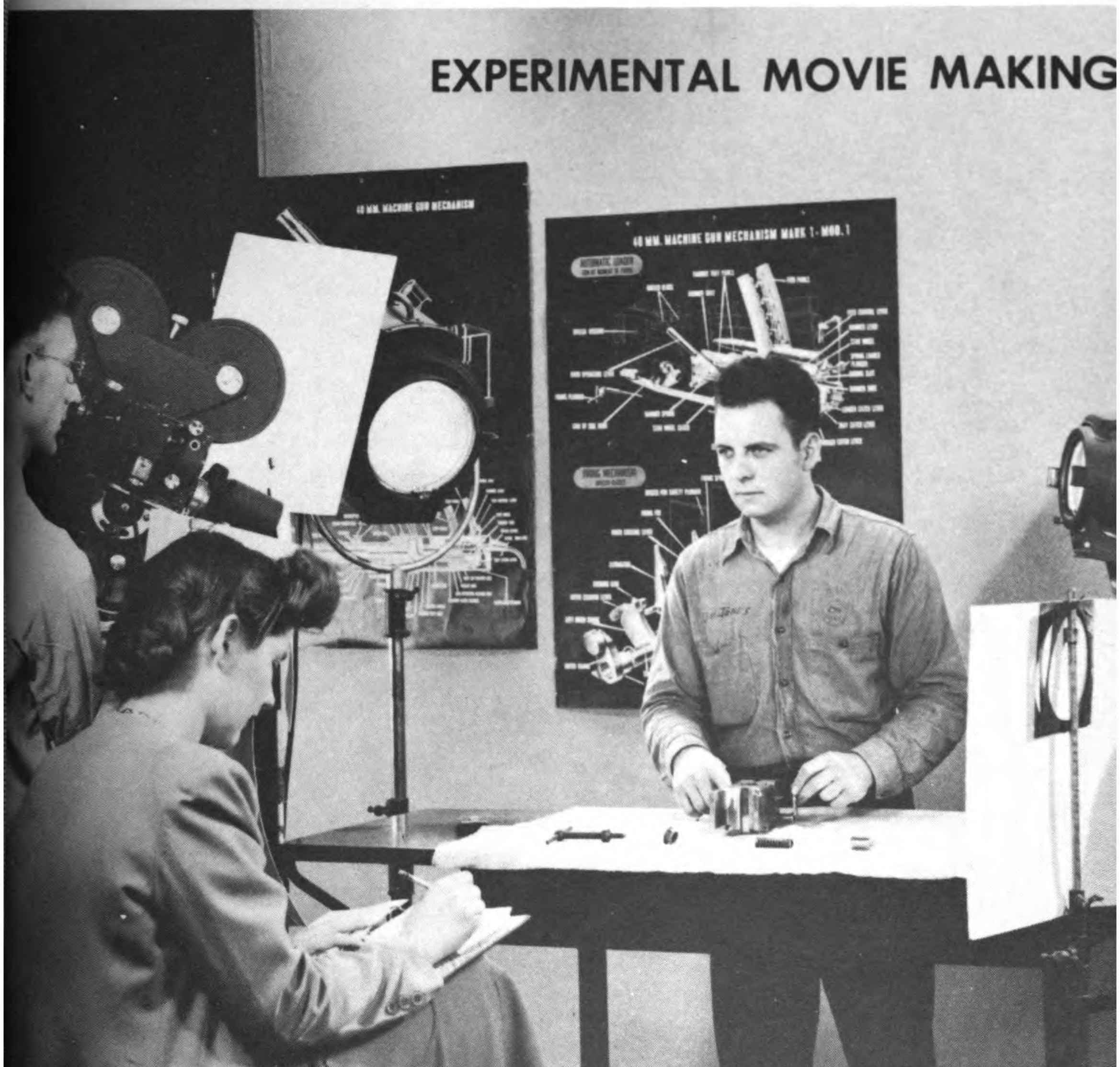
OFFICE OF NAVAL RESEARCH JULY 1951

RESEARCH REVIEWS



NAVEXOS P-510

DEPARTMENT OF THE NAVY
WASHINGTON, D. C.

COVER PHOTO: These movie makers are not producing any "super-colossal" epic that you will see in your local theatre. In fact only a selected few will ever see this film--for it is an experimental one, designed to test how well certain motion picture techniques can be used for instruction on military matters (in this case on the breech block of a 40-mm gun). It will eventually be shown to a group of Navy recruits like those pictured in the article "New Research Baby" on pp. 20-27 of this month's issue.

In this issue--

The first plane ever outfitted and used exclusively for Arctic research, this "flying laboratory" saw scientists and crew through numerous icy landings.

Operation Skijump -- Flying Research in the Arctic

A ski-equipped research plane, operating under ONR auspices, has succeeded in overcoming many of the obstacles that have kept the vast frozen deserts of the Arctic ice pack one of the few relatively "unknown" areas in the modern world. Ten members of a scientific expedition called "Operation Skijump" returned recently with some interesting information about these regions.

The mission, which left Woods Hole, Mass. early in March to begin this year's work, made use of a Navy R4D (two-engined Douglas plane) equipped with skis. A picked Navy crew was headed by LCDR Edward M. Ward, USN. The two civilian oceanographers on the expedition were John F. Holmes and Lawrence V. Worthington, both of the Woods Hole Oceanographic Institution.

Though the primary aim of the mission was to obtain oceanographic data--which has been practically non-existent for this area--another result was a definite demonstration that the icy wastes of the Arctic made excellent landing fields. As LCDR Ward phrased it, "I would rather lose two engines over the ice pack than any place in the U. S.--except, of course, Kansas." He reported that the ice strips used for landings were about 5,000 feet long, five or six feet thick and free of obstructions. So smooth was the ice in some cases that there was no necessity for using the skis--ordinary wheel landings were successful.

The procedure for landing consisted of making "touch-and-go" trials on the ice before settling down permanently. In one case a near mishap occurred when scientists making soundings discovered that it was only 18 inches thick and that the strip was bending under the 30,000-pound plane. All hands hopped aboard for a quick departure. Total time elapsed between landing and take-off--five minutes! This was the only occurrence of this kind, however, for the crew soon learned to distinguish between old, solid ice and that which was new and flimsy. In fact they became so adept at recognizing ice topography that they were able to predict the time of arrival at Point Barrow several hours before they landed by noticing the patterns visible in the ice formations.

The mission divided its efforts between short sorties when brief landings were made to take soundings and longer journeys when the scientists and crew settled down to do the arduous job of burrowing holes in the ice through which coring tubes could be lowered. During these operations the depth of the water, its temperature, salinity, direction of current and bottom samples were taken. Cutting a satisfactory hole through the ice presented some problems, however, for if the saw hit the water before the hole was almost complete, water rushed in and made further work impossible. Blasting was tried instead, but the cavities made by this process were, according to LCDR Ward "about as big as a Washington efficiency apartment" and presented a danger both

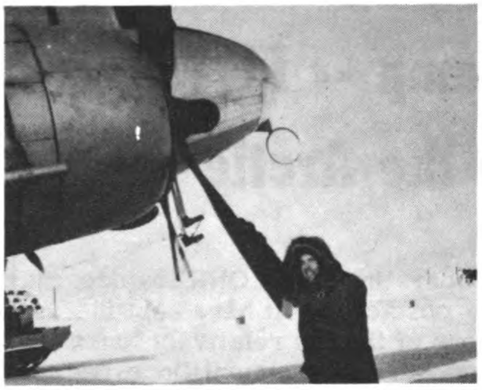


Figure 1 (left): Contact: Ready for take-off over the Arctic ice pack. Little trouble was experienced in cold starting of airplane engines.

Figure 2 (below): Having arrived at their destination, scientists and crew start cutting holes in the frozen ocean. They found evidences of animal life--shrimp and jellyfish--during one sampling of these waters.

to personnel and the plane. Finally a chain saw proved to be the solution to the problem.

Operations were carried out continuously while temperatures ranged from -25 F to 30 F, but little trouble was encountered in starting the engines "cold" even after periods of several hours on the ice. In this situation the crew benefited greatly from Air Force experience in cold weather engine starting techniques.

Altogether some 12 landing sites were established by the Skijump crew during the two months they spent in the Arctic area. The last of these established a record for a northernmost landing of a U. S. military plane--820 miles south of the North pole.

LCDR Geyer Honored for 30 Years' Naval Service

Rear Admiral Thorvald A. Solberg, retiring Chief of Naval Research, presents a painting of the USS MALOY to LCDR John H. Geyer, who recently completed 30 years of naval service. The MALOY was the last ship LCDR Geyer commanded. Though he is being transferred to the retired list LCDR Geyer will continue on active duty as Acoustical Scientific Officer in the Detection Section of ONR's Undersea Warfare Branch, where he has rendered valuable service since 1948.

Sound - Fertile Field for Research

by
R. B. Lindsay
Brown University

When you open your mouth to speak you are said to emit sound. If there is anyone in the vicinity possessing normal auditory apparatus or, in default thereof, a suitable hearing aid, he is said to hear the sound. This is one of the commonest of all physical phenomena. Men--and of course women--have been talking for a long, long time and legion are the poor victims who have had to listen to them. But the human voice, though often potent, is obviously not the sole illustration of sound; there are the sounds of inanimate nature like the thunder of a storm, the whistling of the wind, and the pounding of the surf, as well as the noises produced artifically by so-called civilized man--the boom of cannon, and the roar of traffic (not to mention the weird stuff that often emanates from radio loud speakers).

The subject of sound, with its appropriate Greek name of acoustics (which means hearing), is thus a very old one and presumably so thoroughly raked over that by now it should be completely understood and hence very dull physics indeed. That is certainly the impression one gets from most elementary textbooks. The fact is, however, that the common view is quite wrong and that there is still a great deal we do not yet know about sound. It involves mysteries as fascinating as those associated with the branches of physics now very much in the public eye, such as atomic energy and relativity.

Let us, at this point, be careful to avoid any possible misunderstanding. It is common knowledge that practical acoustics has made enormous strides in the past 30 years. The great improvement in the acoustical properties of rooms for listening to speech and music; production of new types of intense sound sources, both in the audible (low-frequency) and inaudible (ultrasonic) range; advances in the precise recording and reproduction of sound; transformation of the hearing aid into a highly sensitive and accurately prescribable instrument for the alleviation of deafness--these are only a few illustrations which testify to this development. But this progress has consisted primarily in the exploitation, by modern electronic techniques, of the fundamental theory of vibrations and elastic waves summarized so beautifully and completely by Lord Rayleigh. His famous treatise on the subject was first published in 1878, but is still, in its numerous editions, the Bible of acoustics. If Rayleigh really "knew it all," then modern acoustics is actually only a branch of engineering. In what sense, then, may we legitimately say

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R. B. Lindsay (A.B. and M.S., Brown University, Ph.D., M.I.T.,) was a fellow of the American Scandinavian Foundation in Copenhagen in 1922-23. He taught physics at Yale from 1923-1930, and then returned to Brown. Since 1936 he has been Hazard Professor of Physics and Chairman of that Department at Brown, where he is also Director of the Ultrasonics Laboratory and the Research Analysis Group (underwater sound). He is the author of numerous books and articles dealing with theoretical physics, and the methodology of physics and acoustics.

that sound still presents mysteries and unsolved problems to tantalize the physicist?

A simple and possibly trivial illustration will serve as the best introduction to our answer. Nearly everyone who has ever been exposed to an elementary course in physics remembers the celebrated demonstration purporting to prove that sound requires a material medium for its transmission. An electric bell, or other continuous sound source, is placed in a bell jar from which the air is sucked out gradually by a vacuum pump. The sound grows fainter as the air pressure falls, and finally it becomes inaudible. The conclusion is that the air, a material medium, is necessary for the transmission of sound. Now of course this is a good experiment and possesses an advantage over many elementary physics demonstrations in that it always works! It may be thought pedantic to criticize it. Unfortunately the simple explanation is not complete and the experiment does not actually prove what we say it does. Let us examine this a moment.

It is well known that the intensity of sound from an isolated point source in air or other fluid decreases with the distance from the source. The primary reason is the geometrical spreading of the radiation--the same amount of energy distributed over a larger surface means smaller intensity. But there is also another reason for the decrease: the absorption of some of the sound energy by the fluid itself, and its transformation into heat. Much effort has been expended in the attempt to explain this absorption and its dependence on the frequency of the sound as well as on the temperature and pressure of the fluid. Viscosity and the conduction of heat are two likely causes, and in certain gases, at any rate, account rather well for the observed loss of intensity. It is possible to calculate the sound absorption in air, due to viscosity and heat conduction at low pressures. It is found that, even at the pressures prevailing in the bell jar when the sound is inaudible, the amount of absorption is still not theoretically large enough to affect the intensity appreciably over the relatively short distance in question, at any rate not to make the bell inaudible. In other words, sound is still <u>transmitted</u> rather well in air in which the pressure is lowered to 1/1000th of its normal atmospheric value.

It is thus clear that another explanation of the bell-in-vacuum experiment is required. More careful investigation shows that the cause is not so much the inability of air at low pressure to transmit sound as inability to get the vibrational energy of the source (the bell clapper) <u>into</u> the rarefied air and then out again through the glass wall into the <u>room</u>. To use the electrical terminology which has been so successfully adapted to acoustical problems, the impedance mismatch between source of sound and surrounding medium has become too great with the lowering of pressure and density of the medium. This is the proper explanation of the bell demonstration. To avoid misunderstanding, it must be stressed that no physicist doubts that if we could achieve a perfect vacuum no sound would be transmitted through it.

The judicious reader will see at once that the real purpose of this story is to focus attention on the problem of the transmission or attenuation of sound in fluids. It has turned out to be one with many fascinating aspects and its successful solution requires all the paraphenalia of modern physical theory. In elementary, and indeed in most of the classical treatments of sound transmission in a fluid, we treat the medium as essentially continuous. This provides sufficient explanation for most of the common properties of acoustic waves such as reflection, refraction, interference and diffraction. But according to the kinetic theory, fluids are composed of molecules which are forever in motion and in frequent collision with each other. In fact it is by such collisions that we believe sound itself is propagated in a fluid. But the extra kinetic energy of the molecules in a given direction is dissipated by the more or less random motion of the molecules in all directions. This is the absorbing (or attenuative) effect whose two aspects we have already referred to previously as viscosity and heat conduction. This effect is measured by a so-called absorption coefficient, α, (which for a plane wave is defined as the natural logarithm of the ratio of the sound intensity at two different points along its path to the distance between them). α depends on temperature, pressure and frequency. Thus, for example, for helium at 15°C, standard atmospheric pressure, and a frequency of 1 megacycle, α has the value 0.055 cm^{-1}.

Investigation proves that the effect of viscosity and heat conduction is adequate to account for the observed absorption of sound in pure monatomic gases (e.g. the rare gases like helium) at all frequencies, and even in some polyatomic gases (like atmospheric oxygen and nitrogen, which are diatomic) over certain frequency ranges. Let us now give our attention to liquids. Here, with very few exceptions the absorption coefficient α calculated from the effect of viscosity and heat conduction is very much smaller than the absorption coefficient actually observed. (The effect of heat conduction is much less than that of viscosity.) Thus, in the case of pure water the measured value of α at room temperature exceeds that predicted by viscosity by some 2-1/2 times over a wide frequency range. The discrepancy in the case of many organic liquids is even greater. In chloroform, for example, at 10 megacycles, the observed value is 50 times the theoretically predicted one. In other words, chloroform absorbs sound to a much greater extent than we would expect from our calculations.

Such discrepancies are a great challenge to the theoretical physicist, and much effort has been expended in getting an adequate theory for the absorption of sound in liquids. It is only recently that progress has been made toward a satisfactory explanation and even now the results must still be considered tentative. The new theory is a bit elaborate, but its key idea can be explained as follows. According to the classical view, the viscosity of a liquid like water is associated with a shear effect of particles from particles and it would at first seem that this is the only kind of viscosity that a liquid can have. Nevertheless it is perfectly possible to imagine the existence of a bulk or expansion viscosity, defined as the ratio of the excess pressure producing a squeeze in a liquid to the rate of squeezing, just as the shear viscosity is defined as the ratio of the shearing stress to the rate of shearing. We must add to the introduction of the bulk viscosity the further notion, already familiar in dynamic elasticity and a number of other fields of physics, of "relaxation". Thus when you put excess pressure on water or another fluid, you do not squeeze it into a smaller space all at once, any more than you succeed in charging a condenser up to its full charge instantaneously when a steady voltage is applied to it through a resistance. In processes of this kind there is always a time lag which we call the "relaxation" time. This means that, in the progress of a sound wave

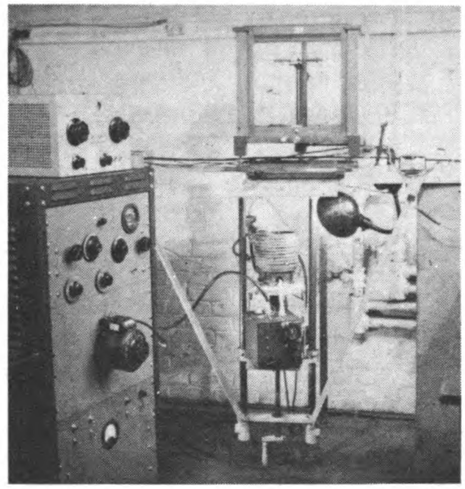

Figure 1. Apparatus for measuring sound absorption in liquids by the radiation pressure method. The vertical tank shown in the center, which contains the liquid, is shown surrounded by a cooling coil. The quartz crystal transducer is in the center of the bottom plate of the tank while the sensitive balance is directly above the tank. Electronic equipment for driving the crystal is shown at the left. Note that the tank may travel vertically on the guide rods shown. (Ultrasonics Laboratory of the Department of Physics of Brown University operating under the sponsorship of ONR).

through the liquid, the excess pressure and the resulting excess density do not keep step and this results in energy dissipation. As a matter of fact, the greater the relaxation time, the greater is the resulting absorption coefficient. But the relaxation time is directly proportional to the bulk viscosity. Hence, if the bulk viscosity can be calculated along with the change in effective compressibility due to the relaxation, the relaxation time can be calculated, and hence the absorption. Or it may even be possible to calculate the relaxation time by an independent theory based on assumptions concerning the molecular structure of the medium. This has been done for water by L. H. Hall at Brown University (Physical Review, 73, 775, 1948), and the calculated dependence of the absorption coefficient α on frequency and temperature agrees very well with that observed in measurements made in several places, notably the Catholic University of America, Cambridge (England) and Brown University.

Several methods have been devised for the measurement of the absorption of sound in water and other liquids. A favorite one, in use at Brown and elsewhere, employs the fact that the radiation pressure of a progressive sound beam, which is proportional to the intensity of the sound, can actually be "weighed" by a sensitive balance. An apparatus for this purpose is shown in Figure 1 and explained in the accompanying legend.

Why should anyone be interested in explaining the anomalous absorption of sound in water, or why, for that matter, should anyone be interested in sound absorption at all? The strict philosophical answer is, of course, that we don't know why scientists want to know anything about anything! People just seem to have an insatiable curiosity over puzzling problems no matter how trivial they may appear to other people. It is presumably the task of the psychologists to explain this inquisitiveness which is the basis of all science.

There are, however, practical considerations involved here. It is scarcely an overstatement to say that the Navy is definitely interested in the propagation of sound in sea water and hence in the absorption coefficient. This interest is a definite incentive for finding out everything possible about the subject, including rather elaborate theoretical investigations, on the general principle that one can never be sure when a highly abstract and apparently trivial result will turn out to be of vast

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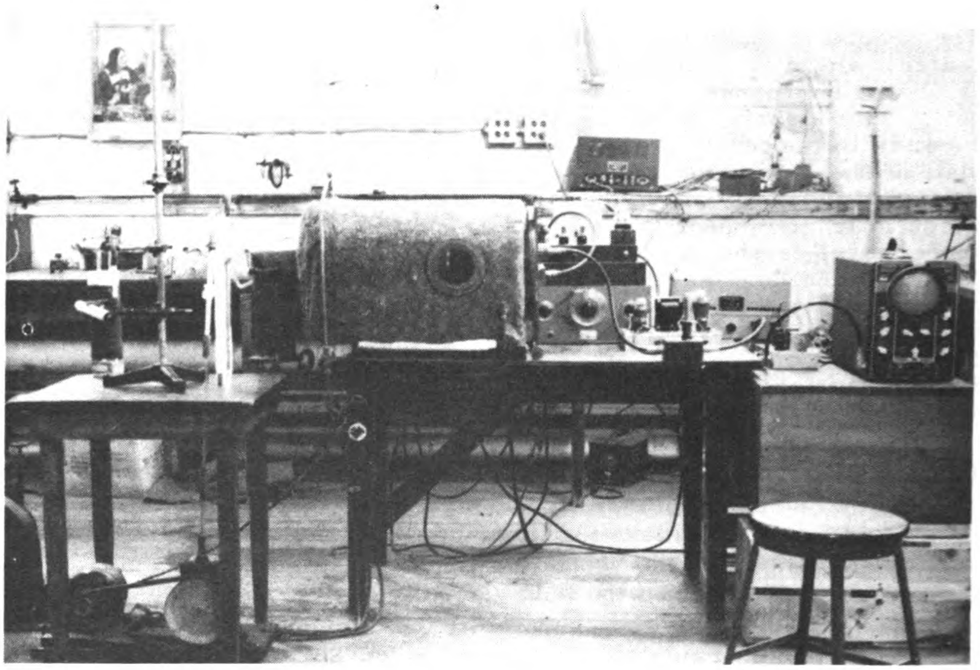


Figure 2A. Apparatus for measuring sound absorption in gases at low pressure. The air tank in the center of the picture is two feet long and is covered with insulating material. The pumping and drying equipment is at the left and the associated electronic equipment at the right. (Ultrasonics Laboratory of the Department of Physics of Brown University).

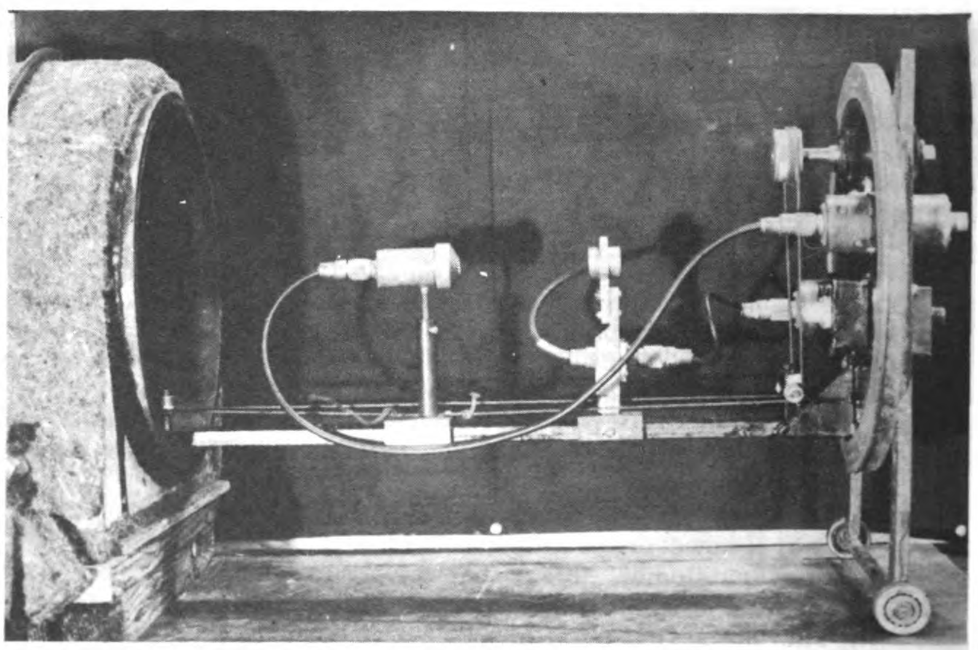


Figure 2B. The interior acoustical equipment of the tank shown in Figure 2A. The relative positions of the pulsing sound source (right) and sound receiver (left) can be changed and controlled from outside the tank when the pressure is decreased.

technological significance. Hence we want to know, for example, why sea water is more highly absorbent than fresh water at the same temperature and frequency. It begins to seem likely that another type of relaxation process, involving chemical dissociation, is at the bottom of this. Work along this line is now in active progress.

Let us conclude this brief excursion into the absorption of sound by reverting to the illustration with which the subject was introduced. Absorption of high-frequency sound in rarefied gases is of more than academic interest. Factors already suggested in the explanation of the bell-in-vacuum experiment make the measurement of α difficult for gases at very low pressures. It is only recently that reasonably reliable results have begun to appear. For frequencies in the megacycle range, an acoustical interferometer technique appears to give the best results (cf. M. Greenspan, Jour. Acoustical Soc. America, 22, 568,1950). For the lower ultrasonic range, however, a standard one-way transmission technique in a tank would seem to be indicated. The accompanying photographs (Figures 2A and 2B) show such an apparatus, currently in use at Brown. So far absorption runs have been made down to pressures of the order of 5 mm of Hg at a frequency of 70 kc. The equipment can probably be operated at a pressure of 1 mm of Hg.

Here again there are some interesting theoretical implications. The classical theory of sound absorption due to viscosity and heat conduction ought to hold pretty well for a monatomic gas at normal pressure and not too high frequency. For low pressure and very high frequencies, however, for which the wave length of sound and the mean free path of the molecules come closer together, the hydrodynamic equations connecting stresses and rates of strain in a viscous and thermally conducting gas no longer are accurate and must be corrected by extra terms calculated from kinetic theory. These calculations lead to a small, though significant, decrease in the predicted absorption coefficient as compared with the classical value for the low pressure - high frequency region. Curiously enough, the measurements so far carried out (cf. Greenspan, loc. cit.) agree better with the classical theory than with the kinetic theory correction. So here is another puzzle connected with the absorption of sound! Its solution will demand more careful investigation by way of both theory and experiment, but we may be confident it will not be long delayed.

(The author desires to acknowledge his indebtedness to colleagues in the Ultrasonics Laboratory of the Department of Physics of Brown University for the photographs presented in this article.)

SDC Develops Sub Helmsman Trainer

Another ingenious device has been added to the large assortment of training aids developed by the Special Devices Center of ONR. The Submarine Helmsman Trainer, an electromechanical device housed in a single portable metal cabinet, will train submariners in continuous maintenance of course under a variety of simulated sea conditions. Designed for use aboard Dockside Reserve Subs, the gadget is able, with the boat moored and motionless, to create for the helmsman the same compass readings that would obtain under given weather conditions and sea states.

Who's Who in Naval Research

Rear Admiral Bolster

Rear Admiral Calvin M. Bolster, the new Chief of Naval Research, is an officer who seems to fit his job like the proverbial glove. He is a Navy man to the core, with a keen appreciation of the problems of scientific research and the peculiarities of the analytic mind.

It is quite a look-back to June 1923 when LT Bolster, fresh with a Master of Science degree from the Massachusetts Institute of Technology, reported for duty to the Naval Air Station, Lakehurst, N. J. This same year saw him Production Superintendent during the construction of the USS Shenandoah, the Navy's first dirigible. He was also in charge of the erection and operation of the first successful helium purification plant while at Lakehurst.

Then in 1927, as Experiment Officer and First Lieutenant on the USS Los Angeles, he designed and tested the trapeze and airplane hookup equipment which permitted airplanes to be operated from airships. Back in Lakehurst, he developed mechanical handling equipment for large airships. After working with the Goodyear Zeppelin Corporation in connection with the building of the USS MACON, he served as her First Lieutenant continuously until the MACON crashed in the Pacific off Point Sur, California, in 1935.

In 1940 he reported to the Bureau of Aeronautics in the Engineering Division, having received another degree (master of Science in Aeronautical Engineering from the California Institute of Technology). There he was directly responsible for the arresting gear installed in our carriers which permit planes to land aboard, for the airplane launching equipment used on naval vessels, such as catapults and other assisted take-off devices. For this work he was awarded the Legion of Merit. In 1946 he became Deputy and Assistant Chief of ONR, a position which he has held continuously except for 15 month's duty as the Assistant Chief of Research and Development of the Bureau of Aeronautics.

It is obvious that a lot of history goes into the making of a personality capable of guiding the destiny of ONR research--a history which shows how RADM Bolster grew into more and more responsible positions. Fortunately it is the kind of background that is needed if the research program of the Navy is to continue to pay off in a powerful and progressive operating fleet.

Alaskan Bird Migrations

by
Donald R. Griffin
Cornell University

Despite the plentiful navigation aids provided for our airplanes, poor visibility still presents major problems and hazards. Passengers and pilots alike feel isolated and somewhat "lost" when flying at night or in thick weather. Hence, it is only with a feeling of humility that one compares human air navigation to the bird migrations, which cover thousands of miles from the Arctic to the Tropics, without the aid of engines or instruments. Could our air navigation profit from a study of the methods employed by birds to guide their flight over trackless stretches of land or ocean? Before we can answer such a question, we must first know what the birds' methods really are.

First, it might be well to question why millions of birds bother to fly north at all. Why should they leave the temperate latitudes for the exertion and hazard of long annual migrations? Crowding, competition for nesting space, and even memories of ancestors who lived millions of years before--all of these factors have been suggested to account for the annual mass movement (Thompson, 1926).

Only recently another factor has attracted attention--the length of daylight, which depends directly on latitude. There have been few actual attempts to study this matter in the Arctic; hence, I should like to mention an observation which seems to be significant in this connection.

In 1948 scientists from Cornell made continuous observations of nesting birds, at Point Barrow, Alaska, for from 24 to 48 hours at a stretch. They found that in the continuous daylight of late June (69°23′ North latitude) robins brought food to the young during 21 hours of the day, resting for only three hours in the middle of the night when the temperature was just above freezing. In contrast, the same species (Turdus migratorius) in the northern United States feeds its nestling young for only about 16 hours a day. The arctic robins made an average of 137 feeding trips per day, compared to 96 made by the others. More important, the arctic birds matured faster--the brood observed left the nest 8.8 days after hatching, compared to an average of 14 days for the same species in the northern U.S. Now it is well known that the period when young birds must remain in the nest is one of the most dangerous in their lives, for they are helpless and readily located by enemies. Thus, it seems possible that shortening of the nestling period increases their chance of survival enough to justify the migration to the arctic latitudes; but further study is necessary to find a definite answer.

Donald R. Griffin (B. S and Ph. D. Harvard University) is well known for his studies on the use of ultrasonic sound by bats to guide themselves through darkness. His other research interests have included investigations of the physiology of protection from cold (in men and animals) and various aspects of physiological optics and acoustics. At present he is Associate Professor of Zoology at Cornell. He first presented the material contained in this article at a meeting of the Alaskan Science Conference held earlier this year.

Essentially the problem of bird navigation is a double one: first, to discover which of their senses tells birds the right direction for a migratory flight, and second, to find the environmental clue which provides the information (Griffin 1944). There is much disagreement about the sensory mechanism responsible for bird navigation. We know that in birds, vision is developed to a much greater extent than the other senses. Yet it cannot account for all bird navigation, for many migratory flights take place at night, through clouds, or even in fog.

One popular theory claims that birds are sensitive to the earth's magnetic field and guide their motions accordingly (Yeagley 1947), but there is little supporting evidence for this idea (Thorpe, et al 1949; Gordon 1948). Another hypothesis advances the idea that birds can perceive the mechanical forces resulting from the earth's rotation. There are enormous difficulties, however, in the way of a bird's being able to feel such effects.

Thus, there is little to encourage us in the many theories which suggest that some new "sense" accounts for bird migrations. But there are other explanations which credit bird navigation to clues perceived by the known sense organs. These theories, if valid, might offer more hope for application to human air navigation. For whatever a bird can see or feel might also be detectable by men.

In this connection we must first consider a theory which undoubtedly has some validity, though it does not provide a full explanation. This is the simple idea that birds rely on contact flying. We know that birds have performed amazing feats in remembering details of things they have seen. B. F. Skinner, for example, has trained ordinary domestic pigeons to peck at a specific object in an aerial photograph of a small area of ground with food as a reward. He found that even four years after their last observation, the birds were able to remember it well enough to peck immediately at the appropriate point, even though they had seen nothing in the meantime which even resembled the picture. This type of experiment should be extended to include photographs of terrain of interest to migrating birds; even now, however, there is enough evidence to show that birds have highly developed ability to remember the physical features of a landscape.

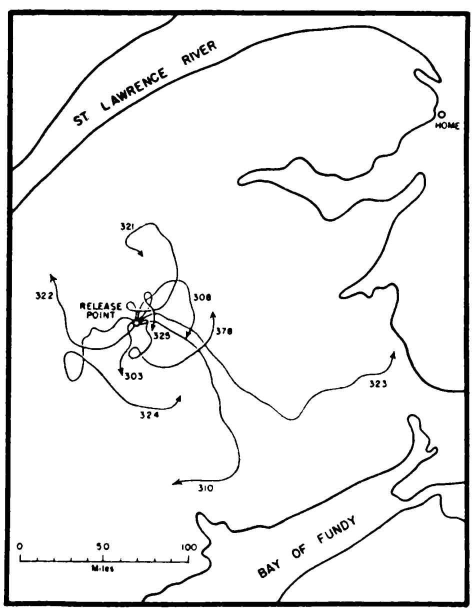


Figure 1. Actual flight paths of homing gannets released at Caribou showed that birds explored in all directions before reaching the coast and presumably familiar territory.

Another example of the importance of landmarks was indicated by experiments conducted in 1947 by R. J. Hock and the author. We were interested in the ability of birds to perform a sort of artificial migration after they are caught in their nests, carried in closed boxes to territory unknown to them, and then set free. Many species have returned hundreds of miles in a few days after such sorties. A study of this type of navigation might help explain natural migrations.

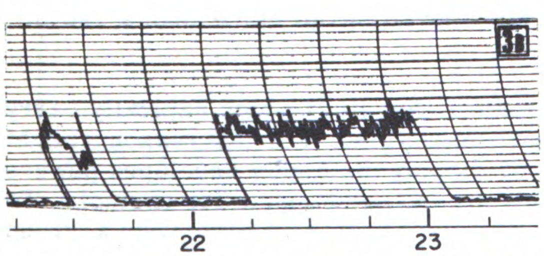
The gannet, a large white sea bird, which nests on an island in the Gulf of St. Lawrence was chosen for our first experiments. Seventeen of these birds were carried inland to northern Maine, a locale 215 miles from their nests, 100 miles from the nearest salt water and definitely new to them. After releasing the birds, we followed their flight in a small airplane in such a way that we could watch a particular gannet for hours at a time. We kept the plane 1500-2000 feet above the birds, which did not seem to be at all disturbed. We found that 62.5 percent of the birds returned home in from 1 to 4 days--a homing performance approximately equal to that of the several other wild species studied in the same way. Nine of the gannets were followed from the airplane for from 25 to 230 miles, while the remaining 8 were used as controls. The performance of the two groups was not appreciably different.

Figure 2. The author holds a long-billed dowitcher after attaching a radioactive tag to its left leg. The tag consists of an aluminum capsule less than 1/4-inch in diameter, with the radioactive material sealed into its center.

Figure 1, showing the paths of these birds, demonstrates graphically that the homing flight was not necessarily direct. Some birds which showed the most marked deviations nevertheless reached their nests within 2 to 3 days. Furthermore, mathematical analyses of more extensive homing experiments reveal that it is quite possible that other species which have returned from several hundred miles may also have found their way by exploration. Yet before airplane observations had been made it was almost universally believed that birds flew roughly straight home in such experiments--deviating no more than a few degrees from the direct path.

Gannets, however, are not among the birds which naturally carry out the longest and most impressive migrations. For this reason it might be argued that they simply did not display the highly developed powers of navigation characteristic of plovers and sandpipers, for example. To obtain evidence on this comparative aspect of bird navigation a group from Cornell University, based at the Arctic Research Laboratory at Point Barrow, spent the summer of 1948 studying birds in arctic Alaska.

Figure 3A. Dr. R. J. Hock places Geiger counter near nest of semi-palmated plover, whose eggs are camouflaged to resemble pebbles. The cable is later buried and the box containing the recording meter is concealed. Figure 3B shows record obtained with this mechanism. Fluctuating baseline shows natural background radiation level, and the abrupt rise at 21 hours and 29 minutes shows the precise moment of the bird's return.



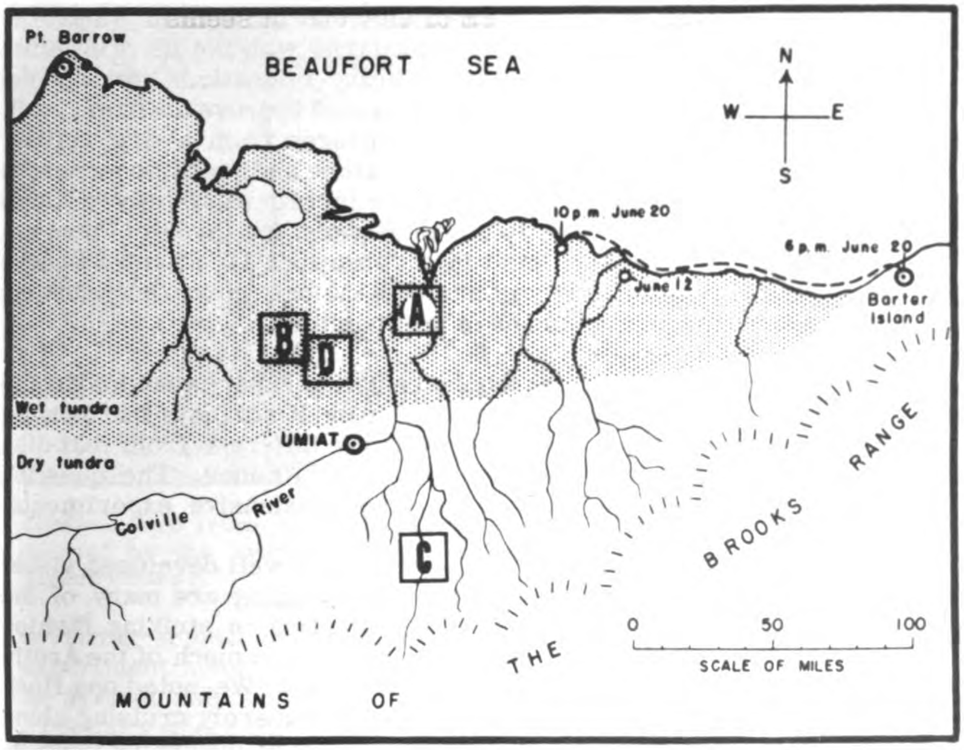


Figure 4. Map of arctic coastal plain of Alaska. A, B, and C are points where semipalmated plovers were released to test their ability to find their way home to their nests at Umiat. Also shown are the points where a large flock of snow geese was observed and the distance evidently flown by these birds during four hours of non-migratory cruising.

Semipalmated plovers (Charadrius hiaticulatus semipalmatus), nesting at Umiat on the Colville River, proved well suited to homing experiments, except that the number of nesting pairs accessible to us was too small to permit homing experiments on the scale desirable. The few birds available, however, gave results comparable to homing experiments in temperate latitudes.

Since the birds would have been frightened by observers watching too close to their nests, a different method of recording their movements was devised. Harmless radioactive tags were attached to them. Then Geiger counters were placed near the nests and records of background radiation made. An increase in radiation indicated return of the birds (see Figures 2, 3A and 3B).

Figure 4 shows Umiat relative to the Arctic Ocean and the Brooks Mountain Range. The plovers used for these experiments probably had reached Umiat by flying through one of the passes in this range of mountains, according to studies made by Dr. L. Irving and his associates. For this reason, we believe that the coast of the Arctic Ocean and a strip of territory between the ocean and Umiat had not been visited by these birds. When one plover was taken to point A, in the unknown territory (55 miles NE of Umiat on the Colville River) it required 14 hours to return. Yet this same bird returned in only 5-1/2 hours when released at point C, a comparable distance away, at a point on the Anuktuvuk

River, 49 miles SE of Umiat. It seems likely that the striking improvement of homing speed could be due to familiarity with the terrain, since the species of bird used is one found in heavy migrations through the valley of this river. Another experiment seemed to prove the same point. A few miles north of Umiat, the tundra changes from a dry, rolling, prairie-like terrain to a flat area broken by lakes and ponds so numerous and so similar in shape that pilots find the terrain extremely difficult for contact flying. So, apparently do the plovers; for three of them, released 33 and 48 miles NW of Umiat in this area took 10, 21 and 35 hours to return. The ten-hour flight was made on the only clear day when the snowcapped Brooks range would have been visible.

Despite the numerical inadequacies of the experiment and some possible complications caused by poor visibility, it suggests that homing by birds which nest in the Arctic is not much different from that displayed by many species studied in temperate latitudes. The question deserves a more conclusive answer based upon extensive experiments.

In addition to the evidence that birds have a well developed visual memory, it is important to realize how wide-ranging are many of the larger species. This was brought to our attention in striking fashion during the summer of 1948 when we made flights over much of the Arctic looking for nesting birds for homing experiments. We noted one flock of snow geese which were not migrating but were merely cruising along the coast in search of food or nesting sites. From observing them at various points, we concluded that they had covered 120 miles in four hours or less. When we allow for the age which ducks, geese, and other large birds are known to attain, it is easy to imagine that in a few years they become familiar with a great expanse of territory.

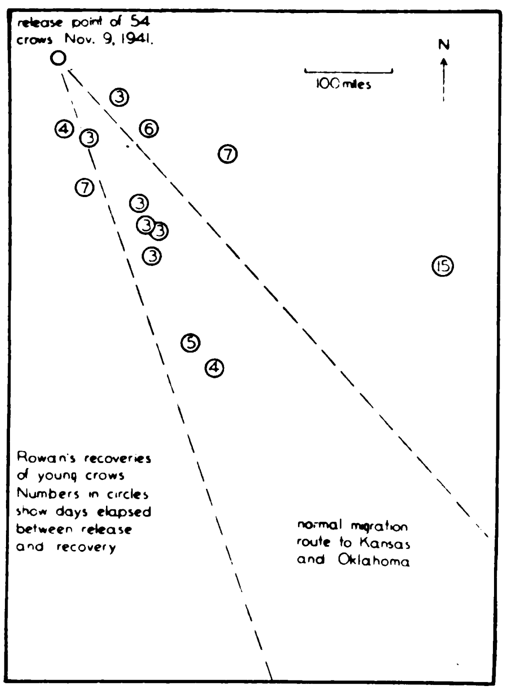


Figure 5. Map of experiment performed by Rowan which showed that young crows could migrate in the correct general direction even after being held in captivity until all adults of species had migrated southeast.

Yet visual landmarks can hardly explain the migratory flights of young birds not guided by adults. We have some rather interesting evidence on these migrations. Several weeks after all the adult wild crows from a certain section of Alberta had migrated southeast to their winter range (known from recoveries of banded birds) Rowan (1946) released some young crows. The intensive local publicity accompanying the release resulted in several reports and recoveries of the young birds at the points indicated in Figure 5. The number within each circle represents days elapsed between release and capture. In a similar experiment performed many years ago with white storks the young birds flew in directions roughly equivalent to their normal migration but

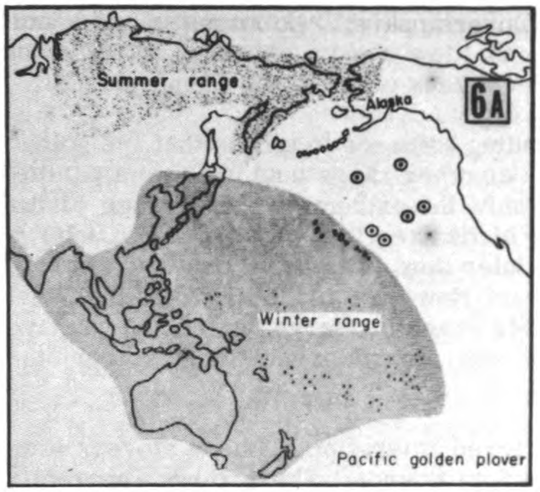


Figure 6A. Migration of Pacific golden plover (6B) from a summer range in Siberia and northwest Alaska to a winter range in the southwest Pacific. Records of this species sighted from ships in the northwest portion of the Pacific are indicated by the symbol ⊙, showing that several birds were not flying a direct course.

deviating sometimes by 30 to 40 degrees (Schuz, 1949). Still another experiment involved capturing adult hooded crows as they passed through an area on the coast of the Baltic Sea, and transporting them west to Flensburg where they were released to continue their spring migrations (Rüppell, 1944). All but one of these recoveries lay to the north and east of Flensburg, in an area roughly the size of the normal summer range, but displaced westward. It appears that the crows continued in the normal direction of their spring migration but flew into Denmark instead of into the Baltic States and Finland.

These three experiments and the one involving the gannets suggest a concept of migration which is different from that ordinarily presented. Clearly, there must be some factor, not yet understood, which guides migrating birds in the right general direction. But it seems that this guidance may not be as precise as we have often believed. The three experiments with young migrants, for example, showed a tendency for the routes to be scattered over an angle from 30 to 90 degrees. If it were true that bird migrations were guided only with this degree of accuracy then at least it would not be necessary to explain a pin-point type of navigation. It has often been argued that, because birds frequently return hundreds of miles to breed in the same small area or even at the same nesting site, they must be able to set a very precise course from their winter range. But if the birds have well developed visual memories and can use exploration at the end of the flight to determine where they will stop, there would be no need for such precision. We know, in fact, of no case where a bird steers a straight course for a distant goal across trackless areas.

Spectacular cases where precise navigation has seemed necessary are the annual flights of many birds to small islands. The Pacific golden plover (Figure 6, A and B), for instance, migrates from the arctic tundra where it nests, through the Alaskan Peninsula and the Aleutian Islands to a winter range which includes almost all the islands of the Pacific Ocean. In the case of those birds which fly to the Hawaiian Islands, it has been argued that they must use precise navigation to cross 2000 miles of open sea and yet strike an island which is only a few miles wide. Since the golden plovers apparently do not rest on water and hence must make the journey non-stop this has always appeared to be one of the most impressive and mysterious cases of migration (Henshaw, 1915).

But actually we have no banding evidence to tell us that the golden plovers from any one point in the summer range tend to fly to a particular Pacific Island. Moreover, only the extreme western edge of the summer range lies in Alaska; the birds are also found nesting in a large section of Siberia. And in the winter they have been reported not only from Pacific Islands but also from New Zealand, Australia, the West Indies, Japan, China and India. This range is a large target, and we have no reason to think that the birds are particularly selective about the portion of it that they fly to.

Nevertheless, there is a marked migration of these plovers over the Alaska Peninsula and the Aleutian Islands. These birds apparently head out over the Pacific and some of them stop on the closest land they can reach--the Hawaiian Islands. We have some evidence (not by any means conclusive), derived from records of plovers sighted by ships in the NE Pacific, which indicates that the course flown by many of these birds over the ocean is anything but a straight line between the starting points and the goal of the migration.

In the light of the evidence, it seems that we should focus our search for the basis of bird navigation not upon some hypothetical built-in physiological instrument capable of setting very precise courses, but upon something which could guide a migrating bird in the right general direction, plus or minus perhaps 20 to 30 degrees. What environmental factors could guide migrants to this degree? Our meagre knowledge of birds' behavior during migration leads to speculation. But a few factors are at least worthy of further study. Wind direction, for example, at altitudes of 2000 feet or more is less variable than it is at the earth's surface. One investigator (Lowery, 1950) has noted a high correlation between the direction of winds aloft and the direction of nocturnal bird migrations, observed through a telescope against the illuminated surface of the moon. Cloud formations also may be stable enough in some areas to afford guidance over what might at first seem to be trackless areas.

Other possibilities that should not be overlooked as possible celestial landmarks, are the sun and moon, for we know that insects--the honeybee, for example (Frisch, 1950)--set flight courses rather accurately by means of the sun's position. Both the sun and moon appear to observers in northern latitudes to lie well south of the zenith and thus offer a limited degree of guidance.

We do not know if any of these factors are actually recognized by birds. We do know that their senses are adequate to detect them all. Obviously more studies are needed before we can arrive at any definite conclusions. Fortunately modern technological advances may help us with one problem--the need to learn more about the actual routes flown by migrating birds. We should find out, for example, how direct and accurate a course they are able to steer, and determine the relative importance of contact flying, guidance by geographical clues (coastlines, river systems and mountains), and atmospheric conditions (wind and visibility). Probably following the birds in planes is not the ideal way to get such information and a new method may have to be devised. Another aspect of the research will be to test the hypothesis that the Alaska summer gives the birds a major advantage by permitting a shorter nesting period. This can be done by making comparisons of growth rates of the same species nesting at high and low altitudes, and of the mortality during this period of their lives.

Studies like these must be regarded as fundamental biology. But even though concrete results cannot be foreseen at present, scientific history should make us cautious in predicting that practical applications will not eventually be forthcoming. Until they are, however, we must just regard our research as a quest for understanding of a major biological problem. Certainly it is a fascinating one and a mystery that has intrigued men throughout the ages. I suggest that the phenomenon of bird migration be born in mind by readers during air travel when visual contact with the ground is obstructed by darkness or by clouds. It is at such times that the accurate navigation of these "citizens of the sky" most strongly arouses our intellectual curiosity, admiration and respect.

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Dr. O'Brien Receives Frederic Ives Medal

Dr. Brian O'Brien, Director of the Institute of Optics, University of Rochester, and an ONR investigator, was awarded the Frederic Ives Medal for distinguished work in optics at the Optical Society of America held recently in Washington, D. C., on March 1-3. The nomination of Dr. O'Brien for this honor by the Frederic Ives Medal Award Committee was unanimously approved by the Board of Directors, it was reported at the meeting by Dr. Wallace R. Brode. The citation made by Dr. Brode said that Dr. O'Brien had contributed to the understanding of vision and resolution in the retina, as well as other branches of optics and physics. It mentioned the fact that his war work included not only many ingenious optical instruments to facilitate vision and detection, but made a distinct contribution to the aircraft and air training program in vision and fatigue. As an accomplished pilot he was able to translate many problems directly from the field to the laboratory. (For his contribution to the war effort, Dr. O'Brien was awarded the Medal of Merit).

"Vision and Resolution in the Retina" was the technical paper presented at the meeting by Dr. O'Brien, recipient of the award. Other investigators whose work is supported by Psychophysiology Branch, Office of Naval Research, and who presented other aspects of this problem were H. K. Hartline and George Wald.

* * * *

New Research Baby

by
Edward McCoy
Pennsylvania State College

Toward the end of the last century when the West was new and stakes were high, Governor Leland Stanford of California bet $25,000 that when a horse galloped, all four hoofs were off the ground at the same time. Several of the Governor's friends bet that he was wrong. To settle the argument, they had rigged up 24 cameras in a row, which were set off by trip-wires as a horse galloped past. (This technique was devised by Gordon Muybridge.) When the films were developed Governor Stanford won his bet. But more important was the fact that the still pictures, seen in a row, gave the impression of motion. And so, in the dubious climate of a race-track, motion pictures were born.

Since that time they have run a long fast race. We are all familiar with the movies as a billion-dollar industry. But what some of us may not know is that the poor relation of entertainment films--the instructional film--is also coming into its own and may figure as a decisive factor in military preparedness. In an emergency situation when there may be scarcity of equipment and instructors, motion pictures for training large masses of men will be essential.

To those accustomed to watching the extravagant Hollywood movies, instructional films, produced mostly by small firms on limited budgets, may seem like a reasonable thing for kids, but hardly a major tool of education or a serious field for research.

For a long time, only a few far-seeing people like Edison and Eastman gave much serious thought to motion pictures as teaching devices. If anything, academic people who might have started such a trend were reluctant to admit that films might do the job of instructors. Very seldom before 1940 was anybody rash enough to suggest that instructional films could do more than assist teachers.

But the emergencies of World War II raised the question: To what extent can films take over a teaching job alone? The question did not get any final answer during the war, but the military services are still interested. So much so, in fact, that they are investing a tidy sum every year for research on motion pictures and other "media of mass communication," like television.

Already, thousands of sailors at the Great Lakes Naval Training Station have taken part in experiments designed to find out what instructional films can do and how they can be improved. (Figures 1, 2 and 3) These experiments are part of the work carried on by The Instructional Film Research Program, sponsored jointly by the Special Devices Center of the Office of Naval Research and the United States Army.

Edward McCoy has been doing script, editorial and testing work for the Instructional Film Research Program since 1949. Previously he spent three years at Temple University, followed by three more in the Signal Corps as a cryptographer and interpreter. He received his bachelor's degree from Pennsylvania State College in 1948.

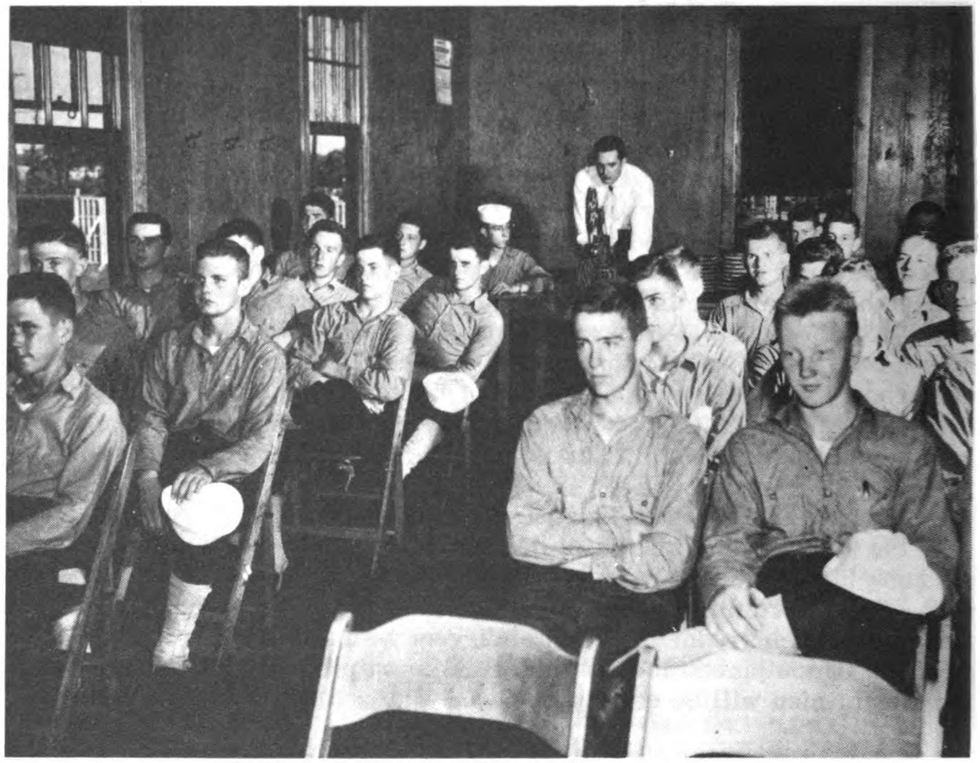

Figure 1. Recruits at Great Lakes watch an experimental film.

Motion picture research of one kind or another has been going on, of course, since Edison's assistant first perfected the kinetoscope. There have been studies made of such factors as photographic equipment, sound systems, projectors, theater accoustics, and the using of films. But comparatively little research has been done on the films themselves. Nobody has really dug in and tried to find out what made a good teaching film tick.

Without any tested principles for making instructional films in World War II, the Army had to rely to a large extent on established motion picture techniques. And established techniques meant Hollywood. Naturally it was of little concern to the entertainment industry whether or not a film could do a good teaching job. And unfortunately, the qualities which make a "terrific" film in the Hollywood tradition did not necessarily make films which would effectively teach recruits the thousand and one skills and attitudes that go into winning a war.

To film researchers it has become clear that the only way to judge an educational film is on the basis of how well audiences learn from it. Opinions of experts in the field, and even those of the audience are usually wide of the mark. What you think of a film often has very little bearing on how well you can learn from it.

Disappointed with the effects of some of the most carefully planned and expertly produced films for war-time training, the Navy (joined later by the Army) decided to take the bull by the horns. They decided to back research that would find out once and for all whether films could do an effective teaching job. If so, how should the films be made, what should they have in them, and how should they be used?

Figure 2. They find out how much they learned from film about assembling breech blocks by trying their skill on tests.

The Instructional Film Research Program, under the directorship of Dr. C. R. Carpenter, was set up in 1947 at The Pennsylvania State College to solve some of these problems.

It was by no means the first in the field of film research. But it was to become instrumental in widening the field and establishing new methods. Its director, Dr. Carpenter, gathered about him a staff and advisory committee which drew its members from the fields of Psychology, Education, Sociology, Speech, Dramatics, Motion Picture Production, and Engineering. Altogether they were a balanced team of many professions and skills, men of theory and men of practical know-how.

Figure 3. Scores are computed.

The problems they were attacking were many and complex. First theories had to be formulated. Then there were many research proposals which had to be studied; experiments had to be carefully planned, and films had to be produced which incorporated the items and techniques to be tested. Then large audiences had to be secured to carry out the testing. Test scores and other data had to be processed, analyzed, and interpreted. Along the way from hypothesis to conclusion, a dozen specialists were involved before the Program could publish a single finding. Moreover film research is particularly complicated. One of its key elements is people--audiences--and the laws of human nature are not nearly so well known as the laws of chemistry and physics, for example.

When the I.F.R.P. went to work in 1947, the background in film research was slim indeed. Although a great deal of work had been done in some areas, almost no studies had been made of the particular characteristics or "variables" which rendered some films effective and others ineffective.

Nevertheless, the I.F.R.P. was not without theoretical resources. A whole system of "learning theory" had been worked out over the years by psychologists and educators. These principles, however, had been worked out for conventional teaching situations - for the classroom and instructor. Nobody was sure how much they would apply to teaching by films. One by one these would have to be tested, using motion pictures. Each test would involve specially designed films. This was the first big research area mapped out by the Instructional Film Research Program.

It was also obvious to the I.F.R.P. staff that there were not enough efficient tools for doing film research. There was no instrument, for example, to measure the effects of films <u>while they were being shown</u>. The only tests that could be made on audiences <u>had to be made after</u> the film-showing. What about the effectiveness of a film from minute to minute as it unfolded on the screen?

To answer these vital questions, the I.F.R.P. decided to design and construct some basic tools that would allow them to keep tabs on every foot of film and the minute-by-minute reactions of audiences. This was the second big research area mapped out in the planning stages of the Program.

These tools are now finished and are being put to use. To the layman, the Classroom Communicator and its sister machine, the Film Analyzer, may look like Rube Goldberg's latest wonder. But in spite of the maze of electronic and mechanical operations involved in the equipment, which combines features of the typewriter, teletype, and calculator, the work it does is simple enough. The Classroom Communicator makes it possible for an instructor to get reactions to his lecture or answers to his questions at any point during his lesson or during the showing of a film. He can not only automatically compute scores of such tests but he can also inform the class of the right answer by using a system of lights. The Film Analyzer makes it possible to keep a continuous record of 40 persons' reactions to a film, second by second, as the film is being shown. With this equipment it will be possible to judge the precise places where a film is weak, or where it is thought to be ineffective.

In addition to perfecting these tools, the Program has undertaken some 40 separate and widely varied research projects. About half of these are already completed and reports on them are being circulated.

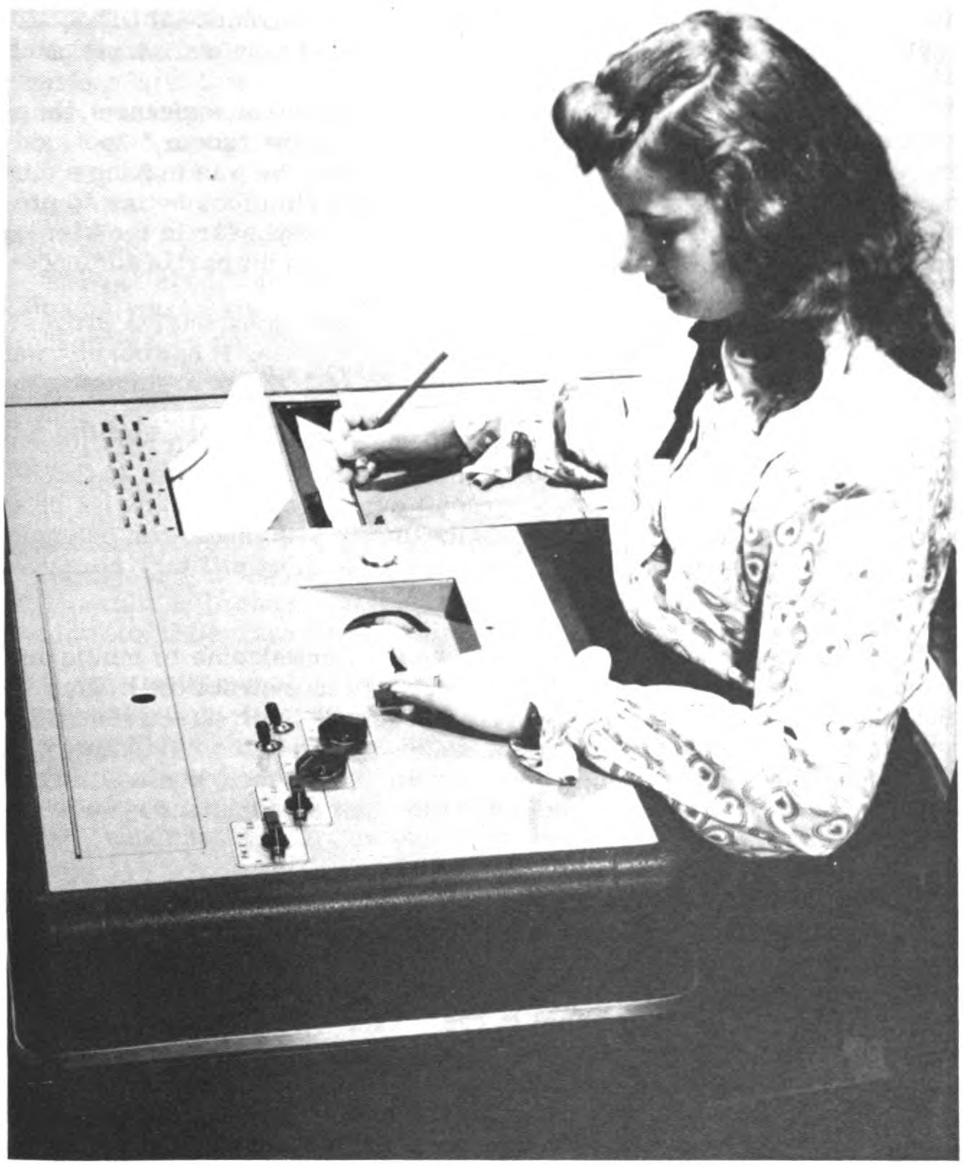

Figure 4. Electrical scoring machines like this speed up compilation of experimental data.

What have they found out? Though the answers fill some thousand-odd pages of technical reports and progress reports, no comprehensive summary of all results has as yet been published. But there is enough already to make motion picture people sit up and take notice.

Hollywood producers have always torn their hair out over bugbears like "slow-pacing" in a film. The Army and Navy had habitually kept their training films "short and sweet." But researchers saw no sure proof that films could not be long, detailed, repetitious and yet still teach effectively--perhaps even more effectively. In August 1949, the I.F.R.P. concluded one of its reports with the eye-opening observation that: "Increasing the length of the training film to one hour does not seem to result in a diminution of interest on the part of learners. Furthermore, a learner's test performance is practically independent of his rated interest in films." In other words, instructional films, like castor oil, could be effective in large doses even if they were unpleasant.

Another experiment indicated that the use of slick, expensive, time-consuming techniques like the extreme close-up, the "zoom," spotlighting, and stop-motion photography is not always a help in making a film more effective. These techniques may make a film look better to producers and specialists, or they may impress the sponsor in the viewing room, but they do not pay off in increased learning on the part of audiences.

Color in instructional films has always been an expensive proposition but there were many arguments in favor of its use. It had beauty, was closer to real life, caught the eye, etc. To test these arguments, the I.F.R.P. did a series of experiments to see what, if any, was the contribution of color to the instructional efficiency of films. Their conclusions were that color apparently has no effect on the ability of a film to teach--<u>unless</u> the use of color supplies "crucial cues" about the material being taught. If you were teaching somebody to mix paint hues, for example, color would obviously be indispensable; for teaching military courtesy, on the other hand, it could do nothing.

One finding of the Program may be a bit unwelcome to musicians. A study of the effects of musical backgrounds in instructional films indicated that music does not particularly increase their effectiveness for teaching some things. But the findings apply only to the particular kind of audience and the particular kind of film. Even though music in this experiment did not help the film, music in other circumstances may very well be vital.

How does the Program reach these conclusions? In most cases, after experimenters settle on those characteristics of a film which are thought to increase its effectiveness, an experiment is designed which will test these "variables". In the case of the music study, two films were made which were identical in every respect except one. One version of the film <u>had</u> music; the other did <u>not</u>. They showed these films to two separate groups of "equated" people (same I.Q., same educational level, same degree of familiarity with the material being taught). If the people who saw the music version learned more from the film than the people who saw the <u>no</u>-music version, then the experimenters could reasonably assume that music contributed to the effectiveness of the film. If the people who saw the <u>no</u>-music version learned more, they could assume that music might be a drawback to the film's effectiveness. If both groups learned about as well, the reasonable conclusion would be that music, in this case, did not make much difference one way or the other.

Some of the experimental designs which the Program concocts are a little hard on audiences. But all audiences have been unusually cooperative. In one study, for example, experimenters wanted to find out whether it was the commentary or the pictures in a film that did the bulk of the teaching. One long-suffering, but amiable audience-group, therefore, was shown just the pictures on a screen--no commentary. Another group sat across the hall and simply listened to the commentary in a lighted room. Still a third group listened to the commentary in a dark room. And a fourth fortunate group saw the film as the producers intended it--pictures and commentary together.

The data for this study have not been finally processed yet, but indications are that, with the films used, the people who heard only the sound track learned more than those who only saw the pictures. The people who saw pictures and also heard the sound track learned more than any of the other groups. Oddly enough, the group that heard the commentary in the dark scored higher than the group that heard the commentary in the light.

What about camera technique? Professionals in the film industry will tell you that a cameraman's "style" depends on the kinds of angles from which he shoots pictures. Once or twice, Hollywood has tried an "experiment" in this area. For example, in the Robert Montgomery picture Lady of the Lake, all scenes were shot from the viewpoint of the leading character. What his eyes saw, the camera recorded, and we saw it on the screen. Experts call this the "subjective" camera angle.

One experimenter of the I.F.R.P. decided that this might be a good camera angle to use in teaching manual skills, like knot-tying, by means of films. It was suggested that the best way to teach a man a manual skill would be to show him the job being done on the screen exactly as it would look if he were doing it himself.

One of the earliest experiments of the I.F.R.P. proved that this hypothesis was right, at least with regard to manual skills of the kind that psychologists call "perceptual-motor skills." The interesting thing here is that the film can do easily what is almost impossible in the classroom unless the student looks over the instructor's shoulder. Obviously, 40 students cannot look over one instructor's shoulder at the same time.

Impressive as the findings of the Program seem, many of them are inconclusive; thus there is danger in trying to generalize them. Many apply only to the specific types of films, material and audiences used in the experiments. In some cases the research has yielded evidence, but not proof.

In spite of the caution with which the I.F.R.P. presents its findings, interest in the Program has been intense and widespread--even international. Government agencies have already made adjustments in their film production and training procedures to bring them in line with research findings. Commercial film producers have sent representatives to study the conclusions of the research staff. Reports of experiments are widely circulated among producers, educators, and psychologists.

What about the sixty-four dollar question? Can films do a teaching job entirely on their own? In one of its reports, the I.F.R.P. observed: "A basic consideration of the Film Research Program has been that of learning whether or not films may be used as relatively exclusive means of instruction. The trends of (research) results confirm this hypothesis." There is no plot afoot to do away with teachers, but if the country has to train large masses of men in a hurry, with an insufficient number of instructors and a scarcity of training equipment, films can be made which will do some teaching jobs almost completely on their own.

The new baby of research has begun to earn its keep.

VNRRU 3-1 is Host to

Rear Admiral C. M. Bolster

Sitting, left to right: CAPT E. F. DuBois, MC, USNR (Ret.); LT Elsie U. White, USNR; Rear Admiral C. M. Bolster; LT Virginia Longino; CDR J. D. Hardy; CDR H. T. Bogle. Standing, left to right: CDR R. J. Bennett, LCDR D. B. Hertz; LCDR R. H. W. Heartel; LTJG V. Richter; CAPT R. H. Griffin (CO of unit); CAPT H. B. Stevens; LTJG N. Koperberg; CDR H. S. Gurin; LT E. G. Gisburne; LTJG M. Bick; CAPT W. Exton, Jr.

Rear Admiral C. M. Bolster, new Chief of Naval Research, was the guest of VNRRU 3-1 at its regular meeting on 24 May. The membership of this unit consists of men and women active in a variety of fields - science, law, engineering, administration - who meet twice a month at Cornell University Medical College, 1300 York Ave., New York City.

Unit 3-1 was one of the first groups activated under the Naval Research Reserve program and its organization was greatly aided by Dr. Eugene F. DuBois (Capt., MC, USNR, Ret.), Emeritus Professor of Physiology of Cornell University Medical College. Through the kindness of The New York Hospital-Cornell Medical Center authorities the Medical College auditorium and lecture rooms are made available regularly to the Navy Unit for meetings.

Customarily, meetings are devoted to presentation of military and scientific lecture material by visiting speakers, or to seminars on problems of research undertaken by teams of members. Once each year this pioneer Unit is visited by a senior member of the staff of the Office of Naval Research.

Probable Effects of Atom Blast Over San Diego Bay Calculated by VNRRU 11-5 as Defense Measure

Do you know what the specific effects of an atom bomb explosion would be on your particular community? Citizens of San Diego now have a fairly clear idea as the result of research conducted by VNRRU 11-5. And, since "forewarned is forearmed", this gives them a good start in their civil defense program.

Most interesting finding was the report that San Diego Bay would probably be safe for shipping eight hours after a single bomb burst at approximately the half-way point in the long linear axis of the Bay. The local concentration of radiation would be reduced by diffusion which would spread contamination over a wider area. Fourteen hours after the explosion, the contaminated water would begin to arrive at the entrance of the Bay and be lost to the Sea. This process should remove one-half of the contamination from the Bay area by the sixth or seventh hour--a rate of dispersal much more rapid than the diffusion noted at Bikini. Thus, if evaporators and underwater intakes were not used, this would be enough time to make the waters navigable.

The survey also revealed that San Diego Bay is unique as a body of water because of its geographical location in semi-arid climate where the mean average rainfall is 10.3 inches per year and the evaporation from the Bay measures approximately 62.37 inches per year. The salinity equilibrium is maintained by diffusion from fresh influx of sea water and evaporation. This is especially true during the summer months of June, July and August, when no fresh water is added at all, either by rainfall, surface runoff, or watertable action. The salt diffusion is greatest during the month of July.

Unit 11-5 still is planning further work on the project. More detailed investigations will be made and special evaporation studies will be conducted at the salt works. Also, model studies will be made of wave damage which might result from either an underwater explosion or from a tidal wave. This is a noteworthy project from the standpoint of the civilian defense work of other units, especially those located in cities which have Bay or waterfront areas. While all groups may not be as well equipped to make such studies, most of them can at least determine the value of such a project to their own area.

Correction: In the note on "Age Limits for Recall of Reserve Officers to Active Duty", p. 25, May issue, column 3 "Involuntary-Line" does not apply to several groups including: Reserve Officers volunteering for active duty, Organized Reserve Officers, officers at present in priority groups for recall (V-12) and Naval Academy Graduates.

Author and Fulbright Fellow in VNRR Ranks

Since most research reservists are specialists in a science or technology, their names are often in the news for outstanding accomplishments in these fields. Recently two members of Southern units have done distinguished work. First, on the distaff side: From New Orleans, La. (Unit 8-1) comes the good news that LT Margaret D. Cameron, USNR, has been selected as a Fulbright Fellow in recognition of her research at Tulane University on the important medical problem of finding a compound for use as an anti-tubercular drug. After she receives her Ph. D. from Tulane, she will go to the University of Leeds in England to work from October 1951 to July 1952.

Dr. Edward G. Rietz, associate professor of chemistry at the University of Miami and LCDR in VNRRU 6-10, is one of the co-authors of the "Encyclopedia of Chemical Technology", a book published recently by the Interscience Encyclopedia of New York. Dr. Reitz is working on a volume for the indoctrination of naval personnel in chemical warfare, in connection with his unit's civil defense program. He is also writing a college text entitled "Problems of Organic Chemistry".

Fourth Annual VNRRU Seminar Held

The success of the annual Research Reserve seminars held at ONR Washington has become habitual, and the recent one was no exception. Officers from all over the country who attended were able to meet not only key ONR personnel, but also important officials from the Department of Defense.

Rear Admiral T. A. Solberg as is his custom, welcomed the reservists and introduced Secretary of the Navy Dan A. Kimball. Mr. Kimball in his talk stressed the vital role which the Research Reserve organization can play in the future security of the nation.

A number of events had transpired since last year's seminar which changed the complexion of ONR's scientific program. Most important, of course, was the increasingly complex world situation. CDR Albert A. Cook, who holds the newly created position of Director of Personnel and War Plans was able to brief the reservists on ONR mobilization plans. Additional information on the reservist's part in the national defense scheme was given by Mrs. Anna Rosenberg, Assistant Secretary of Defense.

A thorough indoctrination into the broad aspects of ONR's research program was provided by talks made by administrators in the scientific branches. CAPT S. M. Tucker, Assistant Chief for Research started this part of the program with a general summary of the scientific objectives of the organization. Other key members of the scientific staff who contributed information on the scientific program were Dr. T. J. Killian, Science Director and Deputy, Dr. R. M. Robertson, Deputy for Natural Sciences, Dr. Mina Rees, Director, Mathematical Sciences Division; Dr. John N. Adkins, Director, Earth Sciences Division; Dr. Urner Liddel, Director, Nuclear Physics Branch; CAPT C. W. Shilling, MC, USN, Deputy for Biological Sciences; Dr. Orr Reynolds, Director, Biological Sciences Division; Mr. W. V. Consolàzio, Head Biochemistry Branch; CDR J. P. Dickson, USNR, Psychological Warfare Officer, Human Resources Division, Dr. J. T. Wilson, Head, Personnel and Training Branch.

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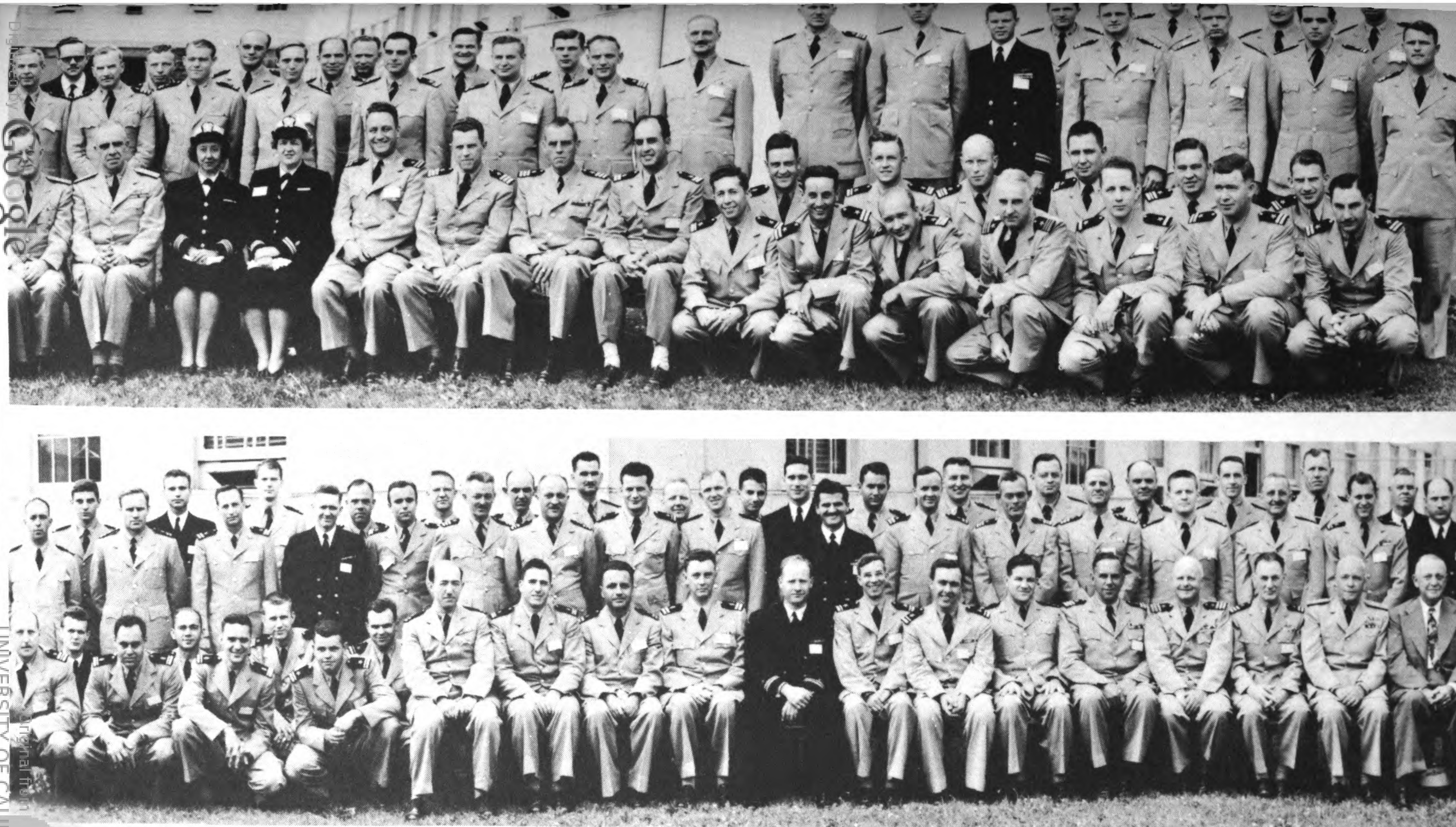
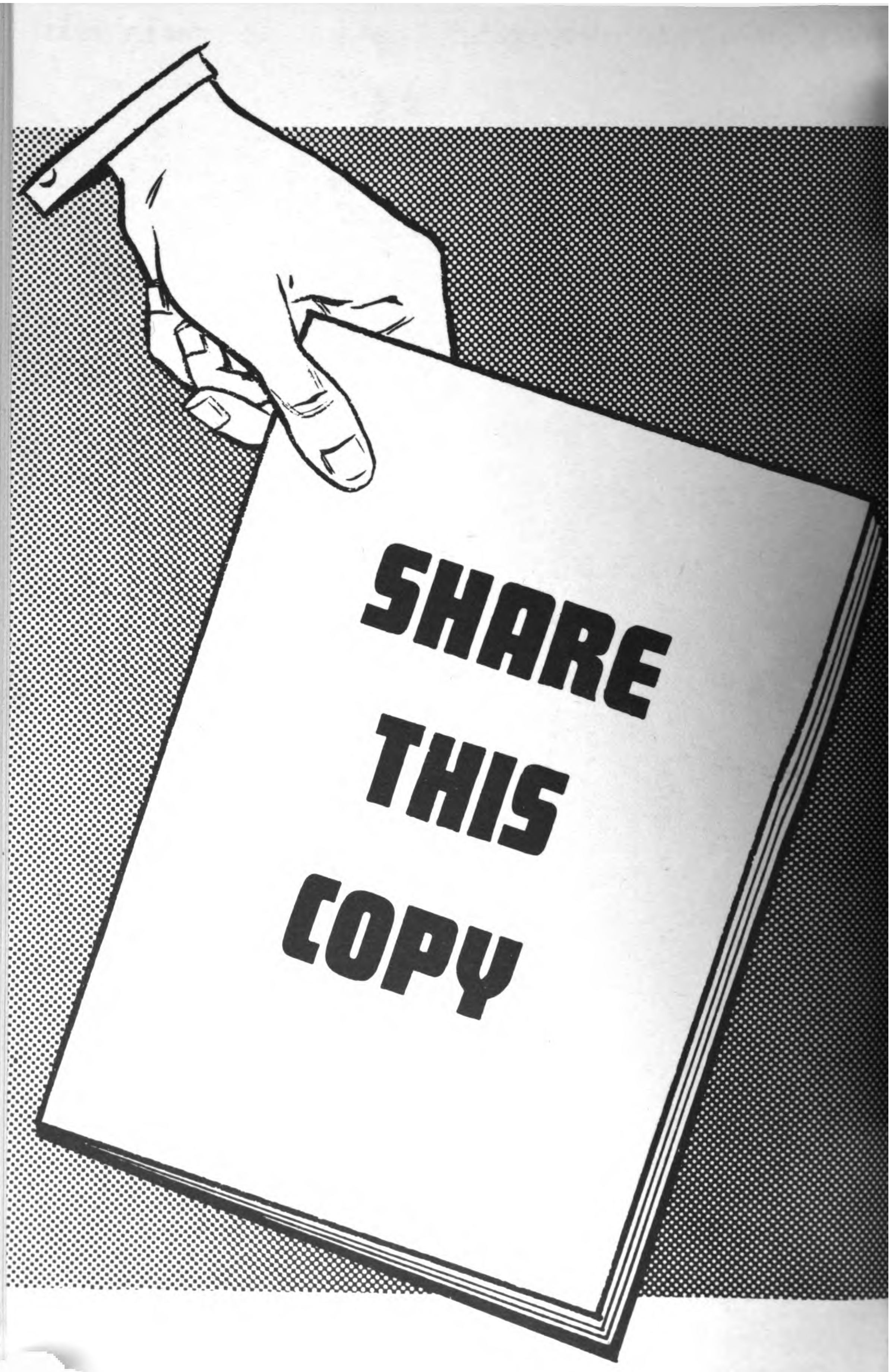


FOURTH ANNUAL VNRRU SEMINAR IN WASHINGTON, D. C.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