveness increases faster than the creativity, so that when a group reaches a certain critical size creativity begins to drop.

Fred Fiedler, of the University of Illinois, has made a number of studies of the productivity of groups as related to the leader's perception of his subordinates. The first studies seemed to show that the more productive groups tended to have task-oriented leaders who could also be described as being somewhat distant from people. As the studies continued, however, this finding did not give the complete picture. It was found later that a leader with a warm therapeutic approach could also be successful if he had as a key man or assistant a more distant task-oriented person.

COMMUNICATION AS A FACTOR IN PRODUCTIVITY

Ernst Cassirer, in his "Essay on Man," describes two kinds of communication: the language of the emotions—the only language animals have and a great part of the language of man—and language which has syntactical and logical structure and follows from symbolic imagination and intelligence. The latter is possessed exclusively by human beings. It is rarely used by itself; most propositional language, except perhaps the purely formal sentences of mathematics, is accompanied by much emotional language.

Some people believe that in a work situation communication should be as devoid of emotion as possible; in other words, a propositional language should be used. Yet this is impossible. No matter what terms one person may use, no matter how objective he may try to be, the person who is addressed may interpret what is said to him in terms of his own emotional experiences. All communication among people is tinged more or less with emotion.

Misunderstandings arise between individuals because of different interpretations of the same words and because of emotion. When a misunderstanding is based upon faulty logic, it can be eliminated by clearer and more logical communication. When a misunderstanding is based upon emotion, we have an entirely different situation. Often a person does not want to understand and invents rationalizations to preserve his lack of understanding.

A supervisor who can clear up the first kind of misunderstanding has a good command of propositional language. A supervisor who can clear up the second kind of misunderstanding is perceptive and has a therapeutic personality. Sometimes all the desirable traits—such as intelligence, logical thinking, a warm personality, sympathy, perceptiveness—may be found in the same person, but not often.

Theodore Newcomb, of the University of Michigan, has some interesting things to say about interpersonal perception and communication. He believes, for instance, that accurate communication is basic to the development of similar attitudes, that accurate communication is rewarding to human beings, and that attraction between people is based on accurate communication. Lack of communication between a supervisor and an employee may in time lead to dissatisfaction and lower productivity. If Newcomb is correct, accurate communication may solve not only rational misunderstandings but also emotional ones.

It does not follow, of course, that the mere volume of verbal communication will lead to understanding. A study of bomber air crews, for instance, showed that during actual flight and bombing the better air crews tended to communicate less than did the poorer ones—that is, the superior crews needed fewer explanations, the members being able to predict each other's behavior. Through accurate communication in the past, they had learned to work effectively with a minimum of words.

SUMMARY

The research worker today is no longer a lone wolf. He works in an organization, some of whose objectives he shares. Some of his needs, however, differ from the needs of the organization. The organization is a structure built upon economic and rational needs. Man is a rational creature, but in addition has certain emotional or nonrational needs. The organization must have some control over its employees; the individual needs a measure of freedom. If the research worker is to be optimally motivated, his needs must be perceived and understood. The supervisor is in the best position to perceive these needs. The organization must make it possible for accurate interpersonal perceptions to take place. The organization should be oriented toward both productivity and employee adjustment.

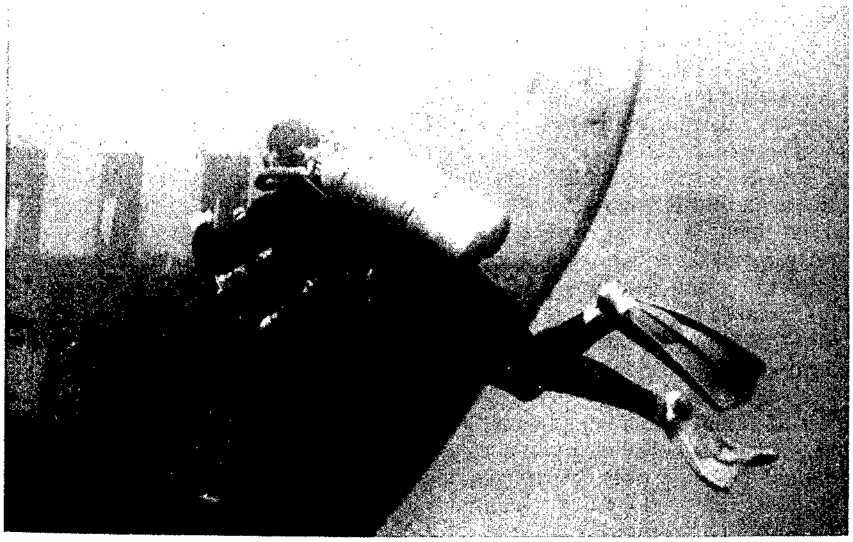
If each research person is not perceived as an individual in his own right, then several kinds of negative behavior may arise which will channel a large part of the productive energy to nonproductive areas. Defensiveness, hostility, frustration, anxiety, and aggression are not conducive to productivity.

Accurate communication is essential in an organization. Correct perception of what is said is as important as is the accuracy of what is said. To achieve this, it is necessary to pay attention not only to the words used but to the deeper and more significant aspects of interpersonal perception. Empathy, or the ability to put one's self in the position of another and look at things from his point of view, is an important characteristic of the good research administrator. Good communication implies accurate information, participation, and an attitude of understanding for the other person.

Genius can overcome many handicaps. For certain kinds of people certain kinds of obstacles may even be necessary for creativity. But it is reasonable to think that many research workers with great potential ability have produced less than they were capable of because the climate in which they thought and worked was not conducive to creativity. How each individual scientist perceives the world and his fellow men is a matter of individual concern; how he is perceived and how he thinks he is being perceived may have a great deal to do in determining his contribution to society.

New Assistant Chief for Research

CAPT Jacob C. Myers, USN, reported for duty at ONR on August 5, 1957, as Assistant Chief for Research. CAPT Myers is a graduate of the U. S. Naval Academy, class of '32. For the past 3 years he has been serving as Commanding Officer of the U. S. Naval Mine Defense Laboratory, Panama City, Fla., after having been Executive Officer there for 1 year. Before this he was assigned to the Bureau of Ships in Washington, where he served as Director of Electronics Design and Development and as Special Assistant for Electronics Reliability.



Underwater swimmer equipped with a breathing unit supplied by two 70 cubic-foot cylinders of compressed air.

Self-Contained Diving and Underwater Swimming

Loyal G. Goff
Biological Sciences Division
Office of Naval Research

Most histories of naval warfare before World War II make little mention of exploits of underwater swimmers in either offensive or defensive tactics. This is not surprising since such activities have been the result of opportunity rather than planned maneuvers and, in general, have not been considered decisive in any major campaign. However, accounts of a few highly successful attacks by underwater swimmers antedate accurately recorded history; for example, Homer tells of a man swimming underwater and cutting the anchor ropes of enemy ships, and other writers report that some early Greek ships' carpenters sank enemy ships by diving under them and drilling holes in their hulls. There are also numerous later unauthenticated reports of boarding and sabotage parties reaching their objectives by swimming. In view of the reported success of this form of warfare it is surprising that before World War II little serious thought was given to the development of equipment and techniques for its advancement.

The development of reliable self-contained underwater breathing apparatus (scuba) in Europe early in World War II permitted man for the first time to range comparatively long distances completely submerged and entirely independent of any surface attachment. The Italians, in particular, quickly recognized the potential of such a weapon and developed swimmer attacks to a high degree of perfection and attained a rather surprising amount of success. Their human torpedos and limpeteers destroyed an estimated 150,000 tons of allied shipping and were a continuing threat to both British and American shipping in the Mediterranean. Because the missions which could be performed by swimmers were considered to be somewhat suicidal, they were not endorsed or condoned by the U. S. warfare philosophy. Therefore, the U. S. Navy made only small and isolated efforts toward developing and attaining substantial capability in this field. The only American groups actually trained in underwater swimming were the OSS operational swimmers (Figure 1) who served primarily with British forces.

At the close of World War II the OSS was disbanded and most of the Navy's swimming UDT's (Underwater Demolition Teams) were discharged, leaving the U. S. with little or no capability in this field. The first attempts to overcome this loss began in 1948 with the training of a small UDT group at the U. S. Naval Amphibious Base, Little Creek, Virginia. At that time the only equipment available to this group were the World War II Lambertsen Amphibious Respiratory Units left over from the OSS operations and one British submersible electric canoe. For several years following 1948 little recognition was given to this new activity, but interest gradually increased as the swimmers demonstrated superior capabilities over conventional divers in many diversified tasks, such as underwater photography (Research Reviews, October 1955), ordnance location and disposal, ship-bottom inspection, damage control, and light salvage.

The Bureau of Personnel, recognizing the growing need for training in the use of scuba, established the Navy School of Underwater Swimmers at Key West in 1954. Graduates from this school may go to Explosive Ordnance Disposal School, Harbor Defense units, and mine sweepers, or be assigned to ships of the fleet whose complement includes divers. Training and performance has been so successful that the lightweight diving gear (hose diving equipment for shallow water) has been discontinued as a supply item and is being replaced by scuba.

Figure 1—World War II OSS swimmer with extended fins, gimballed compass, and depth gauge.

Along with the increased freedom of movement and capabilities of the free diver came many new problems. The release from the surface attachment removed both the possibility of communication with the parent craft and the margin of safety afforded by the life line. The diver immediately became more susceptible to accidents resulting from improper decompression, inert-gas narcosis, oxygen and carbon dioxide toxicity, and mechanical failures in his equipment (Research Reviews, September 1955). Such accidents are complicated by the lack of a helmet to protect the diver from drowning while he is incapacitated. Almost all studies carried out by the Physiology Branch of ONR in this field have been directed toward acquiring an understanding of the mechanisms of the adverse effects of various components in respirable gas mixtures. When these mechanisms are adequately defined, it may be possible to reduce at least some of the existing hazards.

It was also observed that divers might be expected to make a series of dives within a few hours time and single multilevel dives for which proper decompression could not be calculated on the basis of existing tables. Along with these and other physiological problems came the need for lightweight flexible exposure suits, techniques and instrumentation for three-dimensional orientation and navigation, and special tools to enable the scuba diver to perform new and varied tasks.

The Bureau of Medicine and Surgery began a critical review of the literature relating to studies of high pressure physiology at the close of World War II. This review revealed that a major portion of the research up to that time had been directed toward defining the limits within which human exposures to the underwater environment could be made and toward methods of treatment when these limits are exceeded. While it was true that some research into the basic mechanisms of physiological phenomena relating to respiration at high pressures and to the adverse effects of the various gases in a respirable medium was being conducted, the effort was inadequate. By 1948, when the Navy first began training underwater swimmers, both the Bureau of Medicine and Surgery and the Office of Naval Research undertook to expand the interest in these problems.

The first large-scale effort to arouse interest was made in 1952 through the former NAS-NRC Committee on Amphibious Operations. The Committee sponsored the Cooperative Underwater Swimmer Project (CUSP) to obtain baseline data on swimmers under field conditions. While the participation in this project was broad and the data collected were valuable, most of the scientists who took part were already involved in swimmer research in some manner, and little recruiting of new interest resulted.

Studies of the performance of swimmers during the CUSP project indicated that the average water speed of submerged swimmers is 0.7–0.9 knots, with an oxygen consumption of about 1.5 liters per minute. These data have been confirmed by later studies in the laboratory and in the field. Figure 2 shows the general relationship between oxygen requirements and swimming speed based on all the known measurements. The exponential character of the curve results from the hydrodynamic characteristics of the swimmers. In one study, drag resistance was converted to work accomplished in terms of foot-pounds per minute and

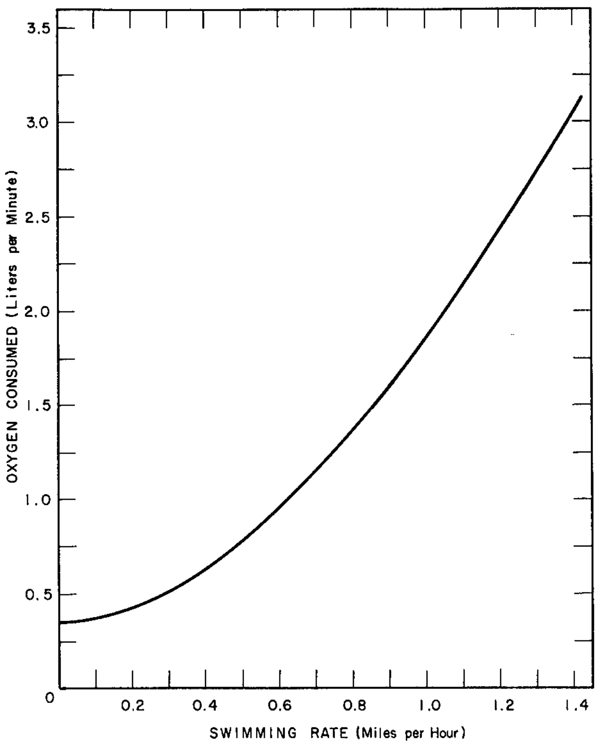
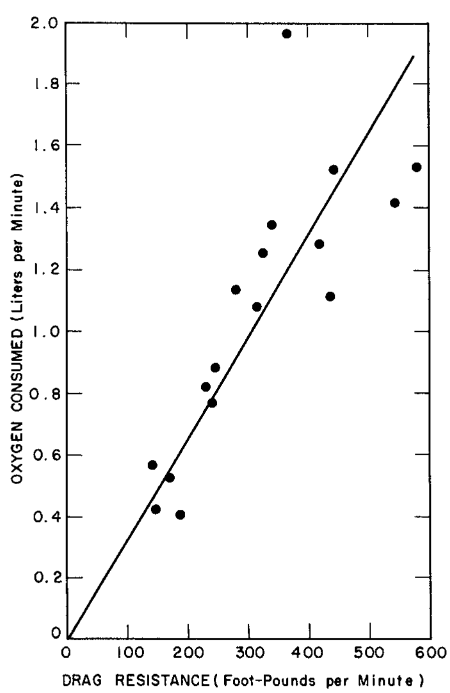


Figure 2—Oxygen consumption as a function of swimming rate. This is a faired curve based on about 500 swims in field and laboratory tests.

Figure 3—Oxygen consumption as a function of "work" in overcoming drag resistance.



compared with oxygen consumption (Figure 3). Motion pictures of the subjects in this study indicate that the marked deviations from the assumed linear consumption of oxygen (represented as a straight line on Figure 3) result from variations in swimming technique or improper adjustment of buoyancy, or both. Examples of the effect of improper buoyancy on swimming attitude are illustrated by frames from three film strips shown as a composite in Figure 4.

The effects of buoyancy, swimming technique, currents, etc., markedly influence the actual amount of oxygen required. The range of oxygen requirements for 200 open-water swims is shown in Figure 5. In general, it can be concluded that fin swimmers cannot be expected to

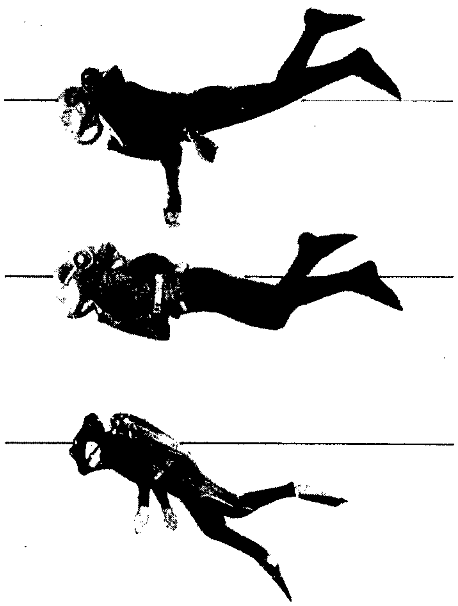


Figure 4—Effects of buoyancy on swimming attitude; top, high shallow kick; center, improved swimming stroke; and bottom, influences of excessive negative buoyancy (appearance of swimming uphill). From Journal of Applied Physiology, volume 10, page 200.

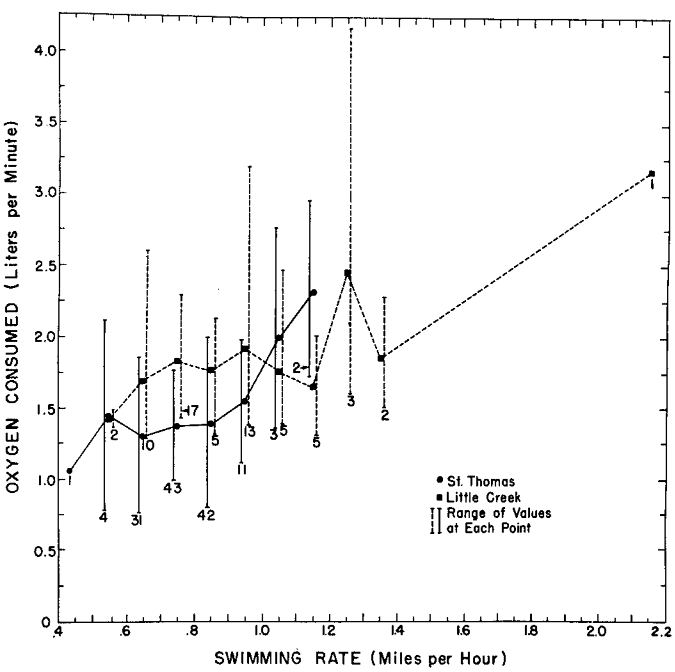


Figure 5—Oxygen consumption in open-water swimming. The point indicating a speed greater than 2 miles per hour is explained on the basis of current, 1.4 miles per hour being the greatest achieved under controlled conditions.

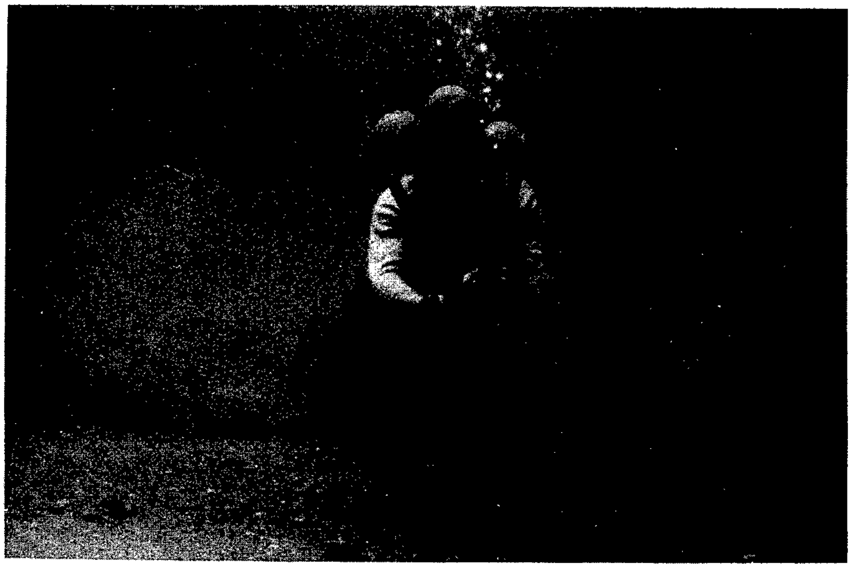


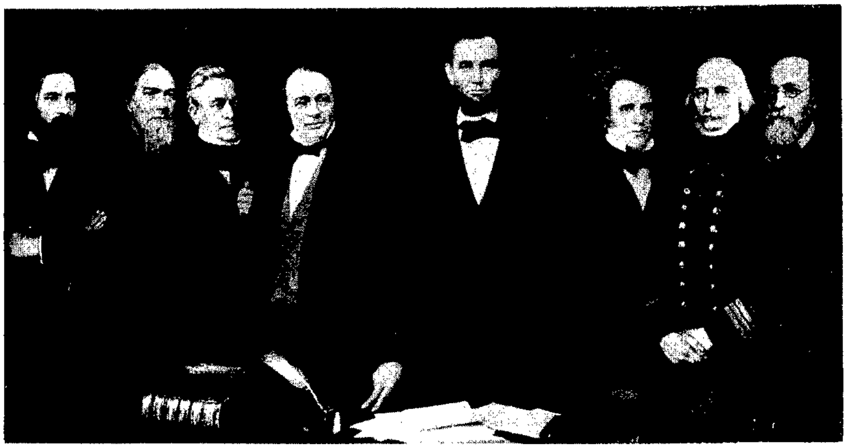
Figure 6—Diving geologist (see Research Reviews, July 1957) wearing an aqualung modified to provide additional air (extra bottle added).

operate in currents of 1 knot or greater, nor can they be expected to work for more than 2 hours continuously on a single dive.

The time limitation is imposed by currently available breathing equipment. Closed-circuit gear which provides pure oxygen could be designed for several hours gas supply but is restricted because of the present inability to provide for the efficient removal of carbon dioxide over long periods of time. Cylinders of compressed air would be too large and bulky if designed for several hours diving. A standard two-bottle (2-hour) unit (see photograph on page 14) is about the largest that can be safely handled. Additional air supplies have been added by individual divers to extend their submerged time (Figure 6) but such units are too heavy and bulky for routine use.

The second major effort to stimulate a broader interest in the study of underwater swimming was the Underwater Physiology Symposium sponsored in January 1955 by ONR and the Panel on Underwater Swimmers of the NAS-NRC Committee on Undersea Warfare. At this meeting a number of competent scientists reviewed both the basic and applied aspects of high-pressure physiology. At the close of the meeting it was evident that knowledge of almost every phase of the problem is inadequate.

ONR, the Experimental Diving Unit, and laboratories of the Bureau of Medicine and Surgery, Bureau of Ordnance, and Bureau of Ships are now conducting research on underwater swimming. However, before an effective research effort can be made, the role of the operational swimmer must be clearly defined, for some confusion and uncertainty still exist as to what it should be. Only after this primary question has been settled will it be possible to justify and initiate a fully adequate research program.



Reproduction of a painting of the founders of the National Academy of Sciences, showing four of the five members of the Permanent Commission. They are, at far left, B. Pierce; second from left, A. D. Bache; third from left, Joseph Henry; and second from right, ADM C. H. Davis. Joseph Saxton was the other member of the Commission.

The Naval Consulting Board. Bottom row, third from left, Thomas Edison; fourth from left, Secretary of the Navy Daniels; far right, Assistant Secretary of the Navy Roosevelt.

Genesis of the Naval Research Advisory Committee

O. W. Helm*
Administrative Assistant to the Chief Scientist
Office of Naval Research

As never before in history, our government seems determined not to be caught napping in the race for technological supremacy. At every level is a group of civilian scientists who are dedicated to the task of advising our public executives on scientific matters. At the top, assisting the President, is the Science Advisory Committee of the Office of Defense Mobilization. A step below, the Department of Defense has its Defense Science Board. The capacity of this latter group to effectively coordinate the work between government agencies and the civilian economy is indicated by the important posts held by its members. These include the chairmen of the Naval Research Advisory Committee, the Air Force Science Advisory Board, the Army Science Advisory Panel, and the Department of Defense Technical Advisory Panels, as well as the president of the National Academy of Sciences, the directors of the National Science Foundation, the National Bureau of Standards, and the National Advisory Committee for Aeronautics. Seven men selected at large round out the 25-member group. Altogether, the Defense Science Board provides a nexus for more than 25 public advisory boards.

The Navy has been no laggard in recognizing the importance of scientific research to military strength. Indeed, reliance on research advisory committees can be traced as far back as the mid-nineteenth century.

The first Navy scientific bureau, the Bureau of Navigation, was headed by ADM C. H. Davis, founder of the Almanac Office. Having served as a member of various advisory boards, Davis recognized the value of such groups and the need for creating a body to advise the Navy Department on scientific matters. His plan, in 1862, was to bring under one head all of the scientific departments of the Navy related to hydrography, astronomy, navigation, and surveying, including the Nautical Almanac, the Observatory, and the Naval Academy. He discussed the proposal with A. D. Bache, the Superintendent of the Coast Survey, and Joseph Henry, Secretary of the Smithsonian Institution. Both of these men fully endorsed it, and Henry immediately presented it to the Secretary of the navy, Gideon Welles. Subsequently, on February 11, 1863, the first naval research advisory committee, called the Permanent Commission, was created.

The scientific nature of the Bureau of Navigation was short lived. ADM Davis left the Bureau in 1865 to head one of its activities, the Observatory. In the same year, Secretary Welles transferred to the Bureau of Navigation the Office of Detail, charged with the assignment of

*The author has been Executive Secretary of the Committee since 1955.

officers to billets. The personnel problem inherited soon became so formidable that the navigation and instruments portion of the Bureau was relegated to a perfunctory status. Thus, the Bureau was transformed into the Navy's personnel agency, and responsibility for its scientific function was eventually diffused among the other interested bureaus.

Having submitted more than 250 reports, the Permanent Commission held its last meeting on September 21, 1865. In 1864, however, in connection with the investigation of superheated steam, the Secretary of the Navy set another precedent when he appointed a Civilian Commission on Practical Engineering, made up of three members from the National Academy of Sciences, three from Franklin Institute, and three selected at-large. The Commission was charged with devising the proper apparatus, and conducting the necessary experiments to ascertain the economies of using steam of different degrees of expansion in marine engines.

These first commissions were followed by many similar bodies created by the Navy for utilizing civilian experience and skill in solving major technical problems. The best known of these was the Naval Consulting Board, organized in 1915 at the request of Secretary of the Navy Daniels to consider the major problems of naval research and development, including not only such questions as new weapons and devices for submarine warfare but also the establishment of a naval research laboratory. The board consisted of Thomas Edison, as chairman, and two members from each of 11 national technical societies. Through its many subcommittees, such as those for submarines, transportation, production, organization, manufacture, and standardization, the board functioned very satisfactorily. Its chief contributions were the screening of some 40,000 inventions submitted to the Navy during the war, and the assistance it gave the Navy in obtaining counsel from scientists and engineers.

The Consulting Board was attached directly to the Secretary's office. A high-ranking officer was designated as Technical Aide to the Secretary and directed to act as a liaison between the board and the bureaus and other naval activities; in addition, he was also made head of a new Office of Inventions, through which all the inventions recommended by the board were channeled to the proper Navy agencies. These assignments were continued after the war and, when the Naval Experimental and Research Laboratory was commissioned in 1923, the Technical Aid was made the director of the Laboratory as well. By that time the Consulting Board had disbanded.

Just as the concept of the National Academy of Sciences emerged from that of the Permanent Commission, so to some extent the Naval Consulting Board paved the way for the Council for National Defense of World War I. And though the National Research Council of the National Academy of Sciences apparently arose quite independently, the Navy made extensive use of it also. For example, ADM Sims, top naval officer overseas during World War I, created a scientific division of his staff and placed the scientific attache of the NRC at its head.

During World War II, the Office of Scientific Research and Development served as overseer of the Nation's research and development effort. The Navy of course had a membership on this office's National

Defense Research Committee. This was the Coordinator of Research and Development, whose office evolved into the Office of Naval Research.

At the end of the war it became obvious that in the interest of national defense there must be provided a peacetime organization for keeping pace with increasingly complex technological problems and the implications of the nuclear era. Accordingly, Representative Vinson's bill, H. R. 5911, was passed by the 79th Congress (Second Session) and became Public Law 588 on 1 August 1946. The law simultaneously created the Office of Naval Research* and the Naval Research Advisory Committee.

The statute provides that members of the Naval Research Advisory Committee be appointed by the Secretary of the Navy. Membership is limited to 15 persons from civilian life, preeminent in the fields of research and development work, one member being selected from the field of medicine.

On May 15, 1946, just prior to promulgation of the law, ADM Bowen, then Chief of the Office of Research and Inventions, held an informal luncheon under the auspices of the Assistant Secretary of the Navy to discuss the formation of the Naval Research Advisory Committee. Those who attended were:

W. John Kennedy, Assistant Secretary of the Navy
RADM H. G. Bowen, USN
CAPT R. D. Conrad, USN
Dr. A. T. Waterman
Dr. Vannevar Bush
Dr. Arthur H. Compton
Dr. Karl T. Compton
Dr. E. U. Condon
Dr. Warren Weaver
Mr. H. A. Winne

These men, agreeing that the Committee should be established, outlined its operation and methods for selecting members. Later, they submitted a suggested membership to the Secretary of the Navy.

Initial members of the Committee were:

Dr. Warren Weaver (Chairman)
Dr. Luis de Florez (V. Chairman)
Dr. Detlev W. Bronk
Dr. Arthur H. Compton
Dr. Karl T. Compton
Mr. Richard J. Dearborn
Dr. Lee A. DuBridge
Dr. William S. McCann
Dr. Philip M. Morse
Mr. Lewis Strauss

*Replacing the Office of Research and Inventions, established May 19, 1945.

These members and their successors represent three important segments of our economy:

- Industry. This segment, which ultimately produces the equipments, has unique development capabilities and carries out many extensive research programs of its own. Many of our most remarkable achievements emanate from its shops and laboratories.

- Academic and non-profit laboratories. These are the most significant source of our research capability. Fortunately, leaders of the academic world are also thoroughly familiar with the Navy's problems.

- Governmental laboratories. This third element in the national research picture is responsible for a large amount of research and development. The government employs about 29,000 professional personnel for research and development (the Navy's portion is nearly 10,000). The work of our government laboratories is second to none.

Since its first meeting on October 14, 1946, the Committee has assembled 33 times. It has rendered valuable counsel in formulating plans for wartime organization of science, for scientific manpower mobilization, for the Navy's recommendation to the Department of Defense on a general policy towards the desired level of basic research to be maintained during a national emergency, and for the conduct of defense research projects at universities. Other advice has ranged from suggesting more efficient use of naval air power to the nomination of the Navy's scientific representation in England and on the continent of Europe.

When, in 1954, ONR was given management responsibility in the Navy's research and development budget by the Congress, and new responsibilities for Navy-wide coordination of development by the Secretary, the Office was solidly backed by NRAC. This broad responsibility of ONR came as a result of the tremendous growth of naval research and development during the past decade.

Before 1956, NRAC served primarily as an advisor to the Chief of Naval Research in developing the new Office of Naval Research. In January 1956, ADM Burke, the Chief of Naval Operations, requested the Committee to intensify its activities on his behalf. After carefully considering the consequences of actively extending its scope many fold, the Committee accepted the challenge. The Secretary of the Navy subsequently restated the mission of the Committee which, in essence, empowers it to initiate its own programs as well as those requested by the Secretary, the Chief of Naval Operations, and the Chief of Naval Research.

At NRAC's 27th meeting on January 17, 1956, its chairman stated that the Committee's duties are purely advisory or consultant and do not include any operating functions. Summarizing some of the guiding principles for operation in its new role, he said,

> We must emphasize again and again we should not do research. We must clearly define the functions which

> people in our position in the civilian economy can perform which are useful to the Navy, and should not undertake to do things the Navy itself will have to perform.
>
> Out of our earlier discussions comes a clear point. If we are to perform any function useful to the Navy, we must be better informed about the research aims of the Navy, and undertake a program of informing ourselves as to what is going on. We agreed that we must be concerned not only with the more limited problems of the Office of Naval Research, with which we are still concerned, but also those of the Chief of Naval Operations.
>
> I would like to emphasize again our task is not to find, as a committee or as individuals, solutions to those problems, but to understand what the problems are, what research is being carried on with relation to those problems, and perhaps offer judgment to the Navy as to whether the research effort is adequate or properly directed and properly staffed in order to meet the needs.

As the first step towards assisting the Committee in formulating a modus operandi for its enchanced mission, the Chief of Naval Operations has arranged briefings and orientation cruises, and has supplied reports to the members to acquaint them with the nature and employment of our naval forces. In addition, several subcommittees have been appointed by the Chairman to examine urgent problems in detail.

Recently, the Committee has assisted in the reorganization of the research and development planning structure of the Navy. Particular problems requiring well-balanced research have been thoroughly considered. Sample topics are "Jet Noise on Aircraft Carriers," "High Lift for Naval Aircraft," and "Long-Range Submerged Communications for Submarines"; these were formally reported upon by the Committee.

Sitting in council with the Assistant Secretary of the Navy (Air), the Assistant Chief of Naval Operations (R&D), the Chief of Naval Research, and other high Naval officials, the committee members have found that resolutions and formal reports, although important, are secondary to this face-to-face interchange of ideas between Navy leaders and the Navy's primary public scientific advisors.

The committee members—scientists and engineers of international reputation—are particularly fitted to translate the requirements of naval science into progressive naval research and development policy. Their combined technical knowledge and broad management experience is helping the Navy in three ways: Realizing the most from research funds, skillful deployment of research personnel, and optimum utilization of the Nation's research facilities.

Thus, the Committee brings together the Nation's superior scientific acumen and the Navy in the ever increasing task of maintaining technological superiority.

Members of NRAC

CHAIRMAN

FREDERICK E. TERMAN. Dean and Director of Electronic Research Laboratory, Stanford University.

VICE CHAIRMAN

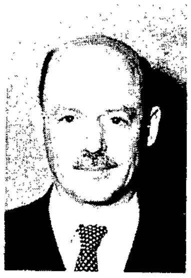
C. G. SUITS. Vice President and Director of Research, General Electric Co.

Dr. Terman joined Stanford University faculty as Instructor in 1925; appointed Professor and Head of the Department of Electrical Engineering in 1937. Director, Harvard Radio Research Laboratory, 1942-45. Appointed to present position in 1945. Member of various governmental bodies, including Defense Research Committee and Office of the Secretary of Defense. Appointed to NRAC on April 15, 1956.

Dr. Suits served as Physics Consultant, Forest Products Laboratory, U. S. Forest Service, 1920-30. Research Physicist, General Electric Co., 1930-40; became Assistant to Director of Research in 1940; appointed to present position in 1945. Member of governmental bodies, including the Office of Scientific Research and Development and the Research and Development Board. Appointed to NRAC on January 1, 1956.

ALLEN V. ASTIN. Director of the National Bureau of Standards. With Bureau of Standards since 1930, serving as research associate, physicist, assistant chief of Ordnance and Electronic divisions, and Associate Director. Appointed Director of the Bureau in 1952. Member of governmental bodies, including Defense Science Board, Scientific Advisory Board (Air Force), Interdepartmental Committee on Scientific Research and Development, Committee on the IGY, and National Advisory Committee for Aeronautics. Appointed to NRAC on February 15, 1953.

EDWARD H. HEINEMANN. Chief Engineer, El Segundo Division, Douglas Aircraft Co., Inc. Served as Draftsman and Body Designer for Yankee Motor Bodies Co., Standard Oil Co., and International Aircraft Corp. from 1925-28. Joined Douglas Aircraft Co., Inc., in 1928 as Chief Draftsman and Assistant Chief Engineer. Appointed to present position in 1936. Other affiliations include Lockeed Aircraft Co. (1931 and 1932) and Northrop Aircraft, Inc. (1932-36). Appointed to NRAC on January 1, 1956.



JEROME C. HUNSAKER. Emeritus Professor, Massachusetts Institute of Technology. Joined M. I. T. in 1912 as Instructor of Aeronautical Engineering. Served as Chief of Aircraft Design, U. S. Navy, 1916-23, and Assistant Naval Attache, London, 1923-26. Became Assistant Vice President of Bell Telephone Laboratories in 1926. Vice President, Goodyear Corp., 1928-33. Appointed Professor, Aeronautical Engineering and Head of the Department at M.I.T. in 1933. Director, McGraw-Hill Publishing Co., Inc., Shell Oil Corp., Goodyear Tire and Rubber Co., Sperry Rand Corp., and Regent of Smithsonian Institute. Member of governmental bodies, including National Advisory Committee for Aeronautics. Appointed to NRAC on February 15, 1953.

MERVIN J. KELLY. President, Bell Telephone Laboratories, Inc. Instructor of Physics, University of Kentucky, 1914-16. Physicist, Western Electric Co., 1919-25. Joined Bell Telephone Laboratories in 1925 as Physicist; became Director, Vacuum Tube Development Laboratory in 1930, Director of Research in 1936, and Executive Vice President in 1944. Appointed President of the Laboratories in 1951. Member of governmental bodies, including Scientific Advisory Board (Air Force) and Defense Science Board. Appointed to NRAC on May 1, 1954.

RICHARD A. KERN. Professor and Head of School of Medicine, Temple University. Professor of Clinical Medicine, University of Pennsylvania, 1928-44. Chief of Medical Service and Rehabilitation Officer (rank of Rear Admiral), U. S. Naval Hospital, Philadelphia, Pa., 1944-45. Chief, Division of General Medicine, Veterans Administration, 1946-47. Appointed to present position in 1946. Member of governmental bodies, including National Research Council, Office of the Assistant Secretary of Defense (R and D), and Defense Science Board. Appointed to NRAC on August 1, 1957.

AUGUSTUS B. KINZEL. President and Director of Research, Union Carbide Co. Served as metallurgist to General Electric Co. and Henry Disston and Sons, Inc., until 1926, then joined Union Carbide Co. as Chief Metallurgist and Vice President. He was appointed President and Director of Research of Union Carbide in 1954. Member of governmental bodies, including Metals War Production Board and Technical Industrial Intelligence Commission. Appointed to NRAC on August 23, 1950. (Vice Chairman, 1952; Chairman, 1953).

EMANUEL R. PIORE. Vice President and Director of Research, International Business Machines, Inc. Physicist, Electronics Research Laboratory, R. C. A., 1935-38. Chief Engineer, Television Laboratory, C. B. S., 1938-42. Senior Physicist, Bureau of Ships, 1942-44. Joined Office of Naval Research as Head, Electronics Branch, in 1946; served as Director, Physical Sciences Division, 1947-48; Deputy Director of Natural Sciences, 1949-51; and Chief Scientist, 1951-55. Appointed Director of Research, Avco Manufacturing Corp., 1955. Appointed to present position in 1957. Member of governmental bodies, including Scientific Advisory Committee, ODM; and National Research Council. Appointed to NRAC on April 15, 1956.

I. I. RABI. Professor, Columbia University. Joined faculty of Columbia University in 1929 as lecturer in Physics. Appointed Professor in 1937. Associate Director of Radiation Laboratory, M. I. T., 1940-45. Member of governmental bodies, including Office of Scientific Research and Development; Scientific Advisory Committee, ODM; and General Advisory Committee, AEC. Appointed to NRAC on March 15, 1952.

FREDERICK SEITZ. Head, Dept. of Physics, and Director, Control System Laboratory, University of Illinois. Instructor of Physics, University of Rochester, 1935-36; Assistant Professor, 1936-37. Research Physicist, General Electric Co., 1937-39. Assistant Professor, University of Pennsylvania, 1939-41; Associate Professor, 1941-42. Professor and Head of the Physics Department, Carnegie Institute of Technology, 1942-49. Appointed to present position in 1951. Member of advisory committees of the AEC and the Office of Scientific Research and Development. Appointed to NRAC on July 15, 1955.

NRAC Staff

EXECUTIVE DIRECTOR LAWSON M. McKENZIE

Physicist, Bureau of Ships, 1942-43. Technical Aide, Office of Scientific Research and Development, 1946-51. Executive Secretary, Interdepartmental Committee on Scientific Research and Development, 1952-54. Special Assistant for Research Administration, ONR, 1954-55. Joined NRAC Staff in 1955.

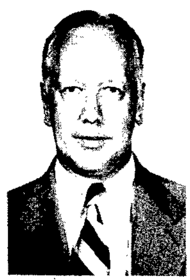
DEPUTY EXECUTIVE DIRECTOR WILBERT ANNIS

Geophysicist, Shell Oil Co., 1936-41. Physicist, Bureau of Ships, 1941-44. Appointed Head, Acoustics Branch, ONR, in 1946. Joined NRAC Staff in 1956.

EXECUTIVE SECRETARY O. W. HELM

EDWARD H. SMITH. Rear Admiral, U. S. Coast Guard (Ret.). Member of International Ice Patrol, 1921-24 and 1926-27. Member of Marion Expedition to the Arctic, 1928. Member of Graf Zeppelin Arctic Expedition, 1931. Member of the Staff of the Applied Physics Laboratory, Johns-Hopkins University, 1946-49; Project leader, Weapons System Evaluation Group, Office of the Secretary of Defense, 1949-51. Director, Woods Hole Oceanographic Institute, 1951-55. Appointed to NRAC on February 15, 1953.

JULIUS A. STRATTON. Chancellor, Massachusetts Institute of Technology. Joined M. I. T. in 1924 as assistant in the Communications Laboratory; appointed Professor of Physics in 1941. Served as staff member of M. I. T.'s Radiation Laboratory, 1940-45, and Director of the School's Research Laboratory of Electronics, 1945-49. Appointed Provost of M. I. T. in 1949, Vice President in 1951, and Chancellor in 1956. Member of governmental advisory groups, including Research and Development Board of the Office of Scientific Research and Development. Appointed to NRAC on May 1, 1954. (Chairman, 1955-57.)



ERIC A. WALKER. President, Pennsylvania State University. Appointed Chairman, Department of Electrical Engineering, Tufts College, in 1939. Associate Professor, University of Connecticut, 1940-42. Associate Director, Underwater Sound Laboratory, Harvard University, 1942-45. Director, Ordnance Research Laboratory, Pennsylvania State College, 1945-52; Dean, College of Engineering and Architecture, 1951-53. Appointed to present position in 1956. Member of governmental bodies, including Research and Development Board and National Research Council. Appointed to NRAC on January 1, 1956.

Former Members of NRAC

Dr. Detlev W. Bronk
Dr. Leonard Carmichael
Dr. Arthur H. Compton
Dr. Karl T. Compton
Dr. Lowell T. Coggeshall
Mr. Richard J. Dearborn
Dr. Luis de Florez
Dr. Hugh L. Dryden
Dr. Lee A. DuBridge
Dr. R. E. Dyer
Dr. W. V. Houston
Dr. J. A. Hutcheson
RADM Paul F. Lee (Ret.)
Dr. William S. McCann
Dr. Clark B. Millikan
Dr. Philip M. Morse
Dr. W. Albert Noyes, Jr.
Dr. J. Robert Oppenheimer
Dr. W. R. Sears
Dr. H. N. Stephens
Dr. J. E. W. Sterling
Dr. G. D. Stoddard
Dr. Lewis L. Strauss
Dr. Warren Weaver

On the Naval Research Reserve

Nuclear Sciences Seminar

The Fourth Annual Nuclear Sciences Seminar, sponsored by the Office of Naval Research in cooperation with the Atomic Energy Commission and its operating contractors, was held at Idaho Falls, Idaho, from July 21 to August 3, 1957. The seminar was arranged and conducted by NRRC 13-6, with LCDR Walter McHargue, USNR, serving as program officer. The purpose of the seminar was to give Reserve officers a better understanding in nuclear physics and nuclear power. Of the 48 Reserve officers who attended, 42 were of the Navy, 2 of the Coast Guard, and 4 of the Army.

The seminar was opened by LCDR Mark Baum, MC, USNR, Commanding Officer of NRRC 13-6. Present at this first session were the Hon. John B. Rogers, Mayor of Idaho Falls; RADM A. N. Bledsoe, USN, Commandant, Thirteenth Naval District; CAPT A. S. Boyce, USNR, Special Assistant to the Chief of Naval Research (Research Reserve); Mr. A. C. Johnson, Manager, Idaho Operations Office, Atomic Energy Commission; and Dr. R. L. Doan, Manager, Atomic Energy Division, Phillips Petroleum Co.

Both the theoretical and engineering aspects of the nuclear reactor field were covered. Scientific material was presented by representatives from the Idaho Operations Office of the Atomic Energy Commission, the Argonne National Laboratory, Westinghouse Electric Corp., General Electric Corp., and Phillips Petroleum Co. Lectures were presented daily and these were augmented by two days of field trips to the operations site on the desert near Arco. On these trips officers had an opportunity to see the materials testing reactor, surface ships reactor, and the submarine reactor. Tours were also made of the chemical engineering development laboratory, chemical processing plant, and the aircraft nuclear propulsion plant.

The program was highlighted on the last day by a panel discussion which summarized the seminar. The panel was made up of top scientists of the operating contractors.

Staff Corps Reservists Promoted to Lieutenant Commander

As reported in the July issue of Research Reviews, 55 members of the Research Reserve were selected for promotion to the grade of lieutenant commander by the Fiscal Year 1957 Inactive Reserve Selection Board. In the past months selections for lieutenant commander have been made by this year's board in the various staff corps. The seven Research Reserve officers promoted and their respective companies are as follows:

HAWTHORNE, Mary E.	1-1	SPERO, Leonard	5-3
EASTERDAY, Otho D.	3-9	BEDINGER, Robert E.	5-5
STOLL, Alice M.	4-2	WATKINS, Reynold K.	9-5
MOLNAR, Dorothy M.	5-3		

LCDR Dickins Retires

LCDR Dickins

On July 1, after 32 years of naval service, LCDR George F. Dickins, USNR, Commanding Officer of NRRC 8-7, Albuquerque, N. Mex., was transferred to the Retired Reserve.

LCDR Dickins has been a "Navy" man since birth. He was reared at Portsmouth Navy Yard, where, as a boy, he became well acquainted with ships and the ways of the Navy. He entered the Naval Academy in 1914 and later completed engineering studies at Cornell University. He then undertook postgraduate work at M.I.T. and Princeton. His father, CAPT C. H. Dickins, USN (Ret.), a former Chief of Naval Chaplains, is, at 93, the oldest living Naval chaplain.

LCDR Dickins served with the Navy during World War I, then was sent to the Far East by the State Department. After serving there for several years he was appointed U. S. Consul General at Singapore. Upon returning to the United States he was assigned to the Office of Naval Intelligence, in which capacity he investigated and reported on the activities of foreign agents in the United States. His next assignment took him to the Hawaiian Islands, where he was placed in command of the Naval Intelligence Units at Pearl Harbor, the Naval Air Base on Ford Island, and the Pearl Harbor Submarine Base.

In August 1941 LCDR Dickins was ordered to duty with the Seventh Fleet as a member of ADM Carpender's staff. He was sent with an advance force to Port Moresby, New Guinea, where he constructed and commanded the first advanced Allied naval base in the Southwest Pacific. Being the senior U. S. Naval officer in New Guinea, he maintained liaison between the U. S. Fleet, the British Naval Forces, and the famed GEN Blamey of the Australian Army Forces. His next command was the U. S. Naval Base at Townsville, Australia. When that base was closed, he moved north with the American Forces taking part in the Okinawan campaign, becoming Director of Economics for the Ryukyus Islands under the U. S. Military Government forces. LCDR Dickins was released from active duty in 1946 and has been an active member of the Research Reserve program since that time.

For the past 6 years LCDR Dickins has been a staff engineer in the Research and Development Division of the Sandia Corp. at Sandia Base, New Mexico. Primarily, he serves as a liaison between Sandia and the military services, ashore and afloat, in connection with nuclear ordnance.

LCDR Ross Receives Harmon Award

LCDR Malcolm D. ROSS, USNR, a member of NRRC 5-8, Washington, D. C., and a civilian employee of ONR's Air Branch, has received one of the 1957 Harmon International Aviation Awards. This is Mr. Ross' second award this year, for he received the Navy League Award in May (Research Reviews, June 1957). Two other winners of the Awards were LTCOL Frank E. EVEREST, USAF, and LCDR Morton L. LEWIS, USN. The formal presentation of the Harmon trophies are traditionally made by the President at a White House ceremony in the fall.

Mr. Ross and LCDR Lewis were cited as the top lighter-than-air pilots for their balloon flight to a record altitude of 76,000 feet on 8 November 1956. (The story of Mr. Ross' most recent balloon flight is told in an article beginning on page 1.) Mr. Ross was also cited for his direction of the project which developed the STRATO-LAB. His efforts "brought to fruition a concept of a laboratory in the stratosphere which opens the way to research in a vast new air world," the Harmon Award noted.

The Harmon Awards, founded in 1926 by COL Harmon, a pioneer aviator and balloonist, are considered the top awards for piloting skill.

Communications Via the Moon

The moon can be used as a radio relay station. That's the conclusion of scientists at the Naval Research Laboratory following 6 years of experiments, using 6 different radar sets. The discovery was announced by James H. Trexler during a meeting of the International Scientific Radio Unions (URSI) held in Boulder, Colo., from August 22 to September 5.

Mr. Trexler's research was begun in 1951 as part of a long-range project to study the moon by radar. The first experiments involved sending low-frequency pulses of electrical energy to the moon and back. On October 21, 1951, it was discovered that radar waves are reflected by the moon as if its surface were comparatively smooth, rather than rough, as it appears optically; thus it was believed the moon might serve as a relay station for radio communication. Continued experiments at the same and higher frequencies have confirmed this discovery.

Mr. Trexler and his associates also noted that their experiments gave a value for the distance from the earth to the moon that differed from that calculated from optical observations. Stimulated by this finding, NRL radio astronomers extended the investigations to super high frequencies, or microwaves. For this purpose, Benjaman S. Yaplee and his associates modified the Laboratory's 600-inch radio telescope so as to operate at 3,000 megacycles. On February 24 of this year, for the first time it is believed, they "bounced" a 3,000-megacycle radar signal off the moon. Three hundred times a second, a pulse which lasted only 2 microseconds was transmitted. About 2-1/2 seconds later, after a round trip of nearly 500,000 miles, it returned as a weak but detectable echo.

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LAST MONTH WITH VANGUARD

- The announcement that VANGUARD intends to launch a 6.4-inch instrumented sphere (see cover) late this year was greeted by some news media as an attempt to "get ahead of the Russians." Actually, the employment of the small sphere is part of a carefully thought out program of preliminary testing, undertaken to provide the greatest possible assurance that the ultimate firings of full-scale (20-inch) satellites will be successful.

Two launching-vehicle tests (TV-0 and TV-1) have already been completed. TV-0 was a modified Viking. TV-1 was a Viking pinch-hitting as a first stage with a prototype of the VANGUARD third stage as its second stage. TV-2, which may have been fired by the time this report is published, is a VANGUARD vehicle with a live first stage and the other two stages dummy but aerodynamically correct in weight and three-stage configuration. If this test is successful, it will be followed by four others, any one or all of which may carry a "payload" consisting of a magnesium sphere weighing about 4 pounds and measuring 6.4 inches in diameter.

As test objectives are reached in the step-by-step program, fewer test instruments will be required in the rocket. This decrease in weight will permit an increase in the rocket's velocity in later tests, but it is highly unlikely that an orbiting satellite will be achieved during the test phase of the project. Although the theoretical possibility of obtaining an orbit has existed throughout the planning of the test portion of the project, it is only incidental to the objective of the test program.

- A specially designed electronic data-reduction facility to process flight information automatically from each of the three-stage VANGUARD test vehicles and satellite launching vehicles will be installed at the Air Force Missile Test Center near Cocoa Beach, Fla. The new facility, which will be placed in operation by early fall, is a joint development of Radiation, Inc., Melbourne, Fla., and NRL.

Known as the Automatic Recording and Reduction Facility (ARRF), the new "electronic brain" operates on the same principles as a high-speed digital computer and will provide Navy scientists with final data on the performance of a VANGUARD vehicle in less than 72 hours after a firing. Formerly, it took weeks of painstaking analyses to reduce some of the data to usable form even though it was radioed from the rockets to earth in a matter of seconds.

- The Navy has announced that Daniel G. Mazur—an electronic engineer at NRL since 1946—has been appointed Manager, VANGUARD Operations Group, at Patrick Air Force Base, Fla. In this capacity, he will supervise the Navy's part of the operations at Patrick for the earth-satellite program.

- On August 15 the Navy opened the second Minitrack satellite tracking station at Navy Electronics Laboratory, San Diego, Calif. (The first was at Blossom Point, Md.; there are to be 10 altogether.) Two engineers of NRL's VANGUARD staff are assisting in operating the station. The instruments are being calibrated by a plane flown out from Patuxtent Naval Air Station.

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COVER PHOTO: A 6.4-inch satellite of the type that will be fired later this year as part of an intensive test program leading up to the launching of an instrumented 20-inch sphere during the IGY. The rectangular objects on the sphere's surface house solar batteries which are to be evaluated for possible use as power supplies for satellites launched later.

RESEARCH REVIEWS reports highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. Articles which meet these broad criteria and possess a good degree of readability are welcomed. Manuscripts and changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C. Research Reviews is listed for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Subscription price: $1.50 per year in U. S. and Canada; $2.00 per year, foreign; $.15 per individual copy. Approved by the Bureau of the Budget, February 28, 1955.