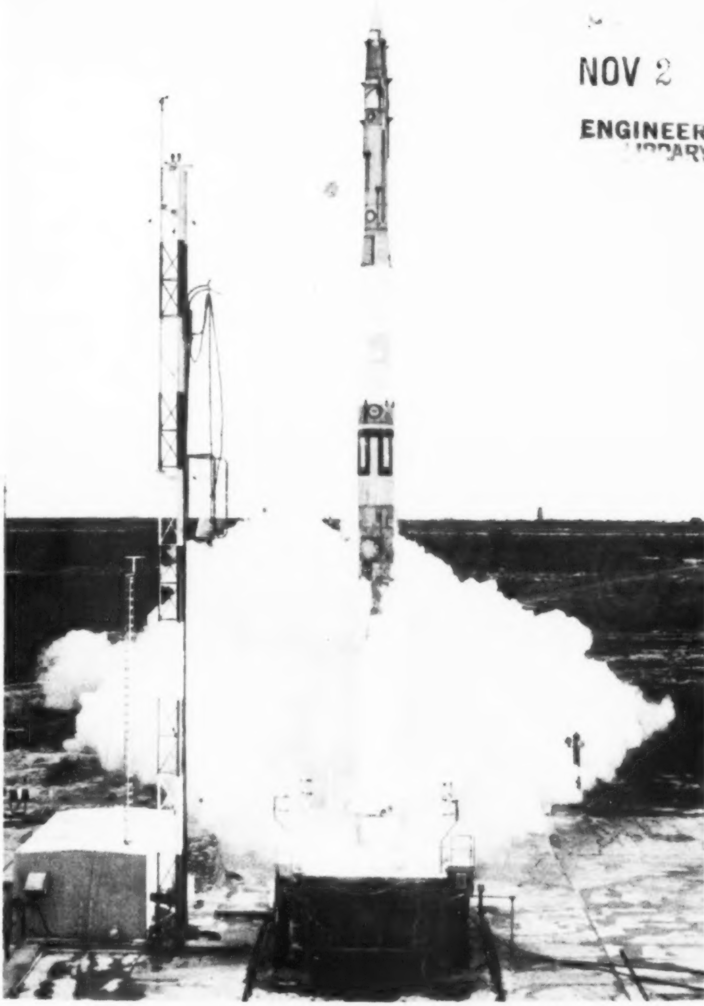
OFFICE OF NAVAL RESEARCH NOVEMBER 1957

RESEARCH REVIEWS



DEPARTMENT OF THE NAVY

WASHINGTON, D. C.

NAVEXOS P-510

Employees of the Control Center at NRL monitor data on Russia's satellite coming in by teletype from IGY tracking stations.

This crew of girls, answering inquiries concerning the Soviet satellite, was quickly assembled at NRL's VANGUARD Control Center when the first signals from the "moon" were reported. The calls were so numerous, the girls worked for 24 hours without a break.

Theirs and Ours--A Discussion of Satellites

On October 11, one week after the Russians unexpectedly launched a satellite into an orbit around the earth, the man best informed on United States efforts to accomplish the same feat—Dr. John P. Hagen of the Naval Research Laboratory—stood before the National Press Club of Washington to discuss "the state of the art." But perhaps even more interesting and enlightening than his talk was the informal exchange of questions and answers which followed it. Here is the transcript of most of this session:

QUESTION: How much sleep have you had since last Friday?

DR. HAGEN: I'm afraid I can't give a very direct answer to that. I haven't counted it.

QUESTION: You touched on this in your talk, but you might like to amplify it: is VANGUARD behind schedule, and if so, why?

DR HAGEN: I think the proper answer is that VANGUARD is behind the working schedule we originally announced. It is not behind the schedule to put a scientific satellite in an orbit during the International Geophysical Year. The delay occasioned between our present status and our working plans set up 3 years ago is the kind that occurs in any project of this nature—you have unforseen difficulties which do add up and over a period of 2 or 3 years can consume a few months.

QUESTION: Will the first fully instrumented satellite definitely go up in March?

DR. HAGEN: I think my answer to that would have to be that it is definitely our intention that it go up in March.

QUESTION: Who made the decision against giving VANGUARD a priority status?

DR. HAGEN: In a very general sense, the Department of Defense.

QUESTION: Many people ask questions about the case of the decimal point. Has the weight of Sputnik been definitely established—184 pounds or 18.4 pounds?

DR. HAGEN: It has not been definitely established, but it is reasonable to assume that the first indication that the weight was 184 pounds—that was really an announcement—is correct. From talking with the Soviet scientists who are over here, our people have drawn certain conclusions. They were told, for example, that the batteries weigh much more than the 18.4 pounds—the smaller weight. When one considers the batteries needed to run the transmitters for a period of 2 or 3 weeks, considers the modulation schemes in the satellite, and considers the state of the art, I think it is reasonable to assume that this 184 pounds might be the correct weight.

QUESTION: Why does Sputnik weigh 184 pounds when our planned satellite is expected to weigh only about 20 pounds?

DR. HAGEN: I can't very well arrive at the motive of the Russians and their design of their satellite, but I can speak a bit about our own motives.

We desire to put an object in an orbit which would have the capability of performing difficult yet precise experiments—the different experiments I spoke of earlier. The first one is the measurement of the ultra-violet radiation from the sun; this experiment had been done in a rocket previously. We analyzed the procedures we would have to go through in order to reduce this to the weight that is necessary to put it in a satellite and found that by using the best of miniaturization techniques, we could, in a package of some 20 pounds, do well a useful scientific experiment. The rocket then was designed around this weight limit. It's hard here to tell which came first—the chicken or the egg—because the design of the satellite and of its launching rocket are interrelated. But within the scope of the project, the 20 pounds weight was adequate to do the things set up to do, and it did fit with the rocketry we had available.

QUESTION: Further on the weight: President Eisenhower said on Wednesday [October 9] that if Sputnik does weigh 184 pounds our scientists would be astonished. Are you?

DR. HAGEN: I am sorry that I was not in the audience when this statement was made. Astonished, yes. But perhaps for a different reason. I know that if we had 184 pounds the number and complexity of the experiments would be tremendously increased. The capability of our rocket, however, does limit us to this weight.

QUESTION: If you were doing this job over again, what would you do different?

DR. HAGEN: Is there a time limit? If I were to do it again and if the framework in which the job was to be done was the same as it was in the fall of 1955 when I was given this job, I don't think we would have gone down a much more different course.

QUESTION: Didn't anybody realize the terrific impact on world opinion of the first launching into outer space? If not, why not?

DR. HAGEN: I think that the people are divided into at least two classes. Many of us who have been working with this kind of thing heartily believed that there would be a great impact not only on the American people but on all people in achieving something like this. This is a matter of opinion, however, and therefore there were opinions on the other side. But I can assure you that people who are working on the project and are connected with this all understood the implication.

QUESTION: If we in the United States were putting emphasis on military problems rather than on a satellite, why haven't we an ICBM like the Russians have, and why do they have both a satellite and an ICBM and we neither?

DR. HAGEN: It is explained by the President in his press release [October 9]. This project is separated from the military ballistic missile project, and I think that makes it impossible for me to answer the questions concerning the military missile.

QUESTION: Is it likely that previous reports of UFO's—I think that in plain language that means flying saucers—is it likely that previous reports of UFO's were artificial satellites of some early experiment by Russia?

DR. HAGEN: I doubt very much whether that is so.

QUESTION: You say you are limited by rocketry available. Does this mean that Soviet rocketry surpasses that of United States?

DR. HAGEN: To put this in its right perspective: We were limited in the rocketry available to us since we were using rocketry outside the military program. The rockets we used—the Viking rocket, for example—was one developed for studying the nature of the outer atmosphere. The same thing was true of the Aerobee, from which our second stage started, so that the limitation here is one deriving from the nature of the rocket that one would normally build to probe the outer atmosphere. If the weight of 184 pounds is correct, there is absolutely no question but what the rocket which acted as a booster for the launching vehicle (Russian) had a thrust that was tremendously larger than the thrust we are using.

QUESTION: Will our VANGUARD satellite fly higher and faster than the so-called "Red-eye"? If so, by how much?

DR. HAGEN: It is our intention to make the orbit of our satellite have an average height above the surface of the earth of about 300 miles. Now there is no virtue, once you get into this area where you begin to have satellites orbit, of height for height's sake. We chose, after some careful consideration, the average height of 300 miles because that is the very region in the atmosphere where we most wanted to find the characteristics of the atmosphere, and you can only study atmospheric densities in the part of the atmosphere in which the satellite flies. Now, in order to give us some safety or a safety factor in putting this thing up there, we are designing excess velocity into the vehicle so that there is a possibility that the orbit will go as much as 1,500 or so miles out from the earth in the apogee position, but on the return it will come back to somewhere close to 300 miles from the earth. Again, though, I would like to stress that within narrow limits there is no great difference in an orbit that is 500 miles big and an orbit that is 300.

QUESTION: If the United States had been willing to spend the money, could we have put up a satellite comparable to Sputnik prior to this time?

DR. HAGEN: I think the answer to that was in the President's release [October 9]. He clearly said, had we been authorized to use military rocketry then we could have launched a satellite earlier than we have yet to do.

QUESTION: Somebody in the audience recalls an old controversy and asks this question: A nation in first place can afford the luxury of wasting an Oppenheimer. Can we still afford it?

DR. HAGEN: Whether we were in first or last, we couldn't afford it.

QUESTION: Today's [October 11] Wall Street Journal reports our State Department expected the Russians to launch their satellite in December of this year. Did our satellite people have the same impression?

DR. HAGEN: It is difficult to say what our program people thought of the date that the Russians would launch. There was much speculation. Our program, you understand, has, as I pointed out, been done quite frankly, quite openly, and the date at which we were aiming was, as of three years ago, as announced, so that the Russians knew that in approximately October of this year we expected to be at the point where we would be launching. I think that it is fair to assume that if they hoped to race they would try to meet or beat that date.

QUESTION: Were the Russians guilty of unethical conduct in sending up a satellite when they did?

DR. HAGEN: From a purely personal point of view—definitely! [Dr. Hagen did not intend that this reply be taken seriously. As it "brought down the house," it was clear it wasn't.]

QUESTION: Have the Russians turned over to our scientists any information on the structure and instrumentation of their satellite?

DR. HAGEN: Officially, no; they have not to my knowledge. The normal flow of information of this sort would be for the Russians to turn this information over to an organization called the ISIGYC, which is a bunch of initials in French meaning the International Scientific International Geophysical Year Committee. This information would be turned into them and they, in turn, would make it available to all the adhering nations who had an interest. The Russians have turned over one piece of paper that I recall which gave in general terms a description of the experiments which they were doing in their rocket and satellite program, but I am sure no information on the structure or instrumentation of the satellite itself.

QUESTION: Do you believe Sputnik was launched by a missile that had an effective guidance system? Does a satellite vehicle need a guidance system to get it into an orbit?

DR. HAGEN: Yes, you do need to have an effective guidance system to get a satellite in an orbit. This is a big complexity—depends on the limitations you want to place upon the orbit and the height to which you are going to launch. In our case, for example, we are planning to launch to about 300 miles, and we don't want the perigee to be less than 200 miles. This means that we must have a guidance system that is accurate to better than 1-1/2 degrees. If you don't have that accurate guidance system, then you must rely on chance and simply send the things up and bat them out until one of them slips by. Now I don't believe anyone who went into a program such as this would do so without having a guidance system that would put the satellite into place.

QUESTION (Paraphrased): Do you think there is television equipment in the Russian satellite transmitting a picture back to earth, as has been recently suggested by someone?

DR. HAGEN (First two sentences paraphrased): I do not think so. Transmission of ordinary radio signals is a relatively simple process. However, when you gather a certain amount of information, it takes, as you know, wider and wider channels in the radio system to carry that. To put all the information that is in television on a screen, requires a much wider frequency allocation or frequency band than does a simple radio communication. I believe that if there were information of this sort coming out of this satellite, one would recognize it by the extreme width of modulation.

QUESTION: Could you put more stages on the VANGUARD and reach the moon? How soon?

DR. HAGEN: I think the answer to that is yes, you could. You wouldn't necessarily put more stages on VANGUARD, but you might put more stages under it. In one way or another you can modify a vehicle to get as far out as the moon. How soon is another question.

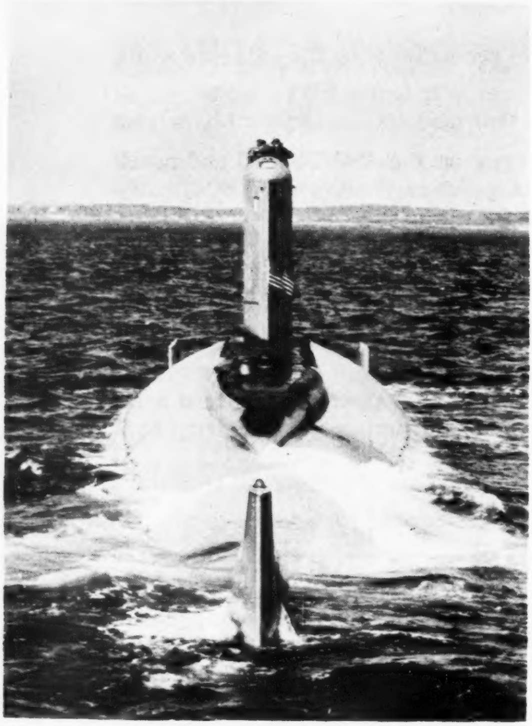
QUESTION: What is your personal estimate of the time required to go from satellite to a true space platform—assuming a crash program?

DR. HAGEN: And by crash program I presume you mean no budgetary limitations? If you didn't have to worry about money, and had all the priority in the world, we would be a little bit older than we are today before a true space platform were put in the air. That is a tremendous thing to do. By true space platform, I mean one that's big enough to accomodate people and large instruments. These satellites, the one that is up there now and these you see here [display models of the VANGUARD sattelite], they are space platforms, but they're all operated by remote control.

QUESTION: Why is the United States satellite set for a frequency of 180 megacycles, while the Russians have a low frequency? Would it not be easier to track at the frequencies where "hams" and others could follow it?

DR. HAGEN: I'm very grateful that someone asked that question, because it is a point I should have made. The frequency, however, is 108 megacycles, and that was chosen for our tracking system so that accurate tracking would be possible. The choice of any lower frequency makes it impossible to precisely track the orbit because the waves are refracted in our ionosphere. We would never have freely chosen the frequencies that were used by the Russians. The Russians agreed with us and all the people adhering to the International Geophysical Year, in Barcelona in 1956, on our decision to use 108 megacycles as a tracking frequency. I think that all recognize the superiority of the higher frequency. It is more difficult for amateurs to hear it, but it is, however, much better for accurate tracking purposes.

Before this edition of Research Reviews is distributed, Russia is expected to send Sputnik II up to circle the earth. As Dr. Hagen said in his talk to the National Press Club, "It is of great importance for us to get an early and a good measure of any satellite appearing in the sky." Thus, our satellite trackers will be as busy "watching" and listening to this new "moon" as they have been to the old (see inside back cover). In the meantime, a large part of NRL's Project VANGUARD team is encamped at Cape Canaveral, Florida, preparing to put the first U. S. satellite into its orbit. (See inside back cover).



"Flying" the Submarine

J. J. Regan
J. H. Ely

Naval Training Device Center
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New York

The experimental submarine USS ALBACORE

Maneuvering a submarine through the water in three dimensions at high speed is extremely difficult for human operators to do by means of the traditional system of control. This system, which utilizes a team of four men—a diving-control officer, a helmsman, and two planesmen—is inadequate because it calls for more coordination between team members than these men can at all times be expected to display; their individual jobs are taxing enough by themselves.

Realizing this, the Naval Training Device Center arranged, in 1948, for an investigation of the man-machine problems involved in controlling the submarine. This study, part of Project THERBLIG, a 6-year program of human-engineering research on submarines and anti-submarine warfare equipment, was carried out under contract to Dunlap and Associates of Stamford, Connecticut.

The first work, done in 1948 at the New London Submarine School, concerned diving-control operations. On the basis of information gathered, the staff recommended changes in design that ranged from minor modifications to complete overhaul of the control station. The most radical proposal involved moving all displays and controls athwartships (the two planesmen ordinarily face the port bulkhead, the helmsman athwartships), reducing the size of the indicator panel, and permitting both depth and helm control to be handled by one man.

During the following year, the research group made a more detailed investigation, this time utilizing motion-picture photography. Of 65 operator tasks photographed on guppy submarines, 64 gave evidence of some human error. The more serious weaknesses, which centered about psychomotor skill (or lack of it) and time delays, appeared to be due primarily to inadequate equipment design and training and to ambiguous operation procedures.

Although the chief recommendations growing out of these studies concerned changes in kind of illumination, size of displays, arrangement of panels, and in other features, the research group believed that the ultimate solution to the problem was complete redesign and relocation of the control-station components. The likelihood of effecting the latter seemed remote, however, until Project THERBLIG was asked to assist in the design of the USS ALBACORE (AGSS 569), an experimental submarine having an unusual hull design and exceptional performance characteristics. As the submarine's high speed was expected to aggravate the already serious problem of controlling depth, its designers believed it should be equipped with a radically new control arrangement.

As a result of its studies of the diving-control station, Project THERBLIG recommended that one-man control, using airplane-type control devices, be considered. After much discussion, however, it was decided to design the station primarily for three-man split control, with the diving officer supervising from behind. This arrangement was agreed upon in order to assure that two- or three-man control was achieved in the event one-man control was not. The drawback to the plan was that it required that all instruments be larger and be spaced farther apart than was desirable for the single operator, thus severely limiting the design for one-man control.

The arrangement of the three control stations was worked out in this way: It appeared that for effective one-man operation, the operator should face forward. Therefore, all three control stations were placed athwartships, with the three operators side by side. While the ship was under three-man control, the central station would be for the bow planesman, and while under one-man control, for the "pilot." The central station was to incorporate control over both the bow and stern planes, which could be coupled together, and over the helm when one-man operation was in effect. The main reason for locating the "pilot" in the middle was so that he could read instruments placed in front of all three stations.

The basic control for one-man operation was to be a yoke of the sort used on large aircraft. Essentially, the yoke is a stick on which a steering wheel is mounted. Fore or aft movement of the yoke causes the submarine to rise or to dive. The wheel, of course, controls the rudder. In conventional submarines, the positioning of a control brings about rate of movement of planes and rudder. Under this system, the operators must keep continual track of the positions of the planes and rudder on plane- and rudder-angle indicators. To avoid this, the 569 was designed so that movement of the controls would bring about a rudder or plane position. The change was an important one, for it meant that while the submarine was under one-man control, the operator would know by the location of his control where the control surfaces were located.

In spite of all of the difficulties and compromises that went into designing the control station of the 569, the research staff felt confident that it would prove that one-man submarine control was feasible. In this expectation they were entirely correct. The 569 has been built, and it can be maneuvered effectively by a single operator. The 569 therefore marks a new era in submarine control. "Flying" the submarine is no longer a dream but a reality.

During the 569 study, the project staff became convinced that a revolution in submarine control was imminent. Although at this time one-man control of high-speed submarines was still a matter of conjecture, its potentiality was important enough to warrant a thorough human-engineering study.

Charles R. Kelley, who undertook this study, conceived of the problem of one-man submarine control as a special example of the general problem of man as an element in a closed-loop system. His first concern was the characteristics of the system to which man belonged. This meant an investigation of the nature and function of the submarine as a military weapon. Next, he explored the physical and mathematical aspects of submarine control. On the basis of the background information he gathered, Kelley suggested 10 arrangements of controls and indicators of various levels of complexity. He then went on to propose research techniques by means of which the arrangements suggested, and others, can be evaluated before actually being included in the specifications of new submarines.

At the outset of Kelley's study it became clear that there is a conflict between the needs of the engineer building a control system and those of the human operator. In general, it is true that as the task of the human operator is simplified, the mechanics of the system become more complicated. Thus, on a given submarine, considerations of cost, space, and other requirements make it unwise or impossible for the engineer to exceed certain limits of design complexity.

In order neither to oversimplify nor overcomplicate the task of human operation, it is necessary to know a great deal about the human operator's capabilities. At what point does simplification of a task leave off and oversimplification begin?

To apply this question to submarine depth control, it is known that accurate control requires that the planes be positioned as a function of depth error (the distance above or below desired depth), of pitch (the angle of the fore-aft axis of the submarine to the horizontal), of the rate of change of pitch, and of the submarine's velocity. Is it reasonable to expect a single operator to take all of this information into account in positioning his planes when he is simultaneously attempting to keep the submarine on course by controlling the rudder? This question is answered indirectly by analyzing other kinds of control tasks, such as gunnery tracking and driving land vehicles. Through this analysis it is shown that it is possible for the human operator to differentiate a signal, to integrate a signal, to combine information from two or more signals, and, in fact, perform separately and sometimes in combination all of the operations required for submarine control.

Some of the principles which Kelley applies to the design and arrangement of indicators appear obvious once they have been set forth, but they have been little applied in the past. For example, the relative size of the indicator scales on the instruments used to determine depth influence strongly the operator's response. The operator will position his planes in part as a consequence of depth error, in part as a consequence of pitch, and in part as a consequence of rate of change of pitch. If 5 degrees on the pitch scale were equivalent to 1 foot on the depth scale one response might occur; on the other hand, if 1 degree on the pitch scale were equivalent to 5 feet on the depth scale, a completely different response might occur. The first arrangement would cause the operator to overcorrect for pitch and to undercorrect for depth error. The second arrangement, which is based on plane-positioning equations for good submarine depth control, would be about right, at least for many submarines. It is important that factors such as these be taken into account in planning indicator scales. They have not been taken into account in the past, even in designing the 569.

Kelley's 10 arrangements for one-man control vary in difficulty from one involving only three simple instruments—a depth gage, pitch gage, and compass—to a panel embodying what might be called fully automatic depth and steering control. Between these two extremes are eight arrangements of increasing levels of mechanical, engineering, or operator-task complexity. At least three of these intermediate systems are varieties of semi-automatic depth or depth-and-steering control.

The simplest of the 10 arrangements centers about the depth gage, pitch gage, and compass. A fourth instrument provided is an auxiliary pitch gage which would not be used in level flight. In this arrangement, the depth gage can be rotated so that the desired depth during level flight can be set opposite the zero-degrees pitch-angle mark. In the same way, the desired compass heading is set by rotating the compass until the heading desired is in line with a marker at the top of the instrument face. Thus the operator can detect an error in depth by a deviation of the depth-gage pointer from the horizontal, and can detect an error in heading by a deviation of the compass pointer from the vertical. This is important, for it means that the operator does not have to read the depth gage or the compass scales in order to make the proper corrective response. Thus quick, accurate control movements are possible.

Also, 1 degree of pitch angle does correspond to 5 feet of depth on the depth gage. Actually, the operator is able to maintain good depth control by "tracking" the depth-gage pointer with the pitch-gage pointer. The error in depth shows the operator the amount of pitch needed to correct the error. The entire set of relationships among the three crucial indicators would be upset if the indicators were not rotatable, or were located differently.

In controlling depth, the operator must respond both to pitch and to its rate of change. In controlling course, he must respond to compass position, its rate of change, and to the time integral of heading error. Hence, with this arrangement the operator performs both differentiation and integration.

Several of the arrangements which Kelley suggests involve a two-dimensional indicator in which depth is indicated by the vertical dimension, and heading by the horizontal. Such an indicator, properly

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constructed, would make it possible to correct an error in depth and an error in heading simultaneously with a single integrated movement of the control. This arrangement is, of course, advantageous from the standpoint of human operation, but it also requires more of the engineer than does the first arrangement suggested.

Another part of Kelley's study concerned techniques by which submarine control systems, and for that matter, other sorts of control systems, can be evaluated before the operating equipment is built. First, a systems analysis should be conducted to determine the performance requirements of the control system. This analysis should take into account the value and the cost of achieving various levels of control-system performance to the over-all value of the submarine. Once performance requirements are known, research should be conducted to develop the simplest system which will provide adequate performance. Analog computers are able to simulate submarine performance well enough to evaluate human tasks in various kinds of control arrangements. A computer and a control stand simulating both the instruments and the controls are required. The controls provide inputs to the computer, which provides signals to the basic instruments, allows entry of disturbances in controlled fashion, and records the system performance. Such controlled experiments can provide fundamental data on the basic performance characteristics of the one-man operator of the submarine.

The installation aboard the ALBACORE of equipment permitting one-man control is a significant step in the evolution of high-speed submarines. However, before "flying" the submarine becomes routine—as it is certain to in the future—additional engineering techniques will have to be applied to the problem of providing the "pilot" with the control station best suited to his capabilities.

Plan to Explore Gulf of California

The Scripps Institution of Oceanography is considering a comprehensive investigation of the Gulf of California as a crustal feature, including its tectonics, oceanography and sedimentation. The Gulf is especially interesting because it is typical of a group of major geographic features, including the Red Sea and the Persian Gulf, whose oceanography has not been thoroughly studied. Because of this, because of its proximity to Scripps, and because in many ways it furnishes contrasts to the adjacent Pacific Ocean, it is well worth considerable attention. Scripps has conducted various studies in the Gulf and on its shores since 1939, but no comprehensive or long-term study. The proposed investigation is planned to continue for at least 3 years, requiring about 3 months of ship time per year.

Proposed studies include tides and currents, especially modes of oscillation, and circulation between the deep basins; seismic study of the bottom; sediments of the Colorado delta and other sources; coastal processes; bottom sediment nature and distribution; antigenic formation of clay; plankton productivity, foraminifera, and larger invertebrates; and other subjects.

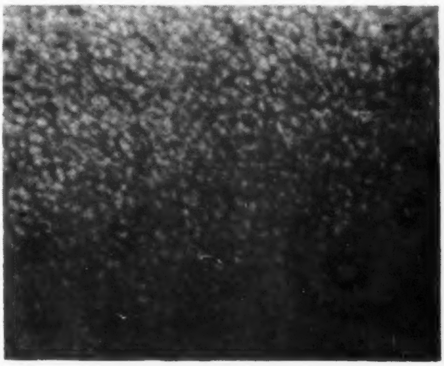
The estimated cost of the project runs around $200,000 a year. Support for the largest part of this will be sought from sources other than ONR.

Research Notes

A Close Look at the Sun

Twice in the past two months—on September 25 and October 17—a huge plastic balloon hauled a 12-inch astronomical telescope to an altitude of about 81,000 feet over Minnesota to observe the sun. The first viewing was of the sun's surface, and the second, of both its surface and rim. Coupled to the telescope was a light-sensitive pointing mechanism, which aimed the "eye" precisely, and a 35-millimeter motion-picture camera. The camera took one picture per second for a period of about 90 minutes. Its aperature was set at f/200, and its speed, at 1/1,000 of a second.

As a result of the undertaking, sponsored by the Office of Naval Research and called Project STRATOSCOPE (see Research Reviews, October 1957), the sharpest photographs ever taken of the sun have been obtained. One of the photographs is reproduced below. It shows the variations in brightness of the turbulent eddies that occur on the fireball's surface. The brighter ones are the hottest, the darker ones, the coolest. They differ in temperature by many thousands of degrees.



Oatmeal or caviar? Actually, it's a part of the surface of the sun viewed through a telescope from an altitude of about 81,000 feet. Scale, about 4,000 miles per inch. Sharp white streaks and black spots are imperfections in the negative.

Static Electricity and Fuels

Walk across a carpeted floor in cold, dry weather and you may shock the person you shake hands with. In the dark, the spark may even be visible. Pour a hydrocarbon fluid from one container into another, and there may be the same kind of discharge of static electricity. If the fluid is sufficiently flammable, you may cause an explosion. That is why aviation gasoline must be handled with extreme care, and why the new jet fuel, JP-4, is not used on board our Navy's aircraft carriers.

A series of experiments have been started at NRL to gather more exact information about the electrostatic vulnerability of modern fuel, in the hope that a standardization test for static hazard may be established.

A fluid readily builds up a static charge when it is transformed into droplets. To effect the transformation, NRL is using an overgrown water pistol, powered by pressurized helium. The stream from the nozzle is caught in a brass receiver which is connected to an electrometer. The voltage developed across the electrometer input resistor is recorded automatically and serves as a basis for computing the transport current. The currents observed provide a measure of the propensity of liquids to generate and maintain static charges under free-fall conditions.

Although the rate of charge transfer is quite low—one electronic charge for each 10^{13} to 10^{15} molecules—the introduction of such charging currents into insulated vessels of low capacitance can result in very dangerous potentials. With charging currents that have been observed, squirting JP-4 into an insulated steel bucket could raise the potential of the bucket and its contents to a computed 670 volts per second. Aviation gasoline would be about 67 volts per second. In either case, proximity of a grounded conductor would soon give rise to a spark that could easily cause a fire.

The ease with which JP-4 gives rise to electrostatic charges suggests that existing regulations concerning electrical bonding be meticulously observed when handling this fuel.

The Carribean's 4,680-foot Stagnant "Pool"

For many years, students of the oceans have assumed that all of the waters of the open sea are in continuous circulation. Stagnant water was known to occur only in the Black Sea and in certain fiords. Three years ago, however, oceanographers cruising the Carribean Sea aboard the research Ship ATLANTIS, of the Woods Hole Oceanographic Institution, made a discovery that contradicted this belief. They found a deep pool of stagnant water, 4,680 feet deep, off the coast of Venezuela. Called the Cariaco Trench, this great underwater valley is shut off from the rest of the sea by a sill which permits no ocean water to enter from depths greater than about 500 feet.

Last year, the oceanographers followed up this discovery with an investigation of the trench, and at the present time are making a second, more thorough study. Of particular interest is the fact that petroleum is thought to have been laid down under anaerobic conditions similar to those that exist in the trench. Higher forms of life cannot exist in this stagnant water. The organic material sinking from surface waters is decomposed by bacteria, thus depositing a layer of organic material on the bottom of the trench and releasing inorganic compounds which cannot return to the surface to aid plant growth.

The research now in progress over the trench consists of many investigations. Here is a brief rundown of these:

- Forty-foot-long samples of ocean-bottom sediment are being obtained by means of coring tubes that are lowered to the bottom on long steel cables.

- Scientists are getting a look at the depths of the trench by means of a new underwater camera capable of making three-dimensional photographs of the bottom, both in black and white and in color.

• Water samples are being taken at various depths in order to determine the chemical composition of the "pool."

• The scattering of light in the waters of the trench is being measured.

• By means of a specially designed probe, the oceanographers are measuring the flow of heat from the earth's interior through the bottom sediment of the trench.

• A continuous profile of the ocean-bottom configuration is being made with a precision echo sounder recorder.

• Information on life at mid-depths in the trench and at other locations in the Carribean Sea is being obtained with a Japanese long-line to which 80 hooks are attached.

The ATLANTIS is expected to return to Woods Hole from its Carribean cruise on December 2.

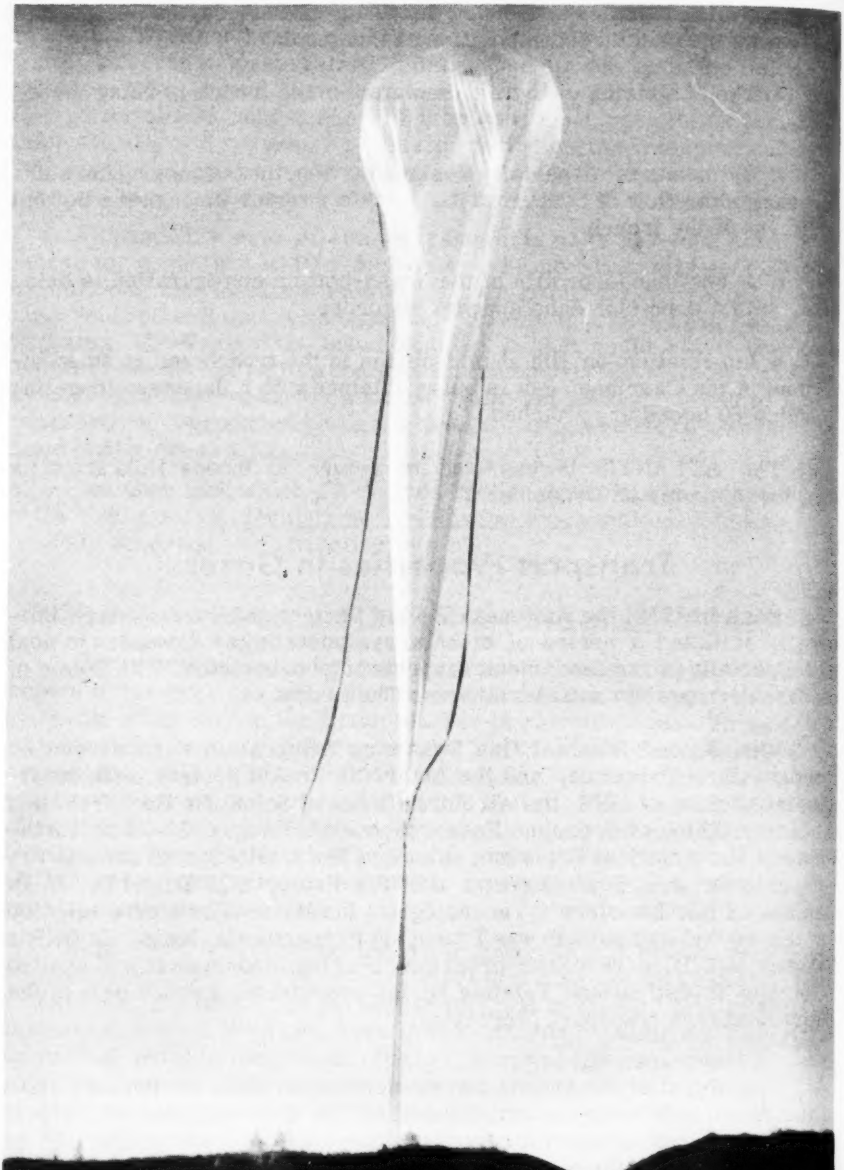
Transport Properties in Gases

Back in 1955, the American Rocket Society and Northwestern University initiated a series of biennial symposia on gas dynamics to deal with specialized and fundamental aspects of jet propulsion. The theme of the first symposium was Aerothermo Chemistry.

The Second Biennial Gas Dynamics Symposium cosponsored by Northwestern University and the American Rocket Society, with the financial backing of ONR, the Air Force Office of Scientific Research, and the Army Office of Ordnance Research, was held August 26-28 at Northwestern University at Evanston, Illinois. The detailed program was arranged by Dr. J. B. Fenn, Director of ONR's Project SQUID, and Dr. A. B. Camble of Northwestern's Technological Institute. The theme selected for the second symposium was Transport Properties in Gases. In ONR's Project SQUID, a research program covering fundamental and applied scientific investigations relating to jet propulsion, a small part of the effort concerns transport properties.

One object of the second conference was to define the present state of the art in both theory and experiment for the determination of thermal conductivity, viscosity, diffusion, and thermal diffusion properties of gases, with particular reference to extreme conditions. Another object was to indicate present and future needs for data with respect to application and design as well as the advance of pure science. A third object was to point up promising avenues of research, both theoretical and experimental.

The conference did much to clear the air, so to speak, in bringing out what data and information are now available, what will be needed, what can be calculated with confidence, and what can be expected from our present experimental efforts. The papers will be published in book form and will be available for sale in January 1958.



Dangling beneath a huge plastic balloon, the STRATO-LAB rises toward the rim of a Minnesota iron mine on its way to an altitude of 86,000 feet.

Pre-dawn preparations for launching.

STRATO-LAB: Then and Now

About a year ago, two Navy aerologists—Malcolm D. Ross of the Office of Naval Research and M. Lee Lewis of the Bureau of Aeronautics—"rode" a pressurized aluminum gondola, called the STRATO-LAB, to an altitude of 76,000 feet. The flight, launched from the "Stratobowl" in the Black Hills near Rapid City, South Dakota, was made by means of a huge plastic balloon. It set a new altitude record and yielded a wealth of scientific data. Since that time, man has reached into the stratosphere, and beyond, in other more dramatic ways, particularly by means of rockets and a satellite called Sputnik. But in spite of these developments, the value of the STRATO-LAB has not diminished. This fact is indicated by the confidence with which the Navy on the 18th of last month launched its second STRATO-LAB balloon and gondola to a high altitude, this time from Crosby, Minnesota. The balloon, built and launched by Winzen Research, Inc., of Minneapolis, Minnesota, was manned by the same two aerologists who set the record a year ago. Before returning to earth, they reached an altitude of 86,000 feet, the highest a two-man crew has ever been. While the space laboratory hovered at that height for about 3 hours, the observers collected data that are now giving a big boost to investigations in the fields of astronomy, aeromedicine, atmospheric physics, astrophysics, and military science.

QUESTIONS

These observations, made for the University of Minnesota, the Naval Ordnance Test Station (China Lake, California), the Naval Research Laboratory, the Office of Naval Research, the Naval Observatory, and the Naval Medical Research Institute are helping scientists answer many important questions. Here are a few:

Where do primary gamma cosmic rays come from? As these rays enter the atmosphere but do not reach the surface of the earth, they can be studied best at high altitude. To determine the source of this radiation, a special gamma telescope, developed by the University of Minnesota, and a recording camera were carried aloft and pointed at the sun and other locations in space. Unfortunately, the camera and the film on which the passage of the rays was recorded were stolen from the gondola before the latter had been moved from the woods in which it landed. They have now been recovered, however, and it is hoped that the source of the rays will be established after the film record has been analyzed.

What changes occur in the composition of the stratosphere from one level to another? To answer this question, the aerologists collected four 50-liter samples of air at intervals above an altitude of 69,000 feet. These provide scientists with the most complete simultaneous vertical sampling of stratospheric air ever obtained.

How bright is the sky when viewed at the outer margin of the atmosphere? Looking up from the surface of the earth, the sky appears very bright. This is so because the innumerable particles that make up the atmosphere scatter the sun's rays. But as one rises above most of this layer, the sky darkens, and at 86,000 feet, it appears almost blue-black at an angle of 27 degrees from zenith. To measure the amount of light still being reflected by the sky at altitude, the observers took light-meter readings from each of the gondola's 10 ports. By the same means, they measured the light being reflected by the earth.

How does the human body react to high-altitude flight? From an R-5D aircraft equipped as a flying medical laboratory, Dr. Norman L. Barr and his associates of the Naval Medical Research Institute monitored the aerologists' heart beats and respiration. Electrocardiograms and respiratory rates of the observers were radioed to the plane and to the ground for analysis. In addition, numerous blood, urine, and metabolism tests were made before and during the flight for comparison with post-flight samples. Similar studies have been conducted during each STRATO-LAB flight made thus far, and a great deal of data has been accumulated. Part of the value of this record is that it reveals the reactions of the same two men—Ross and Lewis—during a series of high-altitude flights. As the STRATO-LAB is a true space cabin—that is, for a short period of time it is just as habitable 86,000 miles in space as it

M. D. Ross and M. L. Lewis wait beside STRATOLAB as instruments are readied for flight to stratosphere.

is at 86,000 feet—the studies of its crew will have an important bearing on the design of manned ships that will some day explore the regions beyond the earth's atmosphere.

Is the STRATO-LAB stable enough to permit observers to make precise telescopic observations? Although the balloon and gondola were pushed along by upper-atmosphere winds at a speed of about 50 knots, the system proved to be very stable relative to fixed points in the sky. Only when the occupants intentionally "rocked the boat" was there appreciable oscillation, and then for but a short time. Already, plans are underway to take advantage of this characteristic. They call for the incorporation of a 16-inch telescope and associated equipment in the aluminum sphere. Dr. John Strong, Director of the Laboratory of Astrophysics and Physical Meteorology at Johns Hopkins University, is organizing the program. On the first flights, scheduled for late in 1958, the planet Mars will be viewed. Although the main purpose of the undertaking will be to obtain data astronomers need to make exact calculations of the water content of the Martian atmosphere, the flight will also enable the observers to get the best look anyone has ever had at the surface of the Red Planet.

THE SYSTEM

Scientists are approaching these and other problems concerning our atmosphere and the space beyond in two basically different ways—directly, that is, by sending both men and instruments high above the earth to make observations, and indirectly, by sending only instruments up. The STRATO-LAB system, of course, is designed for the direct approach. It provides not only the lift needed to get the men and instruments up, but also permits them to remain up for many hours in an environment they can tolerate, and to return safely to earth. Essentially, the system consists of a huge plastic balloon, a 64-foot cargo-type parachute, and a sealed aluminum gondola.

The balloon, which has a volume of 2 million cubic feet and a diameter of about 170 feet, is made of polyethylene, 2 mils thick. This milky-looking plastic is well known to almost everyone, for it has been widely used for commercial packaging.

The gondola is suspended from the balloon by a cradle-like network of nylon webbings. Inside this aluminum sphere the pressure is kept the same as that at an altitude of about 18,000 feet, while the partial pressure of oxygen is kept about the same as that at sea level. As a safeguard in the remote event the gondola's pressurization system fails, the crew is equipped with a bail-out oxygen supply and parachutes. Flight instruments are mounted on one side of the gondola's interior and scientific instruments and radio controls on the other. This arrangement permits one man to pilot the balloon, while the other conducts the scientific observations. Although the gondola has only 15 square feet of floor space, it has proved to be roomy enough for the crew to carry out a wide variety of experiments.

Hanging between the balloon and the gondola is the cargo-type parachute. This serves as an automatic safety device in the event of balloon failure.

LAUNCHING

So that the wind would not disrupt launching procedures, an open-pit iron mine, about 400 feet deep, was selected as the launching site. The balloon was prepared for inflation by laying it out on the road leading into the pit, the load ring of the balloon being placed near the bottom of the pit. The balloon bubble was inflated with helium until it provided enough lift to support the valve in the top of the balloon when the bubble was released. As inflation was continued, the balloon lifted itself over the road. When the balloon was completely extended vertically and was supporting its own weight, it was anchored by the load ring to a tractor. Inflation was resumed until a dynamometer indicated that the balloon was capable of lifting its full load. The load ring was then attached to the gondola, which was held down by an anchor line and winch. When everything was readied, the anchor line was severed, allowing the balloon to rise. The initial rate of ascent was about 1,200 feet per minute, but after the gondola had cleared the rim of the pit, the pilot valved helium until the rate of rise was about 700 feet per minute.

LOOKING BACK

Although the STRATO-LAB program, as such, was not initiated until 1954, its roots can be traced back to 1946, when the Office of Naval Research began a broad program of upper-atmosphere research. As the program called for studies of atmospheric physics, nuclear energy, and cosmic radiation, a platform was needed that not only could carry many instruments to high altitudes, but that could also remain at those altitudes long enough to permit the necessary observations to be made. Inherent limitations precluded the use of airplanes, rockets, and rubber balloons as vehicles for this purpose.

HELIOS, ONR's first upper-atmosphere research project, was begun in 1946 through a contract with General Mills, Inc. It called for the use of a cluster of plastic balloons to carry a manned, instrumented gondola to the stratosphere. However, a year's work revealed that plastic-balloon technology was not far enough advanced to accommodate this aim.

Next, ONR undertook Project SKYHOOK, designed to launch unmanned, instrumented plastic balloons into the stratosphere. Ten years ago, on September 25, 1947, the first flight of a SKYHOOK balloon occurred. The balloon, developed by General Mills, Inc., carried a 63-pound payload of nuclear emulsion over 100,000 feet in the air. Since then, over 1,500 SKYHOOK flights have been made for various investigators supported by ONR and for some Canadian and European scientists. Both Winzen Research and General Mills have participated in these launchings, and in recent years, the Atomic Energy Commission has joined ONR in support of the project.

Once Project SKYHOOK had demonstrated the feasibility of plastic balloons for high-altitude research, many different projects were undertaken. Aside from the STRATO-LAB flights, the following have particular significance:

- In 1948, the first successful three-balloon cluster was launched.

- The first shipboard SKYHOOK launching took place in 1949 aboard the USS NORTON SOUND. Since then nearly 300 shipboard launchings have been made.

- Project ROCKOON, begun in 1952, featured SKYHOOK balloons and small DEACON rockets. The rockets were lifted by the balloons to a height of about 70,000 feet, where they were automatically released.

- On September 7, 1956, the University of Minnesota launched a giant Mylar plastic balloon which set an unofficial balloon altitude record of 145,000 feet.

- Early in 1957, the Navy began launching giant weather balloons from Japan at regular intervals for flights across the Pacific Ocean. The system, called TRANSOSONDE (short for trans-ocean sounding) provides Navy meteorologists with weather data for hundreds of thousands of square miles of ocean.

- On September 25, 1957, the 10th anniversary of the first SKYHOOK flight, and again on October 17, an unmanned SKYHOOK balloon carried a special solar telescope to an altitude of about 81,000 feet, obtaining the sharpest photographs ever taken of the sun. (See photograph on page 11).

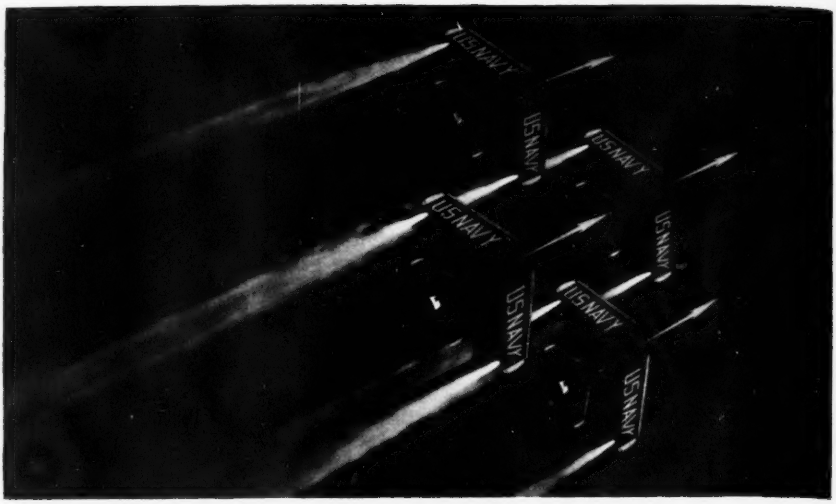
- Recent Air Force projects, such as MAN HIGH and FARSIDE have also utilized the balloons and balloon techniques developed for SKYHOOK and other ONR balloon projects.

The STRATO-LAB program got underway in 1954 when the gondola shell originally designed by Jean Piccard and built for Project HELIOS was refitted and tested. The first flights, conducted in 1955, were made to low levels to collect atmospheric data. These were followed, early in 1956, by intermediate-altitude flights, and finally, later that year, by the first high STRATO-LAB ascent.

IN THE LIGHT OF CURRENT DEVELOPMENTS

In the light of current developments in space-flight technology, the STRATO-LAB might seem, at first thought, to be an old-fashioned vehicle for conducting research above the earth. Why, one might ask, is the Navy continuing this program when rockets and satellites can operate at much higher altitudes? Primarily, the reasons are these: The space laboratory can be lifted above 99 percent of the earth's atmosphere, thus offering an excellent means of looking into space. It can be brought to a virtual standstill at high altitude, enabling the crew to carry out experiments that would be impossible to make from rockets and satellites, which move at high speeds. It can remain at high altitude for many hours, therefore permitting the observers to collect extensive data. It is a very stable platform. It utilizes human beings, who can carry out stratospheric experiments more easily, accurately, and economically than automatic devices can. And it can carry a larger instrument load than present-day rockets and satellites.

Although these advantages are not spectacular ones, they lead, nevertheless, to very practical results.



The Navy's acrobatic team, "The Blue Angels," fly a close precision formation. This group symbolizes the high degree of flying perfection that is the goal of the Naval Aviation Training Program.

Aspects of Aviation Psychology

Wilse B. Webb
Naval School of Aviation Medicine
Pensacola, Florida

Aviation psychologists at the Naval School of Aviation Medicine, Pensacola, Fla., take a very realistic attitude toward the selection and training of men for naval aviation. They know that these men are attempting not only to learn a complex skill requiring about 18 months of training, but at the same time are exploring and developing a pattern of life in relationship to their ambitions, their emotional makeup, and their abilities. In other words, aviation psychologists must be concerned not only with abilities but with motives; not only with the elements of training, but with the meaning of training; not only with momentary needs, but with lifetime goals. Furthermore, they must consider these factors in terms of the dynamics of modern aviation–that is, in terms of new developments in aircraft equipment and the new input-output ratios effected by them.

Some of the conclusions reached through studies made along these lines are given below:

- The motivations of men entering aviation training are often quite tenuous.

- In motivational testing, the development of tests that will not reflect the subjects' attitude toward taking the tests is critical.

- Psychological selection procedures can result in the saving of much money, even when their validities are rather low.
- Peer nominations, or "buddy ratings", are powerful research and administrative tools.
- The proficiency of cadets at different stages of training can be effectively predicted.
- Cadets tend to worry more about failing in the program than they do about physical harm that may come to them as a result of flying accidents.
- Human engineering can and should be applied to the cadet's task.
- Accident proneness can, to some extent, be identified.
- Follow-up studies of men who have completed training can help establish effective procedures for selecting the men best suited to enter the training program.

Now, let's start at the beginning and consider each of these in turn.

INITIAL MOTIVATION

It is frequently a tenet of selection testing that persons who apply for a job really want that job. If this very convenient assumption is true, then testing need amount to no more than sorting the individuals on the basis of aptitude and underlying attitudes. Unfortunately, in our situation the picture is quite different. This fact is indicated by answers given to a simple unsigned questionnaire by about 200 cadets within a few days of their arrival in the Naval Air Training Program (see table on next page). These men were told to mark any statements on the questionnaire which seemed to fit their present attitude. Surprisingly, 3 percent of the individuals were not sure they actually wanted to fly, only one-fourth of them accepted flying as a career, 16 percent had decided on the program quite recently, and nearly 40 percent were not confident that they could follow through with their decisions to learn to fly.

One of the corollaries of these findings is that many of the men who enter the naval flight training program are persuaded to do so, and that the kind of persuasion and the realism of it have a lot to do with their success in the program. Consider, for example, the draft, which can have considerable persuasive force. When draft quotas are high—as they were in 1953—many men came into the program to evade the ground forces or enlisted status. Because a high percentage of these men did not particularly want to fly, they later dropped out of the program voluntarily. At the present time the draft pressure is much lower; therefore, voluntary attrition is much lower, too.

Furthermore, young men are apparently more likely to be persuaded to enter the program through personal contact than they are by persuasive literature or long-term interests in flying. A survey of "first information sources" of a large number of cadets indicates that most of these men first became interested in the program through talks with "door-to-door salesmen" of the Navy, such as the procurement teams, or through close friends who were associated with naval aviation.

Interest in flying shown by 200 cadets upon entering the Naval air training program.

I am not sure I want to fly, and I am not sure I have made the right decision . . . . 3 percent

I am not sure I want to fly, but I sincerely want to give it a try 14

I am not sure I want to fly, but this looked like the best way to serve my military tour 9

I am sure I want to fly, but I don't know whether I am capable of flying 38

I am sure I want to fly, and I would like to make flying a career 24

I am sure I want to fly, and this opportunity fulfills a long-term interest 47

I am sure I want to fly, but this is a recent interest 16

It becomes evident then—and this factor is very important in our thinking—that we are not training men who are highly motivated. Our problem is not only to train these men, but also to convince them of the importance of their training.

MOTIVATIONAL TESTING

Our attempts to measure motivation in such a way as to enable us to predict a man's suitability for training have led to consistent failures. We have used practically every known test in the kit of the psychologist, but to little avail. Perhaps we have not yet measured the right variables. Perhaps, too, there is not enough variation in motivation to form a basis for predictions. One of the areas we have selected for study is the examinee's conscious practice of modifying his answers to test questions in order to obtain "acceptable" rather than "true" scores. Motivational testing, where selection and elimination are involved, is quite different from such testing in a clinical setting. In clinical testing the subject is trying to tell you everything he can about himself; in selection testing, however, he is attempting to confirm a decision he has already made by answering as he thinks he should.

We have explored ways around this problem. For instance, in a series of experimental tests, we made the discovery that when the examinees are told to fake their answers on one sheet and to give true answers on another, the true answers thus obtained reveal a greater number of socially unacceptable traits than do the answers given on tests administered as selection devices. Another method of determining motivation is forced-choice questioning. Instead of asking the examinee if he considers himself honest and if he considers himself intelligent, we pair the questions and ask if he would rather be considered honest or intelligent. But the test that appears to offer the most promise is the information test. Instead of asking the examinee if he likes to fly, we ask what he knows about flying. We are now extensively analyzing this procedure.

SELECTION TESTING

The accuracy of tests we have devised to predict success or failure in training is far from perfect. Although selection research must be continued in order to adjust our initial screening measures to changing requirements, it is not likely that the accuracy of these measures will be improved greatly. We will continue to eliminate people from the program who could become aviators and permit others to enter who will fail.

In these days of tightened procurement, can we afford testing programs that eliminate potential aviators? Let us look at the economy of the current program. About 15 percent of all physically qualified applicants are rejected during one year on the basis of psychological tests (750 men per 5,000). Our most conservative follow-up studies show that of these 750 men, 60 percent (450 men) would have failed if permitted to enter the program. As the Navy spends about $18,000 on each man it eliminates from flight training, the money saved in one year as the result of psychological testing in all likelihood amounts to several million dollars.

PEER NOMINATIONS

Peer nominations—the process by which each member of a group rates every other member—have proven highly reliable, both across and within groups and within sessions and between sessions. Further, we believe we can use this technique to measure any behavioral characteristic that can be meaningfully described. For example, we have used peer nominations to measure morale and enthusiasm, friendship and followership, and most extensively, leadership and nontechnical interpersonal proficiencies.

PREDICTING PROFICIENCY

The most important advance we have made through our use of psychological yardsticks has been in the measurement of proficiency. We were faced with the fact that nearly 25 percent of the men who "passed" our selection tests did not succeed in the training program. This condition could only be remedied by increasing the validity of our present tests, which, as stated before, did not seem too likely, or by using additional measures. Two well-known principles came to our rescue: First, a prediction based on specific information is more likely to be accurate than one based on general information, and second, the quality of present on-the-job performance provides a good clue as to the quality of future on-the-job performance.

As we wanted to know how a trainee would do on his job in the future, the more we could find out about his work and how he reacted to it, the better we would be able to predict his future proficiency. Therefore a progress grade was developed for each of several levels of training, based on the most effective empirically determined measures for testing proficiency of future performance. For example, the pre-flight progress grade combines the student's selection test scores with his grade in the navigation course, his physical-training grade, and his officer-like-qualities grade. These combined grades were found to correlate very well with performance in later stages of training. Only if the student runs into difficulties do the administrators use the progress grades to determine whether the individuals are or are not to be given additional time to improve. If a man having a low progress grade runs into difficulty, he has confirmed the prediction of having low potential for continued training, and the time given him to show improvement is limited accordingly. On the other hand, if he has a high progress grade for a previous stage, he is likely to be given extra time to improve.

ANXIETY

It is in the very nature of military aviation that pilots may be called upon to function under conditions of extreme physical and emotional stress. Because of this fact, psychologists have run tests aimed at finding out what amount of stress such individuals can be expected to withstand. Under the assumption that learning to fly provokes much anxiety, we have given several different stress-tolerance prediction tests and have made an intensive study of anxiety among about 60 cadets. These have led us to the discovery that anxiety is not caused so much by physical threat as it is by the possibility of failure. Thus one of the critical problems facing instructors is taking "fear of failure" properly into account.

ACCIDENT PRONENESS

Psychologists often think of aircraft accidents in terms of accident proneness. Implicit in this thought is the assumption that measures can be devised to isolate those individuals most likely to have accidents. Our studies now indicate that the trainees most likely to have accidents are those whose proficiency is low early in training. Many factors are included in these findings, but it is sufficient to remark that when low-proficiency trainees are dropped early in the program accident-proneness becomes markedly less evident.

HUMAN ENGINEERING

One of the more popular fields of study in aviation psychology is human engineering—the analysis of a task in relation to the sensory-motor aspects of the operator. Our approach to the problem has been through the survey technique. We ask the operator to tell us what errors he makes, what discomforts he experiences, and what accidents he has had. Although the results are frequently obvious, they are unassailable. If a number of operators report difficulty with a task, it is likely that they are saying something meaningful. Two brief examples may be noted on our most widely used training aircraft, the T28. It was found that the magneto switch, which was to be used in emergencies, was placed in such a position that the pilot, when strapped to his seat, would have to have an 8-foot arm to turn it off. We have recommended its change. We further noted that the blower handle, which is activated when the aircraft reaches a high altitude, is next to the flap handle and is unprotected. Our prediction that the pilot might accidently grasp the wrong one has been confirmed by two recent accidents.

FOLLOW-UP STUDIES

The conclusion that sound elimination policies must be based on actual follow-up studies of performance is perhaps the most obvious of all the conclusions I have listed. Briefly, we have found that we can get meaningful information about the acceptability of a product from its users—in our case, the Fleet. With such data (and only with such data) human quality control can be effected. Once the poor qualities of a product have been defined, they can be eliminated by eliminating individuals or by raising training standards. Our data have indicated that if we eliminate about 7 percent of our trainees at an early stage of training we would not only save money, but would also increase our output of flyers because we would free training instructors and facilities from unproductive work. The results of this study have been instituted in the training program.

No matter how I wish otherwise, there are still great difficulties to be overcome in integrating the wealth of findings being derived from research in aviation psychology and in applying them to the workaday world of selection and training programs. Nevertheless, psychology has and is serving naval aviation well. This is to be expected, because the Navy has done well by psychology. It has given us support, encouragement, and, above all, that necessary freedom to do our job to the best of our ability.

The IGY Research Rocket Program

The notoriety achieved by the glamorous satellites tends to drive out of mind the fact that the IGY upper atmosphere research program has been using rockets ever since the Year began on July 1. One hundred and ninety-four instrumented rockets will be flown under the auspices of the United States National Committee.

Five types of rockets are being used. The AEROBEE-HI is well known to Research Reviews readers; it can carry a 150-pound payload to altitudes of 150 miles or better. It is supplemented by the standard AEROBEE, where altitudes of about 60 miles are desired. The two-stage NIKE-CAJUNS and NIKE-DEACONS carry payloads of 40 pounds to 100 miles and 75 miles respectively. The Deacon, when borne to 60 or 70 thousand feet by a "Skyhook" balloon, becomes a ROCKOON; under that name, it goes on up to about 60 miles.

The Aerobees and Aerobee-Hi's are being fired mostly at Ft. Churchill, Manitoba, with a few from White Sands and Holloman Air Force Base; the Nike-Cajuns are being launched at White Sands and Guam; the Nike-Deacons fly seaward from Pt. Mugu, and the 85 Deacons are all scheduled for launching from naval ships at sea. The agencies involved are the Naval Research Laboratory, Air Force Cambridge Research Laboratory, Army Signal Engineering Laboratory, State University of Iowa, and Ballistic Research Laboratory of Canada.

Although the time aloft, for a rocket, is measured in seconds—instead of days and weeks, as for a satellite—a great deal of scientific information about the upper atmosphere is being gathered at relatively small expense by means of this vehicle.

(Courtesy IGY Bulletin, of the National Academy of Sciences. October 1957.)

On the Naval Research Reserve

Nuclear Sciences Seminar Held at Brookhaven

From September 8 to 21, the Sixth Annual Naval Reserve Nuclear Seminar was conducted at Brookhaven National Laboratory, Upton, Long Island, New York. Naval Reserve Research Company 3-9, the host unit, presented the seminar in conjunction with the Atomic Energy Commission, Brookhaven National Laboratory, and the Office of Naval Research.

The theme of the seminar was "Nuclear Reactors and Power." Well-known speakers, both military and civilian, from all parts of the country, lectured on practically every reactor program that could be presented. The program closed with a very interesting talk on fusion reactors by Dr. Arthur Ruark, Chief, Controlled Thermonuclear Branch, Division of Research, Atomic Energy Commission.

The attending group consisted of 36 Naval Reserve officers, 5 Army Reserve officers, and 4 Air Force Reserve officers. All had military secret clearance and had previously taken nucleonics courses. Another factor governing selection for attendance was a demonstrated interest or background in the nuclear field.

In addition to tours around Brookhaven National Laboratory, off-site visits were made. One was made to the Electric Boat Company's yard in Groton, Connecticut, where nuclear submarines were observed under construction. Another was made to the U. S. Naval Submarine Base in New London, Connecticut.

The Commanding Officer of NRRC 3-9 is CAPT John S. Medd, USNR, and the administrative officer representing the Commandant of the Third Naval District for the seminar was CDR Jere C. Austin, USNR. The Program Officers were: Senior Program Officer, LT Chad J. Raseman, USNR; and Assistant Program Officers, LTJG Clifford H. Scarlet, USNR, and 1ST LT Gerald C. Kinne, USNR.

The next Reserve seminar at Brookhaven National Laboratory is scheduled for September, 1958.

CAPT Howard B. Stevens Retires

On October 1, CAPT Howard B. Stevens, USNR, was retired as Commanding Officer of Naval Reserve Research Company 3-1, after 3 years as its Skipper. The first research unit to be organized in the Third Naval District, NRRC 3-1 was evaluated as outstanding for fiscal year 1956 and earned a commendation from the Chief of Naval Personnel. In civilian life Mr. Stevens is a professional engineer and the Port Captain of the Department of Public Works of the City of New York.

On September 28, CAPT Stevens and his family were guests at a farewell dinner at the Officers' Mess at the New York Naval Shipyard. Highlight of the occasion, attended by 60 members and friends of NRRC

3-1, was the presentation of a token of appreciation to the retiring commanding officer. This was made by CAPT Theodore Blanchard, USNR, formerly Special Assistant to the Chief of Naval Research (Research Reserve) and now Deputy Chief of Staff for The Naval Reserve in the Third Naval District.

Enlisting in the Navy in 1917 at the age of 20, CAPT Stevens saw duty in World War I on the USS IDALAS, a converted PC. After completing Officer's Training School, he served as Ensign on the transport USS LEVIATHAN. Following the armistice, he received a degree in electrical engineering from M.I.T.

His World War II service included duty as Executive Officer of the USS PIONEER (AM 105). Later, he had charge of the minesweeping section in the office of The Chief of Naval Operations, in which capacity he was responsible for the preparation of the Minesweeping Manual. This background was later found invaluable in the Research Company's Naval Sciences Division, which CAPT Stevens headed before assuming command of the Company in 1954.

Commanding Officer of Research Reserve's First Company Retires

CAPT Frederick C. Wiesner, USNR, Battalion Commander of the Washington Research Reserve companies was retired from the Naval Reserve on October 1. CAPT Wiesner has been a leader in the Research Reserve Program since its inception in 1948 and was the commanding officer of the first unit established—Volunteer Research Unit W-1.

On September 19, CAPT Wiesner presided over his last battalion meeting. The guest of honor at this meeting was RADM T. A. Solberg, USN (Ret.), former Chief of Naval Research. RADM Solberg recalled his long association with CAPT Wiesner and commended him for his devoted naval service. Speaker of the evening was Dr. John H. Green of the Canadian Joint Staff, who spoke on "Canadian Research and Development." In attendance were members of the Washington Reserve Research companies—5-8, 5-9, and 5-10. CAPT Wiesner was presented with an engraved plaque designating his services.

CAPT Wiesner's career in naval service dates back to World War I and covers service to two countries. The first of these was Germany. After graduating from the naval academy there in 1914, he entered the University of Charlottesberg, from which he received a degree in electrical engineering. From 1915 to 1918 he served in the German Navy,

The three Commanding Officers of the Washington Research Reserve companies bid farewell to CAPT Frederick C. Wiesner, USNR, Battalion Commander (center). Appearing with CAPT Wiesner are CDR W. M. Smedley, USNR, of NRRC 5-8; CDR R. Trumbull, USNR, of NRRC 5-10; and CDR A. J. Hiller, USNR, of NRRC 5-9.

then was appointed to the Delivery Commission of Naval and Merchant Ships to Allied Commands. He came to the United States in 1922, and in 1929 was commissioned a lieutenant in the Naval Reserve. His civilian work with the Navy began in 1932, when he took a position as Inspector of Machinery at Groton, Connecticut. He is now the Head of ONR's Power Branch.

West Coast Companies Conduct Field Trips

Naval Reserve Research Companies 12-2, 12-5, and 12-6, located at Livermore, Berkeley, and Davis, California, respectively, recently made a field trip to the U. S. Naval Shipyard, Mare Island. RADM Martin J. Laurence, USN, Shipyard Commander, arranged for members of the staff to discuss their work with the Reservists. The excellent presentation covered some of the plans for and problems that have arisen in the design and building of the USS HALLIBUT, the guided-missile nuclear-powered submarine, which is under construction at that yard.

Another field trip was made by NRRC 12-1, 12-2, 12-3, and 12-5—San Franciso, Livermore, Stanford, and Berkeley—to the U. S. Naval Radiological Defense Laboratory, San Francisco. The presentation given by the Laboratory staff on problems they are meeting and solving was considered outstanding. An interesting tour of the Laboratory followed the discussions.

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LAST MONTH WITH "VANGUARD"

● VANGUARD test vehicle TV-2 was launched from Patrick Air Force Base on October 23. The test was rated "extremely successful." Peak velocity, 4,250 miles per hour, was reached at 140 seconds; the rocket achieved an altitude of 109 miles, and fell into the Atlantic 328 miles off the coast of Florida. (TV-2 was a prototype of the first stage of the final launching vehicle, and second and third stages, which were dummies, except for some test instrumentation.)

● The Russian satellite "Sputnik" provided an excellent operational exercise for the VANGUARD tracking system. The IGY tracking installations in the Western Hemisphere and Australia—as well as amateur stations all over the world—were tuned to receive at an agreed-upon frequency of 108 megacycles; Sputnik's signals were at 20.005 and 40.005 megacycles. To change frequencies meant—for most installations—far more than twirling a dial or changing crystals; it meant converting circuits and altering antenna geometry. Nevertheless, NRL picked up a signal from the satellite as it was crossing the hump of South America on its second circuit of the earth—some 2-1/2 hours after the announced time of launching. By then the VANGUARD Computing Center was in full operation, receiving messages from amateurs, answering requests for frequencies, and supplying news-hungry reporters with up-to-the-minute information.

During the following day (Saturday, October 5) conversion of the receiving equipment at outlying Minitrack stations progressed so that by the end of the day six of them were reporting, and by 1 a.m. Sunday it was possible to establish a tentative orbit. At 5 p.m. on Sunday the project director held a press briefing. By Monday, October 7, sufficiently definitive information was available that it was possible to draw up and print maps showing the orbits for the next six revolutions. Such maps have been issued to the press several times a day since.

On Monday morning, October 7, NBC was permitted to install within the control center three cameras for three 7-minute live television pick-ups for the program TODAY. Later that same day, Dr. Sergei M. Poloskov, Anatoly G. Blaganravor, and R. A. M. Kasatkin, Soviet delegates to an IGY Committee meeting in Washington, visited the control center.

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COVER PHOTO: A stream of fire and clouds of smoke trail VANGUARD test vehicle TV-2 as it roars skyward from its launching pad at Patrick Air Force Base, Florida. (See inside back cover and pages 1-6.)

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