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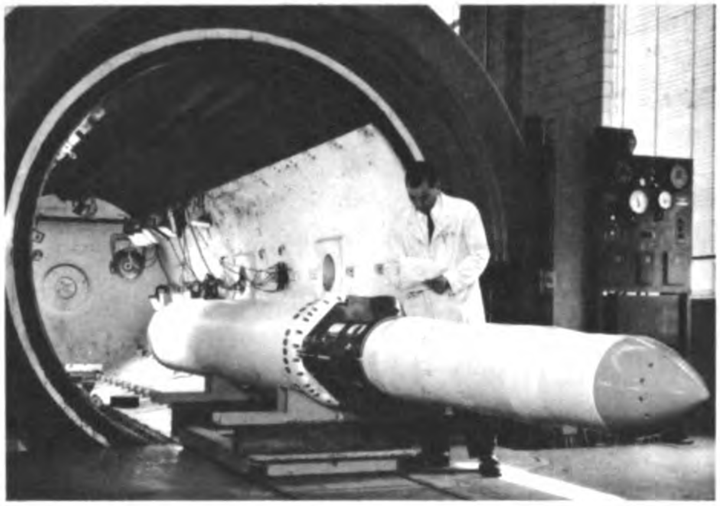

SUBROC and chamber in which underwater pressure tests are conducted.

A New Missile for Submarines

The Navy's most advanced anti-submarine weapon – a missile designed to be launched underwater, travel long distances through the air at supersonic speeds, and return to the ocean to sink enemy submarines – has successfully completed a major testing program and is now moving on toward operational status.

The 4,000-pound weapon, called SUBROC (short for Submarine Rocket), first began taking form early in 1957 as an outgrowth of work carried out at the Naval Ordnance Laboratory, White Oak, Maryland, to determine the feasibility of the ASTOR and ASROC weapon systems. The objective was to develop a missile that could utilize the full potential of the Navy's new attack-class nuclear submarines as launching platforms, and which could also locate and sink enemy submarines at far greater distance than conventional weapons.

SUBROC is launched horizontally from standard submarine torpedo tubes by means of conventional ejection methods. After leaving the submarine and moving a safe distance away underwater, the missile's solid-fuel rocket motor ignites and propels the vehicle upward into the air. A unique, thrust-vectoring device utilizing four jetevator-type nozzles enables the missile to change course underwater, so as to emerge at the proper angle, and to control stability during the rocket burning sequence.

Separation of the rocket motor from its nuclear depth bomb is accomplished through the combination of a thrust-reversal system and explosive bolts, which permits the warhead to continue on its trajectory as the spent motor tumbles to the sea. Once separation occurs, fins on the depth bomb control pitch, yaw, and roll to steer the missile to the target and control the angle of water reentry. A shock-mitigating device cushions the impact, and the depth bomb sinks and explodes.

The development of SUBROC has presented many difficult problems. First, the size of the missile had to be limited in length and diameter to the size of a submarine torpedo tube. Second, the powerful rocket motor had to ignite underwater and propel the missile out of the water and into the atmosphere. And third, because of the water-to-air-to-water operational cycle, SUBROC had to embody the hydrodynamic qualities of a torpedo and the aerodynamic characteristics of a missile. In the course of the extensive research and development required to incorporate these features into the missile, NOL has utilized many unique facilities, including ballistic ranges, wind tunnels, water impact ranges, plastics and x-ray laboratories, and environmental evaluation facilities.

SUBROC is being developed under the technical direction of the Naval Ordnance Laboratory. The prime contractor is the Goodyear Aerospace Corporation.

Unconventional Computers of the Future

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In less than 20 years the digital computer has grown from a laboratory curiosity to an essential piece of equipment in many walks of life. Most modern business enterprises have many standard activities, such as payroll preparation, run off on a computer. State and Federal governments have also been among the major users of computer time. The first "large scale" digital machines were used by the military to calculate ballistic tables for gunfire, and today digital computers may be found aboard Navy ships and even on some military aircraft.

The tree shown in Figure 1 illustrates the tremendous "proliferation" of machines which has taken place just since 1944. On the right-hand trunk is shown the history of high-speed parallel "scientific" machines. Slower but somewhat less expensive serial "business" machines form the left trunk, and a sampling of military computers appears in the center. This graphic portrayal of our digital-computer heritage was prepared by personnel of the Computing Laboratory at the U.S. Army Aberdeen Proving Ground to show the important role which ENIAC, designed and constructed at the University of Pennsylvania, played as the first electronic digital computer. The pot in which the tree grows was added by the author to indicate that the fundamental logical operations involved were demonstrated first on Howard Aiken's Harvard Mark I, a relay machine developed partly under Navy sponsorship.

With such a wide variety of digital computers available today, not to mention the various types of analog machines in use, one might well ask why the Navy should be interested in new and different computers. Of course evolutionary improvements, representing new growth on the tree, are to be expected and are in fact needed by the Navy. However, our concern here is with basic research leading to revolutionary advances which would not be expected to occur simply in the form of new growth on the existing tree. What are the reasons for this interest? There are at least three, all stemming from the Navy's operational requirements.

First, in spite of the amazing speed and capacity of contemporary machines, several classes of problems are simply too large to be solved by them in reasonable time, if at all. For example, some important logistics problems can be solved only through the use of linear programming techniques with several hundred variables, and such solutions require so much time on even the largest present-day machines that they are completely impractical.

A second problem with present-day machines is that of cost. In terms of dollars, one popular large-scale machine on the market carries a price tag of about 2.5 million dollars; more conservative users can rent the same machine for about 63 thousand dollars per month. But the cost is not measured in money

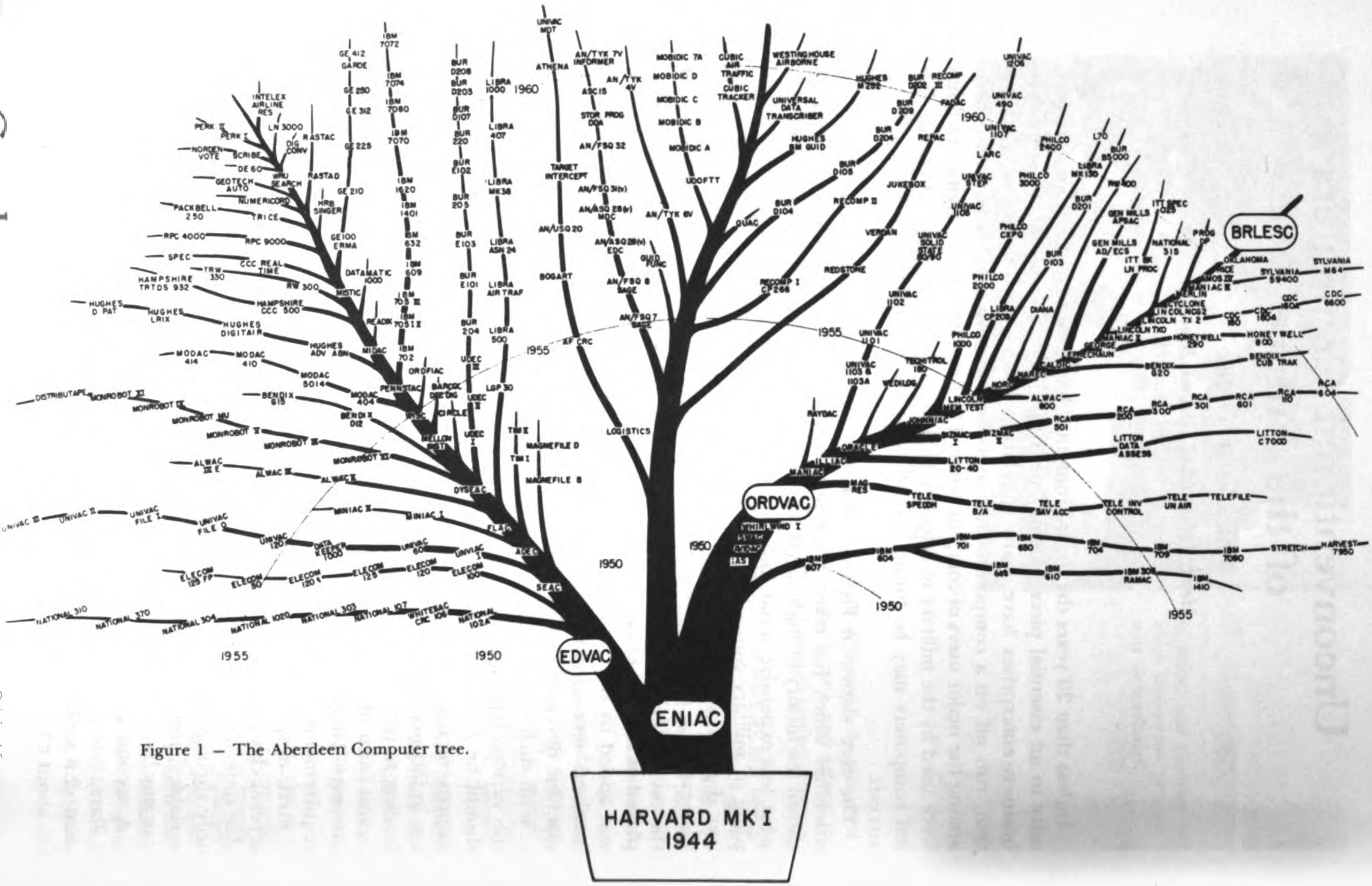

Figure 1 – The Aberdeen Computer tree.

Figure 2 – The large LARC computer located at the Navy's David Taylor Model Basin near Washington, D.C.

alone. Aboard ship, in aircraft, and especially in artificial satellites, weight and space are at a premium, and as Figure 2 shows, today's large-scale general-purpose computer is not a small machine. A less easily measured cost is that of reliability – not only the problems of maintenance and repair, but also the cost of failure. Most serious in the eyes of the operational Navy, however, is the cost in total time required to solve a problem on a computer. Actual running time, sometimes excessive in itself as noted earlier, is not as troublesome as is the period required to program and – when changes are necessary – to reprogram the computer. In other words, today's machines are so "stupid" that we spend excessive periods of time figuring out what to tell them to do and then telling them how to do it. Modern command-control systems, for example, require several hundred man-years of programming effort just to get them "on the air." And unless the commander's questions are foreseen weeks or months ahead of time, they might as well not be asked because the solution methods can't be programmed fast enough.

The third reason for interest in new machines lies in our inability to solve some types of problems by computer. Although a few devices are now available to "read" printing (e.g., to scan typed material and feed it directly into a computer), no machine has been devised so far that can read handwriting successfully. Furthermore, it is exceedingly difficult to evaluate by machine such non-numerical factors as threat, word context, or utility. In short, unless a problem can be defined explicitly and its method of solution delineated in detail, it generally cannot be handled by a computer. Yet in many cases it would be extremely valuable to have the aid of a machine in such circumstances. Reliable automatic validation of signatures or voices would be useful. Substitution of machines for men in remote or hazardous situations (e.g., in satellite reconnaissance work) would be humane, to say the least. In general, however, the purpose is not to replace men but rather to amplify their intellectual capabilities and to relieve them from mental drudgery for the undertaking of more challenging tasks.

Novel Computer Organization

One major change which is forthcoming in computing machines involves the physical and/or logical interconnection patterns of the components and subsystems. In conventional general-purpose digital machines, the interconnections are fixed, but the computer is "adapted" to solution of individual problems by means of the program, which specifies a particular sequence of mathematical operations to be performed in pursuing the desired solution. Much greater efficiency can be achieved if the components and subsystems are themselves re-connected into an ad hoc machine organization for each problem. This principle has been utilized for years in analog computers, where a physical subsystem corresponds to a mathematical function (e.g., integration); in the future we may expect to see similar philosophies applied to logic and computing components and subsystems such as AND gates, arithmetic registers, and associative memories.

An experimental machine of this type, called Fixed-Plus-Variable Structure by its originator, Professor Gerald Estrin, is under construction at UCLA under the joint sponsorship of ONR and the AEC. Even less conventional is the "Holland Machine," which is not a physical piece of equipment but rather an organizational concept advanced by ONR contractor Dr. John H. Holland at the University of Michigan. Such a machine would contain many identical elements of modest logical capability, interconnected by communication links in a regular pattern (such as a grid with elements at the nodes), with information flowing over the links to permit cooperative activity by many elements to solve a problem. In addition to exhibiting some interesting mathematical properties, this approach offers a way to achieve extremely large-capacity computers at reasonable prices, since fabrication of regular lattices of identical elements is relatively easily automated.

In another novel form of computer organization, the information flows along "tracks" and is processed as it goes, like a train having cars added or dropped at various cities, rather than having all processing done in a few registers to which information is brought and then returned to storage. The conventional computer handles information the way a job shop handles construction, whereas this newer organization works like an assembly line. One implementation of this concept involves magnetic "stepping strips" along which bits of information move from step to step at a regular rate controlled by a clock. An even more promising form uses continuous lines called "neuristors" because of the analogy to information handling by biological nervous systems. This concept, devised by ONR contractor Dr. Hewitt Crane of Stanford University and the Stanford Research Institute, permits information to propagate along a line by using local energy, just as a flame does as it propagates along a fuse. Various physical implementations are currently under investigation, including distributed thin-film diodes, cryogenic lines, wires in chemical baths, and glass-fiber lasers. Here is a situation in which the novelty of the computing concept calls not only for different organization but also for new devices.

A third class of novel computer organization is comprised of distributed logic machines, in which information processing is not performed in specific locations but rather according to the pattern of simultaneous collective values of many separate but physically identical elements. Inasmuch as machines of this type are in general either self-organizing or are "carbon copies" of self-organizing systems, they will be described in the next section.

Self-Organizing Systems

The term "self-organizing" is used here to describe machines whose internal structure is modified in response to environmental stimuli in order to improve their performance. They are frequently called "learning machines," and various other terms with hazy definitions are sometimes applied to them, such as "artificial intelligence" and "bionic systems."

Self-organizing machines are generally used to categorize a wide variety of environmental situations into desired classes. With quantized graphical inputs, for example, they can be made to classify printed characters as letters of the alphabet, separate letters from numerals, or recognize aircraft silhouettes in a photograph. Given numerical inputs, they can be made to separate the real numbers into those which are correct solutions to a specified mathematical function of the inputs and those which are not. In all of these cases, the machine actually implements some desired logical function of its inputs. Furthermore, it does so without being "programmed" in the usual sense of digital computers. Rather, to prepare it for operation the machine first undergoes a "training" period during which examples of correct categorizations are provided while the internal machine organization adapts until it duplicates this desired "behavior."

During the training period a series of representative samples of the operational environment is presented, and after each sample the machine gives an output; if the output is erroneous the machine is instructed to modify its internal structure until the correct ouput is produced. Thus over a series of training samples the machine structure will converge to a form which represents the correct input-output relationship (assuming that the machine is capable of realizing the correct relationship at all). Following this training period, the machine (or a fixed copy of it) can be placed in operation with no further internal modifications ever being made; however, in dynamic environments the machine may be made to continually modify and improve its own performance through "bootstrap" techniques.

The earliest working demonstration of a complete self-organizing system of this type was made by ONR contractor Dr. Frank Rosenblatt, using a machine which he calls a "Simple Perceptron." At about the same time, another ONR contractor, Professor Bernard Widrow of Stanford University, independently devised a remarkably similar machine, the "Adaline," starting from entirely different concepts and philosophies.

The Perceptron, as shown in Figure 3, consists of three interconnected layers of active elements. The first layer contains sensory, or "S," units which respond to an external stimulus (e.g., they may be photocells arranged in a matrix onto which a letter of the alphabet is projected optically). The second layer consists of a collection of threshold logic elements called association, or "A," units, and each A unit is connected to an arbitrary (randomly selected) collection of S units. When a stimulus is presented, the corresponding S units are activated; in addition, if enough of the S units connected to any given A unit are energized, that A unit is also turned on. Since each A unit is connected to a different random sample of S units, each responds to different stimulus patterns or pattern characteristics. Thus each different distinguishable stimulus will cause a different combination of A units to respond. These unique combinations represent pattern "recognition" (i.e., they distinguish between different patterns). An output of this type is useless for practical purposes because the resulting pattern categorizations do not correspond to desired classes.

Thus it is necessary to have the machine separate the stimulus patterns into classes according to some criterion. For example, we might wish to place the letters "T" and "t" into one class ("true"), and the letters "F" and "f" into another ("false"). To accomplish this with a simple Perceptron the outputs of all the A units are combined selectively, using as much or as little of each as is necessary to achieve the desired result. Specifically, the output of each A unit is passed through a weight, or variable-gain control, and is then summed with the similarly processed outputs of all the other A units. When the result surpasses a certain threshold (also variable), a response, or "R," unit (the third layer) is turned on. It is the weights (and the response threshold) which are varied after each stimulus during a training period. Again using the "true-false" example, suppose we decide to have an R unit on for "true" and off for "false." If a T is presented as a stimulus but the R unit does not go on, then according to one practical training routine all weights on energized A units are increased until the R unit comes on. Conversely, if an F is presented and the R unit comes on, all weights on energized A units are decreased until the R unit goes off. When a correct response occurs, no changes are made. If enough samples of T, t, F, and f are presented and correction is made after each error, the weights will eventually reach such a combination of values that the desired answer always occurs. The example used here is a very simple representative of the large and useful class of linearly separable functions, all of which can be solved by this type of self-organizing system (given enough S, A, and R units).

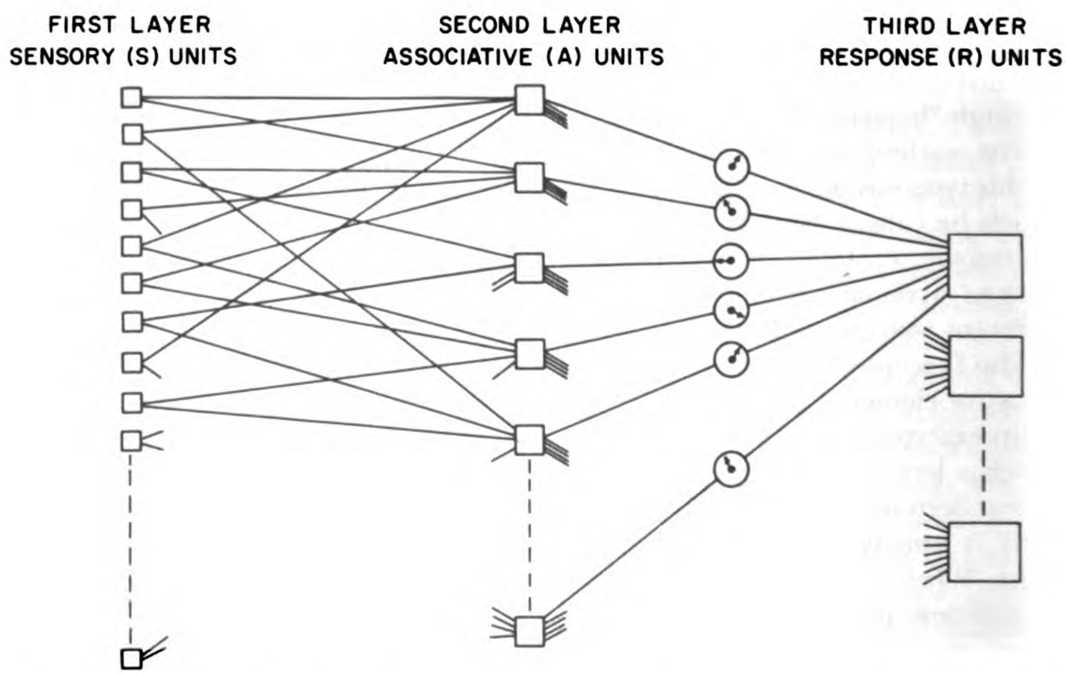

Figure 3 – The simple Perceptron. Several arbitrarily selected S units are connected to each A unit. Every A unit is connected through an adjustable weight to each R unit.

Such systems have several extremely interesting and valuable properties. In a large machine, each individual unit or connection contributes so little to the overall operation that it may be removed or destroyed without any noticeable effect on performance. Thus these machines offer high reliability. Another important property is the ease with which geometric patterns are handled—an activity to which conventional computers are rather poorly suited. Human speech is also a stimulus which self-organizing systems handle nicely; such machines have been used experimentally as recognizers of spoken words and phrases. It is particularly exciting to consider the inverse process of machine learning: an analytical function of the S-to-A mapping and the A-to-R weight combination would be a mathematical description of the input pattern, providing quantitative answers to such questions as what makes an A an A and not a B—a concept which the human learns intuitively at an early age but which so far has defied rigorous description.

A fourth property of self-organizing systems is perhaps the most important: the training operation completely replaces the process of programming required by conventional digital computers. For one thing, this saves time, because it is necessary only to provide examples of problems or patterns to be encountered, together with the desired responses, rather than to specify a detailed solution procedure or algorithm. But even more important, the solution procedure need not even be known (since the machine will learn it), and thus, in principle, self-organizing systems can be used to solve problems which we don't know how to solve ourselves! This brings up the most novel and exciting possibility of all, to which the next section is devoted: the use of computers to help in solving new problems.

Heuristic Processes

Funk and Wagnalls dictionaries define "heuristic" as "aiding or guiding in discovery," and the word has been used in this sense for about five years to describe programs which enable computers to play games, prove geometry theorems, and perform other activities which we normally associate with human problem-solving behavior. Whereas conventional computer programs lead to answers (if the programmer knows how to obtain them), heuristic programs lead to methods of solution (and thus eventually to answers also).

Consider two housewives who visit a restaurant, are introduced there to delicious chicken cacciatora, and decide to prepare it at home for their families. One looks through her cookbooks until she finds a recipe, then follows it step by step until the dish is finished. Her activities are analogous to conventional programming; note that she will always end up with essentially the same result, but it may not be the exact product she was after originally. Now the other housewife enters her kitchen with an idea of what she wants, and she just starts cutting up a chicken and cooking it in a tomato sauce with various spices which seem reasonable to her to use according to her experience and taste. Furthermore, when she tastes the mixture, she observes that it "seems to have too much sherry but might need a bit more garlic." Her activities are analogous to heuristic programming; the results could be pretty bad, especially at first, but after repeated trials (learning from each one) she has a fair chance of duplicating the delicious taste which the restaurant chef achieved. Furthermore, her heuristic methods will work even if no recipe exists in standard cookbooks. Finally, note that once she achieves the desired result, she can record the process which produces it and thereby generate a recipe (algorithm) which makes heuristic solution unnecessary for others.

In similar fashion, heuristic programs for computers search for methods which will lead to solutions. In general, this process involves generating alternative possible courses of action, evaluating the relative efficiency of the various alternatives according to some criteria, selecting and pursuing the most promising one, and then repeating the process as more is learned. So far, these techniques have been tried primarily by scientists who are interested in learning how to solve problems with machines. Such games as checkers and chess have provided excellent vehicles for such investigations, but the techniques are also applicable to more "useful" problems, such as analysis of air threats to Navy task forces, optimal allocation of available fleet units in the face of competing demands for their services, and determination of acceptable repair parts to keep critical equipment operating in the absence of authentic spares.

Prognosis

Several novel techniques and principles for the processing of information have been presented here. These included machine organization, self-organizing systems, and heuristic programs. Each is already sufficiently established that it is not just a blue-sky dream, yet none can be seen in an operational system. What then is their current status and what does the future hold in the way of important applications?

In some cases, implementation is waiting partly upon the devising or developing of appropriate devices and fabrication techniques. Nothing has been said here of the excellent R&D presently underway on solid-state logic devices, parametrons, magnetic and cryogenic thin films, microelectronics, content-addressed memories, lasers and other optical processing methods, programming languages, etc. Most of this work is oriented toward improvements in conventional computers (in fact, that was the reason for excluding it here), but major contributions to new types of machines will also follow.

In general, however, the techniques described here suffer from the fact that, although their feasibility has been demonstrated, inadequate understanding of them exists to provide a sound basis for design. Both scientific and engineering research are still required, and it will probably be quite a few years before applications of these techniques are commonplace. Nevertheless, some novel machines might be used now in a few special situations, such as voice identification and short-range weather prediction.

Self-organizing machines of the type described here are probably closest to operational practicality – at least in their simpler forms – and may be expected to appear in a few selected systems in the near future. The pressure for larger and larger computers dictates that machines organized around iterated identical elements, with their accompanying ease of fabrication, will be next on the scene. Heuristic programs are the least well understood of the subjects described and may not show up in operational systems for a decade.

In every case, however, the promise of these new techniques for really significant advances in the speed, capacity, reliability, and capability of mechanized information processing marks them as being among the most important subjects for current research, not only for the Navy but for the Nation as a whole.

The Study of Airborne Microorganisms

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For more than a century, biologists have known that microorganisms exist in the air as well as in the earth and its animal and plant life. Pasteur and Tyndall demonstrated this fact when they showed that such processes as the putrefaction of sterilized meats and the clouding of vegetable broths could be prevented if the air above these products was kept free of organisms. Only in the last 50 years, however, have scientists explored to an appreciable extent the physical and biological behavior of bacterial aerosols.

The problems posed by the exposure of human beings to some airborne microorganisms are broad in range—involving, on the one hand, mass outbreaks of respiratory infections, such as the 1957-58 world-wide epidemic of "Asian flu," and, on the other, deaths resulting from pulmonary anthrax of personnel engaged in wool and hair processing. The subject is therefore of deep concern to researchers in many fields; public health is of course the area of greatest concern, but important also are the large areas of military and industrial health.

Initially, studies of bacterial aerosols were made in connection with investigations of naturally occurring respiratory diseases. Thus, the science of air hygiene came into being. As information was gathered, however, it became evident that fundamental principles needed to be explored under controlled conditions available only in a laboratory. In response to this need, the Office of Naval Research, 13 years ago, established the Naval Biological Laboratory at the U.S. Naval Supply Center, Oakland, California.

NBL is operated by the School of Public Health of the University of California at Berkeley under contract to ONR. Its experiments, which are conducted cooperatively with the Bureau of Medicine and Surgery's Naval Medical Research Unit No. 1, concern fundamental investigations in aerobiology and experimental pathology of infectious diseases as they apply to public health and to medical problems of the Navy. Essential to these studies is the creation and maintenance of the technology required to produce highly virulent aerosols and to expose animals to them without endangering human observers.

The Properties of Airborne Microorganisms

Through research conducted at NBL, a much better understanding of airborne microorganisms has emerged, particularly in terms of the factors governing their movement and viability. As these activities are dependent in large part upon the air environment, an effort has been made at NBL to define the properties of microorganisms in these terms. The properties may be described briefly as follows (microorganisms are referred to here as "particles"):

- The particles have size, mass, and sometimes electric charge.
- They fall at a constant velocity as a function of size and density.
- They migrate in a thermal gradient toward cold surfaces.
- They are in constant agitation. Upon collision, they coalesce to form larger particles that may settle faster than the original particles. Acoustical forces may increase both the agitation and coagulation of the particles.
- Because of inertia, particles in an air stream that is led through bends in a pipe or through orifices tend to collect on the interior surfaces. Deposition is quite heavy at velocities near that of sound; whereas at velocities less than half that of sound it is very light.
- Particles of a uniform size mixed in closed chambers decrease in number at a logarithmic rate specific for a given size and density.
- Particles scatter light. A measure of the light scatter area is useful, because it indicates instantly any malfunction that might occur while the particles are being dispersed or sampled.

In preparation for aerobiological experiments, microorganisms of special interest are combined with either a liquid or a powder, usually the former, and placed in a device designed to disperse the mixture, according to the requirements of the investigation, in an aerosol chamber. All effective laboratory-type dispersers utilize air jets which commonly produce a flow of about 10 liters of air per minute under a pressure of 20 pounds per square inch to disperse 0.2 milliliters of liquid per minute.

Aerosol Chambers

Aerosol chambers are of three types:

- Ducts, called "dynamic chambers," in which air is kept in constant linear motion (Figure 1). The application of these chambers is limited, because they can be used only for experiments of 20 minutes or less duration.
- Stirred settling chambers, wherein a known volume of air is stirred by a fan (Figure 2). In these chambers, aerosols can be stored for as long as 5 hours. They are used principally for making analyses of particle sizes.
- Rotating drum chambers, in which air is stationary with respect to the drum (Figure 3). In these chambers, first designed and built at the Naval Biological Laboratory, particles remain suspended for as long as six days without being influenced significantly by gravity, and may remain in a useful concentration for as long as two weeks. The particles tend to oscillate about a point, because at one time during the rotation of the drum they are falling, under the influence of gravity, toward the inner part of the drum, and at another time during the cycle they are falling toward the periphery of the drum.

Sampling devices used in conjunction with the chambers ordinarily apply the principle of inertial impaction, although types that depend on electrostatic and thermal deposition have been utilized, too. By the inertial impaction method, air is drawn through an orifice at a velocity near that of sound, causing the aerosol particles to be deposited on a nearby solid surface or in a liquid. The solid surface may be nutrient agar, or, if microscopic observation of the particles is desired, it may glass or metal. The liquid may be nutrient medium or saline or distilled water.

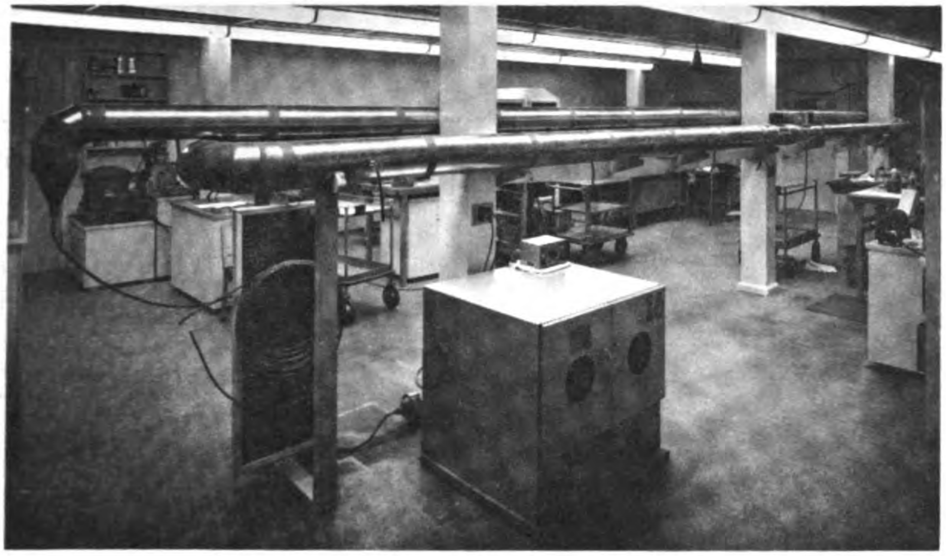

Figure 1 — An aerosol transport apparatus. This system provides data on cloud travel at minimal expense. As set up here it is being used to study only harmless bacteria.

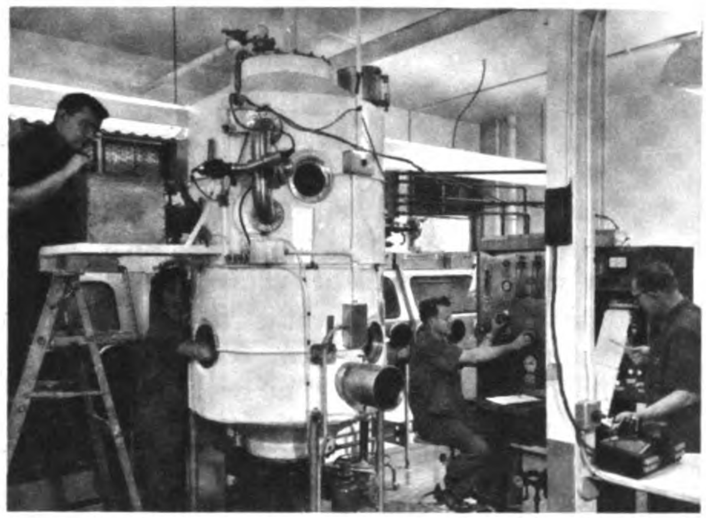

Figure 2 — A stirred settling chamber designed for studies of pathogenic airborne bacteria.

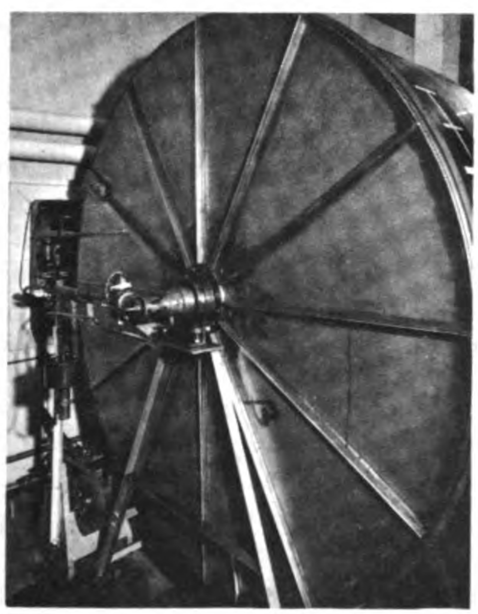

Figure 3 — End view of a drum showing sampling port at the axle and a portion of the drive system.

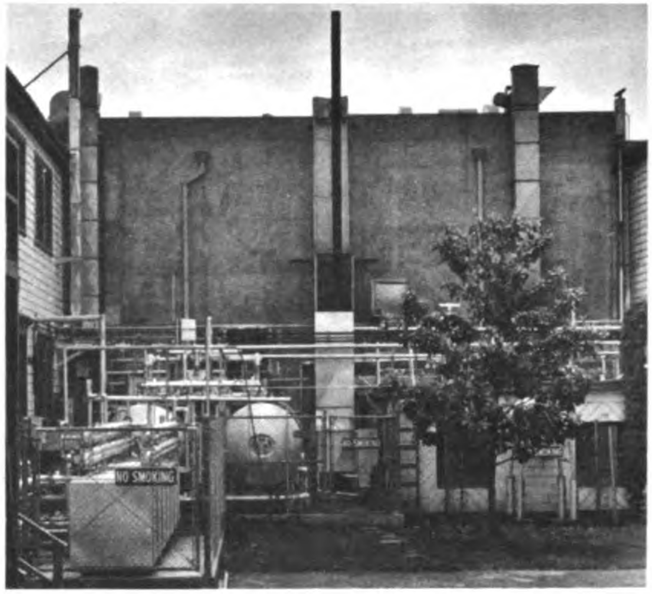

Figure 4 – View of the torch and autoclave system wherein all waste material is treated that might contain pathogenic bacteria.

The Drum

The most versatile of the chambers, and thus the one used most extensively at NBL, is the drum. It is mounted on a rack in a manner that allows free rotation around the axis of symmetry perpendicular to the plane ends. A small baffle within the drum causes the air to circulate in synchrony with the movement of the drum. Sampling and injection of aerosols are accomplished through a hollow air-tight axle. The drum is air conditioned and is housed in an insulated, temperature-controlled room so that the humidity within the drum can be regulated. The culture atomizer, sampling devices, and all control valves are mounted under a safety work-hood which protects investigators while they study pathogens. All waste air is conducted out of the laboratory to a 40-foot torch system where the airborne bacteria are incinerated (Figure 4). Liquid wastes are treated in a continuous autoclave system before being discharged into the sewage mains.

By means of the drum some of the influences of temperature and humidity on selected bacteria and viruses have been ascertained. These data show that each microbial species has its own distinct environmental requirements for maximum survival and infectivity. Through investigations of aerosols that have been kept in a drum for as long as two weeks, new information has been obtained on the physiological requirements of microorganisms during such periods and on the strain variations which occur among the organisms.

Bacterial Viability

To determine the viability of bacteria which have existed in an aerosol chamber, the organisms are removed from the chamber, the sample is incubated, and the resulting colonies are counted. The number of viable cells per liter of contained air is then calculated, and these data are plotted as a function of time to obtain what is termed the "total biological decay." By subtracting the physical decay from this figure (the physical decay is determined either by light-scatter measurements or by placing radioactive tracers, dyes, or spores in the dispersion fluid) the rate of biological decay is found.

The rate of biological decay has been shown to vary with both temperature and relative humidity. Usually it is smallest at the highest and lowest humidities, but no strict rule of thumb can be stated. In general, it is smaller at lower temperatures. However, with a given species, the rate also varies with the growth medium, the age of the culture, and with growth temperature. Some species are more susceptible to these influences than others. Viruses behave in somewhat the same manner.

The respiratory infectivity of some microorganisms varies as a function of aerosol age. Sometimes all living cells seem noninfective, whereas other times the ratio of living to infective cells appears to decrease (an apparent increase in virulence).

Theories and Variances

Various theories have been advanced to account for the death of bacteria in the airborne state. It has been suggested that the loss of water by bacteria sets up osmotic forces that disrupt the cell or that it results in the denaturing of proteins or nucleic acids, probably as a consequence of the rupturing of hydrogen bonds. However, these theories do not account for the following variances:

- The rate of biological decay does not remain the same over long time periods; often it decreases as a function of aerosol time.
- Bacteria can be freeze-dried and stored in a vacuum for years without much loss of viability.
- The decay rate is often dependent upon the sampling medium employed; enriched medium, for example, encourages a greater number of colonies to form.
- The shape of the survivor curve can be changed by subjecting the bacteria to alternate periods of cold and warm temperatures before they are atomized.
- Periods of "recuperation" have been noted wherein bacteria that seemed to be "dead" were later "alive."
- The shape of the survivor curve does not remain constant as a function of culture age.
- The absence of oxygen enhances the survival of dried bacteria.

These variances, in turn, suggest the following theories:

- Survivor curves are a measure of the distribution of "resistance" within the population tested.
- Resistance is related to the physiological state of the cell, which is, in turn, related to the age of the cell in terms of generation time and growth conditions.
- Living bacteria may be injured during experiments and thus unable to form colonies. Therefore, all measurements of the rate of biological decay possess inherent error.
- There is no single mechanism of bacterial death; death may result from a

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Geographic Orientation: A Problem for Research

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The task of the Joint Army-Navy Aircraft Instrument Research (JANAIR) committee* is to carry out research programs to form the basis for improved instrument systems in piloted aircraft. JANAIR recently reported the results of an investigation of an aspect of pilot performance which, up to now, has received little attention from the scientific community. The problem concerned "geographic orientation"—the pilot's awareness of his navigational position during flight.

The investigation, directed by Dr. James J. McGrath of Human Factors Research, Inc., Los Angeles, California, was focused on low-altitude missions under visual flight rules (VFR) and sought to answer the following questions: Under operational conditions in present-day aviation do pilots become "lost" or geographically disoriented frequently enough to have a significant effect on mission success? If they do, what is the role for research in improving the pilot's ability to maintain an accurate awareness of his position in the geographic field?

Do Aircraft Pilots Often Get "Lost"?

Reports of aircraft accidents studied by HFR revealed that 82 aircraft were completely destroyed and 122 men were killed in Navy, Air Force and Army aviation during the past five years because pilots became "lost." During the past three years in civilian aviation, 235 accidents were caused by geographic disorientation. These statistics describe only a minor aspect of the problem, because the vast majority of pilots who become "lost" survive the experience.

Geographic disorientation is evidently such a common experience among military pilots that when 72 Navy, Marine, and Army aviators were asked to describe their most serious personal experience of being "lost" in flight, the majority described their most recent experience, usually an incident which had occurred within the past few months.

The large number of civilian pilots who became "lost" was indicated by the Flight Assist Reports issued by the FAA for 1962. Of the 1,492 assists given to pilots on the Federal airways that year, 1,270, or 88 percent, were given to "lost" pilots.

The training records of 133 Naval aviators showed that 50 percent of these pilots became "lost" on more than one-quarter of their low-altitude missions, and 15 percent of the pilots became "lost" on more than one-half of their missions.

To determine the impact of geographic disorientation on the success of military aircraft missions, the investigators analyzed almost 1,000 critiques of mis-

**The author is chairman of the JANAIR committee.*

sions flown on the low-altitude attack courses (airways designated for low-altitude VFR flight training). The results indicated 27 percent of these missions failed or were seriously compromised because of geographic disorientation.

In answering the first question, therefore, the investigators found that aircraft accidents caused by geographic disorientation take a significant toll of aircraft and human lives, and that aviators become "lost" far more frequently than suggested by aircraft accident statistics. If the training operations now being conducted with light attack aircraft on the low-altitude attack courses are at all representative of combat missions, a substantial number of such missions can be expected to fail because of geographic disorientation. The problem clearly demanded research attention.

The Role for Research

The next task was to develop a systematic plan for a program of research that would reveal the causes of geographic disorientation. To form the basis for such a program, a large number of specific research requirements was developed from an analysis of the following data collected during the investigation:

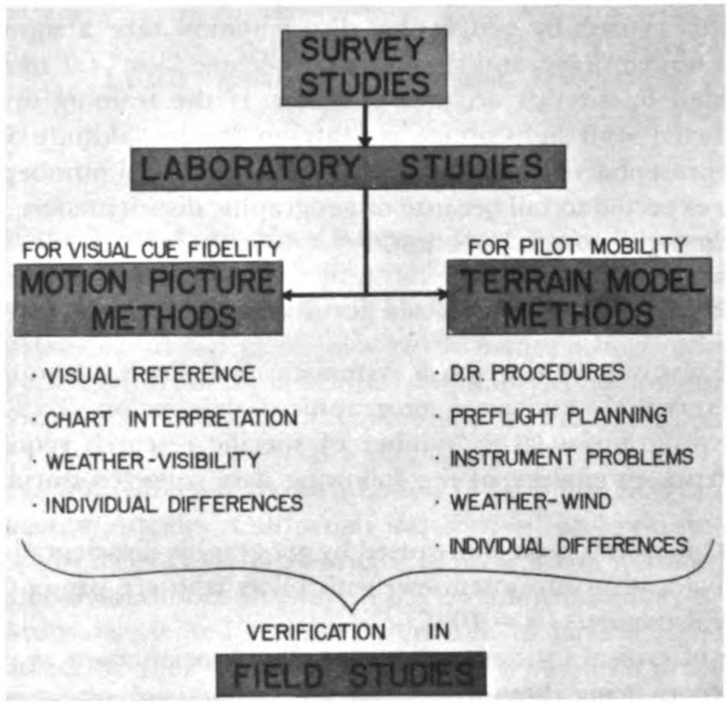
- Reports of aircraft accidents caused by geographic disorientation (N = 343).
- Individual and group interviews with pilots who are presently flying low-level, VFR missions (N = 109).
- Reports of critical incidents of geographic disorientation as related by the pilots experiencing them (N = 108).
- Training records of pilots of light attack aircraft (N = 133).
- Reports and evaluations by chase pilots of low-level navigation missions flown on the low-altitude attack courses (N = 959).
- Experimental data from a study of the geographic orientation process described below (N = 75).
- Reports of flight assists given to aviators "lost" on the Federal airways (N = 1,270).
- Responses to a questionnaire survey of U.S. Army aviators (N = 305).

Major Problem Areas

The data and the specific research requirements derived from them are described in detail in a technical report issued by HFR. To summarize these findings briefly — the causes of geographic disorientation under low-altitude, VFR flight conditions point to the following major problem areas:

- Faulty selection, detection, and identification of visual checkpoint references.
- Faulty dead-reckoning procedures and poor control of aircraft in flight.
- Deficiencies in chart information, chart interpretation, and chart handling.
- Unusual environmental conditions having an adverse effect on visibility.
- Inadequate preflight planning.
- Deficiencies in flight instrument design and in instrument reading.
- Individual differences in pilot skills, attitudes, and judgment.

An outline of a program of research on these problem areas is presented on the next page. The first phase of the program consisted of the survey studies which have been reviewed here. These studies were conducted to give structure to the research problem and to provide a basis for experimental hypotheses to be tested in laboratory studies.



Outline of program of research on geographic orientation.
"D.R." means "dead reckoning."

Laboratory Studies and Verification

In evaluating experimental techniques for the laboratory studies, two primary requirements were established:

- The need for fidelity of visual cues: the method should provide visual stimuli comparable to those experienced in aircraft in flight.
- The need for some form of pilot mobility: the pilot should be allowed to make navigational decisions and to act on those decisions.

No known simulation technique will adequately satisfy both requirements; therefore, in the laboratory studies which constitute Phase II of the program, complementary experimental methods are being used.

For those research problems which demand fidelity of visual cues, the experimental studies will involve the use of high-resolution, wide-angle, color motion pictures back-projected on a screen surrounding a simulated cockpit. For those research problems in which visual-cue fidelity is not essential, but where it is mandatory that the pilot be allowed command of the movement of the aircraft, the research will involve the application of a model of the geographic field over which a television camera moves. The camera will be servoed to the controls of a simulated cockpit, and the output of the camera will be projected on a screen in front of the cockpit.

The final phase of the program will concern the verification of the findings of the laboratory studies through field studies of navigational performance in real aircraft in flight.

Jupiter and the Red Giants

A mass of detailed data on Jupiter and seven red giant stars was gathered by the Stratoscope II balloon-borne 36-inch telescope launched into the stratosphere from Palestine, Texas, on November 26. The instrument made infrared studies at an average altitude of 80,000 feet throughout the night and was brought down on a wooded hillside near Kosciusko, Mississippi, the following morning.

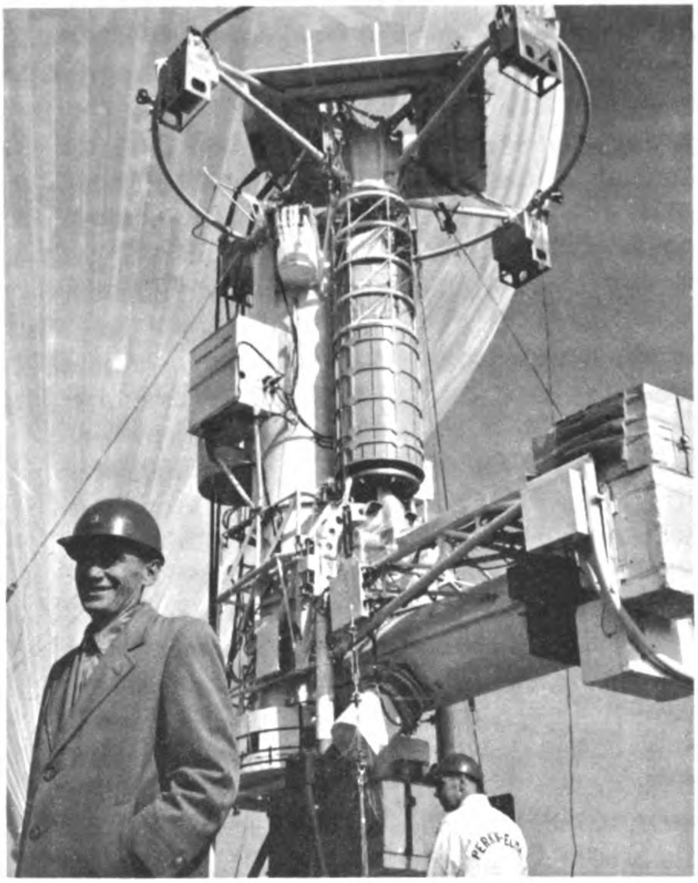
The Stratoscope II project is directed by Dr. Martin Schwarzschild of Princeton University and is sponsored by the Office of Naval Research, the National Science Foundation, and the National Aeronautics and Space Administration.

The chief objective of this second flight of Stratoscope II (the first flight was made last March) was to trace the infrared spectra of Jupiter and a number of red giant stars. The stars observed were Betelgeuse, Mira, Aldebaran, R Leonis, MU Geminorum, RHO Persei, and MU Cephei. Spectra were obtained by three sensitive infrared detectors, and the information was recorded on an airborne magnetic tape recorder. Sample records were telemetered to the ground during the flight so that investigators could make preliminary estimates of the type and quality of the spectra and thus adjust the observing program to take maximum advantage of the valuable hours the detectors were in operation.

Jupiter, the largest of the planets, has a mean diameter of 87,000 miles and thus is more than 10 times the size of the Earth. Its density of 1.34 matches closely that of the entirely gaseous sun. The planet's surface features are highly complex and are generally believed to be made up of immense cloud formations. Because of the low density of Jupiter, the planet is believed to be composed mainly of the lighter elements hydrogen and helium. Prior to the recent flight of Stratoscope II, astronomers had detected hydrogen, ammonia, and methane in the planet's atmosphere. Helium had not been identified because it does not emit detectable energy at Jupiter's low temperature (-140°C). Stratoscope investigators hoped that the sensitive infrared detecting apparatus used in conjunction with the telescope would enable them to find out if other gases are represented in Jupiter's spectrum.

For a long time, astronomers have been interested in the large, bright stars called red giants that are much cooler than most other stars. They have wanted to know how they were "born," how they exist, and how they are likely to die out. Because they are so large (Betelgeuse, for example, is about 1,000 times as large as our own sun) and also comparatively cool in their outer regions, they appear to be in an advanced stage of star evolution. By means of the distribution of light energy throughout the various wavelengths of the infrared spectrum, the Stratoscope team hoped to gather much information that can be used to check present-day theories regarding these stars.

In the infrared portion of the spectrum, the investigators expected to find lines or bands indicating the presence of molecules in the atmospheres of the red giants. The fact that a gas exists in molecular rather than atomic form reveals that it is "cool" and thus that the star is well along in life. Analyses of the line groupings reveal also the particular molecules making up the gases, and thus they tell astronomers much about the composition of the stars.



Professor Martin Schwarzschild of Princeton University, Director of Project Stratoscope, stands beside the 36-inch-aperture, three-story-high balloon-borne telescope before the instrument's second flight into the high atmosphere, made last November.

The telescope lies on its side in woodlands near Kosciusko, Mississippi, after its successful flight last November. The instrument suffered only insignificant damage on impact, as the exterior struts and padding took up all the shock.

Other objectives of the Stratoscope II flight were to make spectroscopic observations of the moon and Sirius. The lunar surface was scanned in the same spectral region as that of the stars. These scans were made to measure the infrared absorption caused by molecular constituents of the Earth's atmosphere above the telescope. These terrestrial absorptions, which are picked up by the telescope, are subtracted from the absorption spectra taken of the stars so that the astronomers can obtain the true infrared spectra of these objects. In addition, the scans of the lunar surface may provide some additional data on the surface characteristics of the moon.

Sirius is of special interest because its spectrum is not expected to contain banding in the infrared – the star's high temperature preventing the formation of molecules. A valuable comparison can therefore be made of spectra of the hot and "cold" stars.

Several strong absorption bands indicating the presence of gas molecules in the atmosphere were observed both in the spectrum of Jupiter and the spectra of the giant red stars. The Princeton scientists are now analyzing 2,400 feet of magnetic tape that carries the record of observations made during the flight. The results will be announced after this work has been completed.

The Stratoscope II telescope, balloons, and guidance, command, and telemetry systems are described in some detail in *Naval Research Reviews, October 1962*. The first flight of the system – undertaken to make spectroscopic observations of Mars – was reported in *Naval Research Reviews, April 1963*. Only a brief account of the balloon-launching technique is given here:

Two balloons are used to launch and carry the 36-inch telescope into the stratosphere. A small balloon (75 feet in diameter when fully inflated) is filled with helium and gradually allowed to rise, while carrying with it the 230-foot diameter main balloon, uninflated, and the telescope and associated rigging. After the system has been erected to its full 600 feet, the main cables holding it down are cut by means of explosive charges, and the system rises into the air at about 800 feet per minute.

At the observing altitude, both balloons are fully inflated. During the flight, two separate control systems are used for the balloon system and for the telescope. Control of the balloon (tracking, ballasting, and valving of helium) is accomplished from a small, specially equipped aircraft and from mobile ground stations. Control of the telescope (pointing and focusing) is accomplished from an astronomer's station, mounted in two small trucks that are positioned along the projected path of Stratoscope.

When the scientific observations have been completed, the balloon is valved down to the ground.

The next scientific flight of Stratoscope II is now scheduled for next fall. Its objective will be to make photographic observations of certain celestial objects, such as the planets, moon, and globular clusters. In carrying out this assignment, Stratoscope II will provide better resolution by a factor of three over the most powerful land-based telescopes. To prepare for the flight, a dummy telescope may be carried aloft next spring to test the balloon's capacity to carry additional weight required because of modifications now being made of the telescope system. Also to be tested, if this flight occurs, will be a new method of orienting the telescope upon its return to earth – intended to decrease the damage that might result upon impact.

INVENTIONS

A New Marine Location Marker

Marine location markers are used by both surface ships and submarines to mark key points on the sea surface to aid in the conduct of rescue, salvage, and other operations.

In the past, these units have been propelled to the desired location, and also ignited, by the air blast of a retro gun. This method has several undesirable features. One of them is that the ignition of the firing chain occurs in the ejector barrel. As a result, the person operating the gun cannot easily avoid inhaling or ingesting the gases given off by the pyrotechnic material, and thus may be severely burned. Another disadvantage is that if the gun does not operate properly, the unit may not clear the ejector barrel; consequently, the pyrotechnic, if ignited, may create a serious fire hazard—one that could continue for as long as 15 minutes. Furthermore, if the marker is dispensed by hand, it must be equipped with fins so as to travel ballistically and strike the water in the proper attitude to initiate the firing chain. Thus far, impact markers have not performed reliably when launched from aboard ships and from helicopters.

As a means of circumventing these shortcomings, Mr. R. W. Szypulski of the Bureau of Weapons invented a marine location marker that can be ejected automatically from a gun or launched by hand with complete safety and reliability. The new method, described in Patent No. 3,105,979, issued October 10, 1963, requires that the pyrotechnic remain inactive until the marker comes in contact with salt water. To set off the pyrotechnic when the marker falls into the water, the unit is equipped with a sea-water cell that generates an electrical current to initiate the firing chain.

One of the important applications for which the new unit was designed is the safe and more reliable launching of markers from submarines at any operational depth. For this use, the invention includes a hydrostatically operated valve that opens at an assigned moment on the ascent of the unit, thereby admitting water into the chamber containing the salt-water cell.

The new marker can be adapted also to operate in fresh water. This is done by adding a small quantity of salt to the chamber which the water enters. When fresh water comes in contact with the salt, a solution of sufficient concentration is formed to activate the battery.

Improved Method of Comparing Waveforms

The recording and analysis of signals emanating from the earth environment and from space are one of the many approaches investigators take in their efforts to learn more about objects of scientific interest. Heart sounds, radar and sonar echoes, geophysical pulse echoes, radio waves from space, and fish and bat "noises" are but a few examples of signals that are being studied. Magnetic tape and wire recorders are commonly applied to this research, but

—Continued on back cover (inside)

RESEARCH NOTES

Unified Approach to Submarine Command and Control

A new approach to submarine command and control systems that considers the two operations as a single task is being taken cooperatively by the Bureau of Ships and Bureau of Weapons. Talent and funds are being invested in this effort to avoid the overlapping, redundancy, and mutual interference of functions that sometimes occurs when the components for each function are designed independently. Through the total approach, the investigators hope to create a more sensitive, responsive, and faster reacting submarine than any yet conceived.

The new approach is called FRISCO, for Fast Reaction Integrated Submarine Control. It is a logical follow-up to SUBmarine Integrated Control (SUBIC), a program conducted by the Office of Naval Research. FRISCO starts with a careful definition of ship missions and of functions required for successful accomplishment of the missions. FRISCO then groups the functions into man-machine combinations in various ways, analytically selecting the best configurations. Only when these configurations have been determined will the designers select the appropriate equipment. They will not be content to juggle existing hardware. If equipment that is on hand meets the needs, it will be used; if not, new equipment will be developed under a special FRISCO developmental program.

The design problem will be difficult to overcome, requiring the careful skirting of many potential pitfalls. To guarantee adequacy, the entire system will be evaluated using a shore-based dynamic engineering model. Only after the system has proved to be satisfactory will it be incorporated into a fleet submarine—probably in the fiscal 1969 shipbuilding program.

Algae Studied as Source of Antibacterial Agents

The ocean's grasses and shrubs—the algae—may provide new compounds for tomorrow's medicines and may become a source of effective anti-fouling agents. Dr. John McN. Sieburth and Dr. John T. Conover of the University of Rhode Island School of Oceanography have discovered that an extract made from the slurry of Sargasso weed kills and paralyzes such ocean creatures as crustaceae and worms. The effects occur even when the organisms are subjected to very dilute concentrations—as low as one part in 100,000.

The two URI researchers began their investigation of Sargasso weed on the first cruise of the URI research vessel TRIDENT (*Naval Research Reviews, May 1963*) about a year ago, as a result of observations made by Dr. Conover when he visited the Sargasso Sea earlier aboard the ATLANTIS of the Woods Hole Oceanographic Institution. The Sargasso Sea is a relatively still area centered in the mid Atlantic and bordered by the Gulf Stream and other surface currents. It was named by Portugese sailors who thought the air-bladder floats of the Sargasso weed looked like "salgazo," or small grapes.

In collecting weed samples on the TRIDENT's cruise, the URI investigators discovered that as the ship moved from the edge to the center of the Sargasso

Sea, the count of bacteria on the weed declined. An important finding was that the toxic substance was manufactured by the young growing tips, but not by the older parts of the plant. Fouling was light or negligible on the growing tips and much more advanced on older parts of the weed.

For years there have been unexplained variations in the populations of fish and shellfish. Is it possible that a sudden "bloom" of algae, producing anti-bactertial agents, may kill the delicate larvae of marine animals? On the other hand, the movement of algal antibacterials up the food chain into the digestive systems of fish may help prevent diseases. Evidence exists in support of both possibilities.

Dr. Sieburth began his search for antibacterial agents a number of years ago when he learned that the intestinal tracts of some Antarctic creatures contained little or no detectable bacteria. To find out why, Dr. Sieburth went on the 1957-58 Argentine Antarctic Expedition. In his studies of penguins, he found that an antibiotic substance was being eaten by these flightless aquatic birds. He traced the substance first to shrimp-like crustaceans, called Euphausids. These creatures, in turn, were eating an algae, called Phaeocystis. From this algae, acrylic acid was extracted. Later, this compound was fed to chickens, causing them to grow faster and helping to protect them from certain diseases. Since then, acrylic acid has been accepted as an antibacterial composition by the U.S. Patent Office.

Dr. Sieburth's work was sponsored originally by the Office of Naval Research. It is now being conducted under a grant from the National Institutes of Health.

Weapons Control by Electrical Energy of Human Muscles

The feasibility of using the electrical energy originating in human muscles for the control of future weapons systems is now being studied under sponsorship of the Office of Naval Research. The ultimate objective of the research, which will be directed by the Philco Corporation, is to devise a bio-operated control system having such reliability and flexibility that it will not be affected by involuntary physical actions.

For some time, medical and biological investigators have known that electrical energy originates in human muscles, but they have experienced difficulty in attempting to differentiate this electrical energy from other electrical signals produced by the nervous system. Another important aspect of the problem is the effects that such physiological and psychological factors as blood pressure and degree of fatigue have on the release of electrical signals by the muscles.

To nullify the effects of some of these variable factors, in the ONR-supported study, the electrical signals produced by the muscles will be analyzed and presented as patterns rather than individual impulses, as has been done in the past. The chief advantage of this approach is that the whole process of detecting, filtering, analyzing, and displaying can be performed very rapidly.

The first phase of the study will be carried out by the Research Division of the School of Engineering and Science of New York University with the cooperation of the NYU Medical College. Surface electrodes will be applied to selected muscle groups of a number of subjects. The resulting data will be routed to an amplifier/filter system to separate the signals from noise (other electrical energy) and other environmental factors. The signals will then be fed into a Philco 2000 computer. The computer output will determine the criteria for a "Perceptron," or pattern recognition device (see the article "Unconventional Computers," this issue) that will enable the subject to observe immediately when the desired signal is obtained. The processing and pattern-recognition aspects of the study will be performed at the Philco Laboratory, Blue Bell, Pennsylvania.

The investigation will provide large amounts of data on which to determine the feasibility of using the electrical energy of human muscles for weapons control systems. Other possible applications are a biocontrolled man-amplifier system, walking vehicle control, and control of functions under extreme g-loads. Valuable insight may also be gained in the field of prosthetics.

FLIP on Station

The unique research craft FLIP of the University of California's Scripps Institution of Oceanography returned to San Diego recently after spending 45 days in the Pacific Ocean – 27 of them on station. At times during the 27-day period, the vessel and its 10-man crew endured 35-foot-high waves and 50-mile-an-hour winds.

The 355-foot-long platform, which was built with funds provided by the Office of Naval Research and the Navy Bureau of Weapons, was towed to her station, 1500 miles north of Hawaii, by the research ship HORIZON of the Scripps Institution of Oceanography. The ballast tanks at one end of the vessel were then flooded, causing the vessel to assume a vertical position with only 55 feet of the cylindrical structure riding above the water. During the entire period FLIP was in operation, the HORIZON stood by conducting additional oceanographic investigations. FLIP drifted only 55 nautical miles during this time.

FLIP was stationed north of Hawaii to make observations of ocean waves and temperatures as part of a summer-long project of the San Diego branch of the Institute of Geophysics and Planetary Physics. The purpose of the project was to collect measurements of southern swell and its attenuation at six locations in the Pacific. The other five observing stations were on islands. FLIP recorded swell from storms almost half a world away, deep in the Southern Hemisphere. The waves were very long and only one to three inches high.

FLIP weighs about 600 tons, 70 of which make up her long, horizontal keel. The research laboratories, living quarters, and engine room are located at different levels above the water line – when the vessel is in the vertical position – in a compartment roughly rectangular in cross section, 14-1/2 by 25 feet. Outside of the research laboratory, about 30 feet above water, is an open-grill platform which is used for making surface observations, for handling small boats alongside, and as a safety station during the flipping operations when the buoy is ballasted and deballasted by the crew. From another, higher platform, equipment can be lowered through a trunk tube, 2 feet in diameter, the entire length of the cylinder without danger of becoming entangled with the buoy or with gear mounted externally. Two other tubes extend from the cabin downward through the cylinders to an ocean depth of 150 feet. They are watertight and equipped with ladders which enable the crew to descend to carry out certain phases of scientific investigations or to check on the operation of the buoy.

Supporting the cabin and extending 100 feet beneath the ocean surface is a steel cylinder, 12-1/2 feet in diameter. Joined to its bottom is a cone-shaped section which flares outward and downward for another 50 feet in transition to a cylinder having a diameter of 20 feet. This larger cylinder continues downward to the full draft of 300 feet. The 60-percent reduction in area within the buoy which occurs between the two cylinders gives the platform a natural period for heaving of about half a minute. When FLIP is in the vertical position, about 1500 tons of sea water occupies the 20-foot cylinder.

A more detailed description of FLIP is given in *Naval Research Reviews, August 1962*.

Basic Research in Perspective

Remarks by Deputy Secretary of Defense Roswell L. Gilpatric at the Chemical Engineering Achievement Awards Dinner, New York City, December 3, 1963.

We support a broad effort at the research end of the R&D spectrum aimed at producing the new knowledge, new techniques, new materials, new devices on which the advanced systems developments further down the road must be based. At this end of the spectrum we should be both generous and adventurous. We can afford to be generous because we can support dozens of projects in this area at a fraction of the cost of a single large-scale systems development. We have to be adventurous because no one can accurately predict today just which areas of exploration are going to be most important in the years ahead.

The Defense Department is sometimes chided for the relatively small amount of its R&D resources applied to basic research as contrasted with the practice in other Federal agencies. Both the Atomic Energy Commission and the National Aeronautics and Space Administration spend far larger proportions of their R&D budgets on basic research than does the Defense Department. Since we recognize the importance of not losing contact with the most creative research people, particularly those in universities, who have been responsible in the past for some of the most radical improvements in the technological equipment used by the military, some increase is planned in the research sector of the Defense R&D budget.

I am not suggesting that we throw away money on every idea that comes along. I mean, rather, that having found talented and qualified people in the fields we believe are going to be important, we should lean over backward to leave them alone. We need worry very little at this stage about dangers of duplication. The possible lines of inquiry to peruse are, for practical purposes, virtually unlimited, so that there is small likelihood of any significant overlapping of effort. And the dead weight of the kind of bureaucratic control that would be needed to ferret out any occasional duplication would involve costs – in dollars, but more importantly in stifled initiative – that would be far more severe than the faults any centralized control would forestall.

ON THE NAVAL RESEARCH RESERVE

Oak Ridge Nuclear Sciences Seminar

The Fourteenth Annual Nuclear Sciences Seminar was held December 1-14, 1963, at Oak Ridge, Tennessee, with Naval Reserve Research Company 6-3 acting as the host. The seminar was sponsored by the Office of Naval Research in conjunction with the Atomic Energy Commission and the Oak Ridge National Laboratory. The 57 participants included 33 reserve officers of the Navy, 5 of the Air Force, and 18 of the Army. LCDR H. E. Cochran, USNR, served as seminar chairman.

The seminar was officially opened with a welcoming address by LCDR J. B. Cory, Jr., USNR, Commanding Officer of NRRC 6-3. Greetings from the Commandant of the Sixth Naval District were extended by LCDR C. K. McDonald, USN, Naval Weapons Annex, U.S. Naval Ammunition Depot. In addition, he discussed "The Last Stop Ashore for the Polaris Missile Before It Goes to Sea." Captain E. J. Hoffman, USN, Deputy and Assistant Chief of Naval Research, reviewed the primary mission of ONR as that of supporting basic and applied research. He also outlined the objectives and scope of the current research program as well as indicating some of the future efforts of ONR. Other talks given during the opening session were by the Honorable R. A. McNees, Mayor of the City of Oak Ridge; Mr. S. R. Sapirie, Manager, Oak Ridge Operations, AEC; and Dr. W. G. Pollard, Executive Director, Oak Ridge Institute of Nuclear Studies.

During the two-week seminar, discussions were devoted to phases of the overall nuclear-research program, including basic theory and applications in the fields of the life sciences, isotope production and use, and nuclear reactors. The lectures were given by scientists and engineers associated with the Oak Ridge National Laboratory, the Oak Ridge Institute of Nuclear Studies, and the University of Tennessee-AEC Agricultural Research Laboratory.

Military speakers gave talks on the following subjects: "The Research Reserve Program," by CAPT D. J. Mooney, Jr., USNR, Special Assistant to the Chief of Naval Research (Research Reserve); "Training Opportunities in the Research Reserve," by CDR E. F. Kehoe, USNR, Education Specialist (Research Reserve); "Nuclear Weapons," by LCDR Glenwood Clark, Jr., USNR, Headquarters, Defense Atomic Support Agency, Research Division, Department of Defense; "Nuclear Power and Propulsion Program," by MAJ J. R. Burke, USAF, Headquarters, USAF, Assistant for Nuclear Energy, Office of Deputy Chief of Staff, Research and Technology; "Army Nuclear Power Program," by LT COL J. J. Kelly, CE-USA, U.S. Army Engineers Reactor Group, Office of Chief of Engineers; "Navy Nuclear Power Program," by LCDR A. F. Lovata, USN, Atomic Energy Division, Office of Chief of Naval Operations; "U.S. Naval Reserve Recording Activity," by CDR R. D. Marion, USNR, OINC, Naval Reserve Recording Activity.

Field trips were made to the American Museum of Atomic Energy, Technical Information Extension (USAEC), Fort Loudoun Dam of TVA, Kingston Steam

Plant of TVA, the Abbott Laboratories, University of Tennessee-AEC Agricultural Research Laboratory, the Experimental Gas-Cooled Reactor of TVA, and the Oak Ridge National Laboratory. Visited at the Oak Ridge National Laboratory were the Oak Ridge Research Reactor, the Bulk Shielding Reactor, the Health Physics Research Reactor, and the Oak Ridge Isochronous Cyclotron.

NRRC 6-18 Wins National Competition

The Chief of Naval Research announced on December 17, 1963, that Naval Reserve Research Company 6-18, Nashville, Tennessee, had been declared the winner of the third National competition for general excellence among Research Reserve companies. Nominations for this award, which is given to the most outstanding Research Reserve company, were submitted by commandants of the Naval Districts.

The award for which NRRC 6-18 was declared the winner—*the Award for General Excellence*—is based on company achievement for the fiscal year ending June 30, 1963. During this period, CAPT W. D. McClurkin, USNR, was in command; he is also the present commanding officer of the company. Presentation of the award to NRRC 6-18 is planned for some time early in 1964.

A panel established to review the records, inspection marks, and other material used as criteria, and to recommend the winning company, was composed of the following officers: CAPT R. H. Gillock, USN, Air Warfare Officer and Director, Military Services Division, Office of Naval Research; CDR R. J. Stankowski, USNR, Assistant for Training and Mobilization, Office of the Assistant Chief of Naval Operations (Naval Reserve); and CDR D. J. Marker, USNR, Head, Selective Reserve Programs Branch, Bureau of Naval Personnel.

Members of the panel which convened to designate the winner of the *Award for General Excellence* commented very favorably on the records of the other companies entered in the competition. These companies and their commanding officers for Fiscal Year 1963 are as follows:

NRRC 1-2, Providence, Rhode Island	LCDR W. M. Hagist, USNR
NRRC 3-9, Upton, Long Island, New York	LCDR W. H. Poulson, Jr., USNR
NRRC 4-13, Philadelphia, Pennsylvania	CAPT R. Mayer, USNR
NRRC 5-12, Dahlgren, Virginia	CAPT J. J. Glancy, USNR
NRRC 8-4, Houston, Texas	LCDR M. G. Gugenheim, Jr., USNR
NRRC 9-14, Madison, Wisconsin	LCDR S. L. Inhorn, USNR
NRRC 11-8, Point Mugu, California	CDR E. C. Whitaker, USNR
NRRC 12-4, Fresno, California	LCDR M. E. Kimberly, USNR
NRRC 13-5, Corvallis, Oregon	LCDR R. L. Lincoln, USRN

It was determined that the *A. Hoyt Taylor Award*, which is based upon the best scientific or technical study, will not be presented in this fiscal year. The panel which was established to review scientific and technical studies consisted of the following officers: CAPT W. E. Berg, USN, Assistant Chief for Research, Office of Naval Research; Dr. L. L. Larrick, Executive Assistant (Scientific Information), Office of Naval Research; and Mr. J. R. Patton, Jr. (CAPT, USNR), Aeronautical Research Engineer, Power Branch, Material Sciences Division, Office of Naval Research.

A Visit to the New London Submarine Base

On the week-end of September 26-27, 1963, twenty-four reserve officers from local Naval Reserve organizations at Denver, Colorado, flew to the New London Submarine Base, Connecticut, under the auspices of the Naval Forces, Continental Air Defense Command, commanded by the late RADM J. H. Mini, USN. The tour was conducted as group active duty for training.

The officers reported to base operations at Peterson Field, Colorado Springs, at 0630 and were airborne at 0700. Before completion of the eight-hour flight, an anchor pool was formed and the winner determined by the exact minute the wheels touched at Quonset Point, Rhode Island. LT R. F. Long, USNR, a member of NRRC 9-26, was the best forecaster, his time being just eight minutes off the estimated ETA at take off. Later that evening one reservist was reminded of a forgotten Navy custom; he entered the Officers' Club Lounge with his hat on and was forthwith reminded to treat the guests for his folly.

The tour of the Submarine Base started in earnest the following morning. Busses took the reservists to New London, where they were met by LT R. G. Van Moppes, USN, the visitor control officer. LT Van Moppes escorted the officers on a tour of the Base before proceeding to headquarters for a briefing by staff members, Commander, Submarine Forces, U.S. Atlantic Fleet. After the Commander welcomed the reservists, his staff gave an excellent classified briefing on the following subjects: "Torpedos and Weapons," by LT A. C. Peterson, USN; "Fleet Ballistic Missile Systems," by CDR Dan Clements, USN; "New Developments," by CDR Jack Paget, USN; "Personnel Matters," by LT T. Thomley, USN; and "Medical and Health Problems," by LCDR R. Tickter, USN. This briefing brought the reservists up to date on current and future developments of submarine activities and weapons systems, with special emphasis being placed on the Polaris submarine facilities.

Following luncheon the group again boarded the bus and was taken to the Medical Research Laboratory for a briefing by Dr. A. Molish on "Human Factors Studies." Following this presentation, Mr. L. Laxer discussed "Color Deficiency Studies." At the conclusion of the briefing a tour of the Laboratory was made.

Next on the agenda was a two-hour tour of the conventional submarine USS SABLEFISH (SS-303), after which the group returned to Quonset Point. The return trip to Colorado Springs was made on Sunday.

This trip was the second that the Naval Forces have offered the local group at Denver. Last spring, a similar trip was made to the Pacific Missile Range at Point Mugu, California. Both of these trips were made under group active duty for training orders. Under these orders, reservists perform the duty without pay or allowances.

The reservists who visited the Submarine Base are grateful to Commander, Naval Forces, and Continental Air Defense Command, whose cooperation made these indoctrination trips possible. The members of NRRC 9-26 who made the trip were CAPT John K. Sterrett, USNR, Commanding Officer; CDR Charles W. Matthews, USNR; CDR Stephen A. Cellerich, USNR; CDR Marion F. Sanders, USNR; LCDR James H. Kruse, USNR; LCDR Alexander R. Ormond, USNR; LCDR Roger E. Ward, USNR; LT Karl A. Kitt, USRN, LT Raymond F. Long, USNR; and LT James H. Ryan, USNR.

Logistics Study Commended

While on two-weeks active duty for training with the Bureau of Ships, LCDR G. D. Hamilton, USNR, a member of Naval Reserve Research Company 3-14, Poughkeepsie, New York, completed work on an important logistics problem that resulted in new instructions being issued to the Fleet and changes being published in the Bureau of Ships Technical Manual. LCDR Hamilton's work also received favorable comment from the Office of the Chief of Naval Operations.

In expressing appreciation for the work accomplished during this training period, the Chief of the Bureau of Ships stated, "This was a significant help to the Bureau of Ships and to the Office of the Chief of Naval Operations and demonstrates the valuable return which can be gained both by the trainee and the Bureau from the assignment of stimulating projects and by diligent effort."

The Commandant, Third Naval District, by endorsement to the letter to LCDR Hamilton, added his congratulations and stated, "Your performance on subject training duty not only reflects credit on yourself, but on the Naval Reserve Program as well. It is a pleasure, therefore, to add my congratulations for the recognition accorded you by the Chief, Bureau of Ships."

Science and Engineering Seminar Scheduled

An additional seminar has been placed on the Research Reserve seminar schedule for this fiscal year. Naval Reserve Research Company 1-5, Worcester, Massachusetts, will conduct a First Naval District Science and Engineering Seminar for the two-week period commencing June 14, 1964. The course, which will be offered on the campus of Worcester Polytechnic Institute, will include topics covering a cross section of the scientific disciplines in the New England area. In addition to the lecture periods which have been planned, scheduled field trips will be made to interesting research activities in this region.

A forthcoming change to the Active Duty for Training Catalog, BUPERS Instruction 1571.4I, will officially authorize this seminar and allocate the quotas. It is planned to issue quotas to the following Naval Districts: First, Third, Fourth, Fifth, Sixth, Eighth, and Ninth. Quotas for other Naval Districts will be considered upon request of the respective Commandants to the Chief of Naval Research.

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series of complex metabolic errors as well as from physical or chemical disruption of a vital part of the cell.

Inasmuch as viruses have no metabolic apparatus, these theories do not account for viral behavior in the airborne state, except that both bacteria and virus populations appear to be heterogeneous. Neither do these theories suggest any simple experiments that might prove the individual conjectures. Instead, they serve only as a point of departure around which the numerous questions that remain to be answered act as signposts directing the way toward many new avenues of research.

TV Camera Photographs Northern Lights

The Atmosphere and Astrophysics Division of the Naval Research Laboratory has developed a closed-circuit television system which requires very little artificial light for illuminating the subject being photographed. The system has been used successfully to photograph orbiting satellites, +9 magnitude stars that are invisible to the naked eye, and terrain illuminated only by starlight or an overcast moon.

At the latest meeting of the American Astronomical Society, held in Washington, D.C., on December 27, 1963, Mr. Grady Hicks of NRL, who developed the TV camera system, and Mr. T. N. Davis of the Goddard Space Flight Center reported that use of the system had been extended to photographing the Northern Lights (aurora borealis). An image orthicon (intensifier) tube is the heart of the system, which is at least 100 times more sensitive than conventional photographic systems used in making pictures of dim objects at night. With this gain in sensitivity, motion pictures of the faintly luminous aurora borealis were recorded in color as well as in black and white at a rate of 24 frames per second. In some instances the rays of the aurora had decayed to such a low luminous level that they were invisible to the naked eye, yet they were easily photographed with the NRL TV camera system. (See photograph on front cover.)

As part of his presentation at the American Astronomical Society meeting, Mr. Hicks showed a motion picture of the aurora at the same rate at which it was recorded. Such real-time motion picture photography of rapidly changing auroral forms furnishes the auroral geophysicist with a new tool for exploring the interaction of interplanetary and solar energy with the earth's atmosphere.

Inventions — Continued from Page 20

other types, such as disks, drums, and belts that operate on magnetic, electrostatic, or modulated-groove principles are also used.

Quite often in the analysis of these records, investigators wish to compare the waveforms on one track with those on another without cutting either medium to isolate the portions of interest. To facilitate this process, Mr. Sumner Gordon of the Bureau of Ships invented a technique that permits repetitive scanning of data of any type on a dual record track. Included in the device embodying his concept is an epicyclic gear train that allows the operator to delay, in small increments, the phase relationship between the signals on the two recorded tracks.

"Repetitive Scanning of a Dual Record Track on a Fragment of a Record," Patent No. 3,105,227, issued September 24, 1963, has important applications in correlation studies of underwater acoustic signals, particularly, because it allows the analyst not only to study stationary, selected portions of the tapes, but also to vary, by mechanical means, the phase relationship between the signals. A further advantage is that it permits the use of original tapes, thus avoiding the expense and time involved in making dubbings of the originals.

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The ever changing shapes of the aurora borealis were captured on film recently by a special TV camera developed at the Naval Research Laboratory. The system picks up some features of the aurorae that are invisible to the naked eye. Shown here are samples of pictures obtained during the experiment. Film was exposed at the rate of 24 frames per second. See article on back cover (inside).