Portraits in Science

Dr. James H. Wakelin

The first Assistant Secretary of the Navy for Research & Development, Dr. Wakelin served in that post from 1959 to 1964.

After W.W. II, he served as Director of the Field Survey Group of O.N.R. PROJECT SQUID under contract to Princeton.

Dr. Wakelin has also conducted research on structure and physical properties of high polymers under O.N.R. sponsorship. He is the author of scientific papers on high polymer physics and co-author of the book "High-Speed Computing Devices."

Clear Air Turbulence– An Aviation Hazard

E. F. Flint
Autonetics Division
North American Rockwell Corporation

CAT—Clear Air Turbulence—lurks high among the earth's jet streams at altitudes above 21,000 feet along the paths where today's high-speed jet transports fly.

CAT is hostile—and insidious. Hostile because its violent turbulence is causing an increasing number of injurious incidents and costly damage; insidious because CAT is invisible, even to weather radar. Like a trap, clear air turbulence gives no warning, and therefore there has been no effective way to detect it in time to avoid it.

The air transportation industry and aerospace organizations have invested substantially in time and resources to develop an effective CAT detection system. Ideally, such a system would be small, lightweight, require little power and be capable of detecting the CAT *at sufficient range* to provide the pilot adequate time to avoid the turbulence, or at least to minimize its potentially damaging effects. Further, the development of a reliable CAT detector would greatly assist airplane manufacturers in establishing design criteria for ensuring structural safety in future aircraft.

Numerous approaches have been taken to develop a workable CAT detection system, including the use of radars, lasers, and long-range optical systems. Because of the absence of liquid moisture at high altitudes, existing airborne radar systems were found to be ineffective. Another approach consisted of equipping an airplane with a laser radar. This system was designed to detect abrupt changes in particle concentration which, it has been speculated, exist at the interface between two air currents causing the turbulence. However, testing of such a system has indicated that it has little or no utility: even if atmospheric turbulence and abrupt changes in particle concentration are associated, it has not been demonstrated that the presence of such abrupt changes will always indicate turbulence, nor has it been established that turbulence is always associated with these changes.

It has been found that atmospheric turbulence in clear air is associated with marked changes in atmospheric temperature. This discovery has led to airborne tests of devices which continuously monitor the air temperature immediately outside an aircraft and alert the pilot if a significant change occurs. Tests of one such device have indicated that CAT is associated with a change of approximately 4°C in the static air temperature. This change usually occurs over a 16-mile sector, with

the center of the turbulence located approximately in the center of the sector. Thus, a device on a plane flying at a speed of 480 knots would provide a rate of temperature change of approximately 1°C per minute for two minutes before hitting the turbulence. Allowing time for processing the signal from the device, an alert time of something less than one minute is provided—not long enough to successfully permit the pilot to prepare for and/or avoid turbulence.

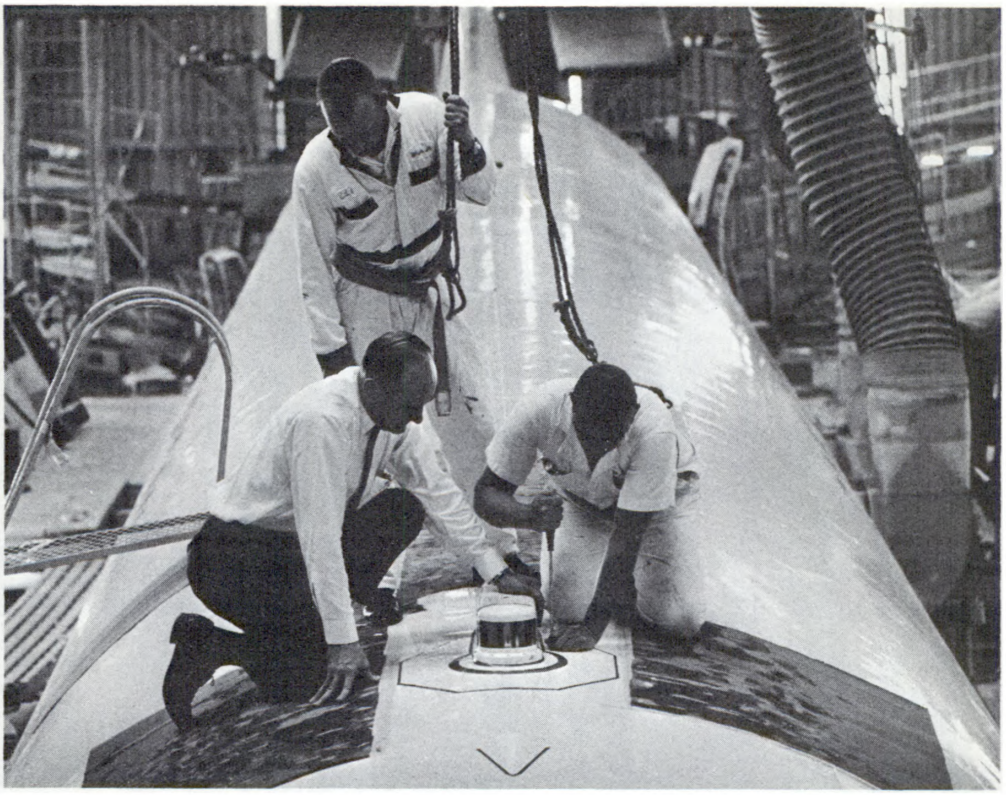
Another problem connected with these measurement devices is that CAT is not always associated with thermal discontinuities. It has been reported in the literature that 80 percent of all turbulence which jet airliners encounter between altitudes of 28,000 and 41,000 feet is associated with the jet streams; and since northern hemisphere jet streams with winds in the neighborhood of 125 knots usually have cirrostratus or ice-crystal cloud formations on the lower south side and ice-crystal haze in other sections, the maximum wind shear and turbulence, other than the polar front turbulence, has been found to be in the proximity of the cirrostratus clouds. The difficulty with thermal probes which have been used is that they sometimes penetrated this area without indicating significant temperature changes. As a result, techniques which have been postulated for detecting thermal discontinuities as a means for detecting CAT will not always provide the correct indication in the vicinity of cirrostratus ice-crystal clouds.

Other methods which have been proposed for CAT detection include active use of radar, microwaves, and visible portions of the electromagnetic spectrum; passive use of millimeter waves and visible light; electrostatic field measurements; ozone detection; and microbarometric measurements. To this date, however, CAT detection and alert notification by these methods are still in the exploratory stages.

Infrared Detection and Identification System

Research leading towards the development of an Infrared Detection and Identification System (IDIS) at Autonetics first began in 1964. In this regard, it is prudent to note that interest in this area arose as a result of ONR-sponsored research in undersea turbulence.

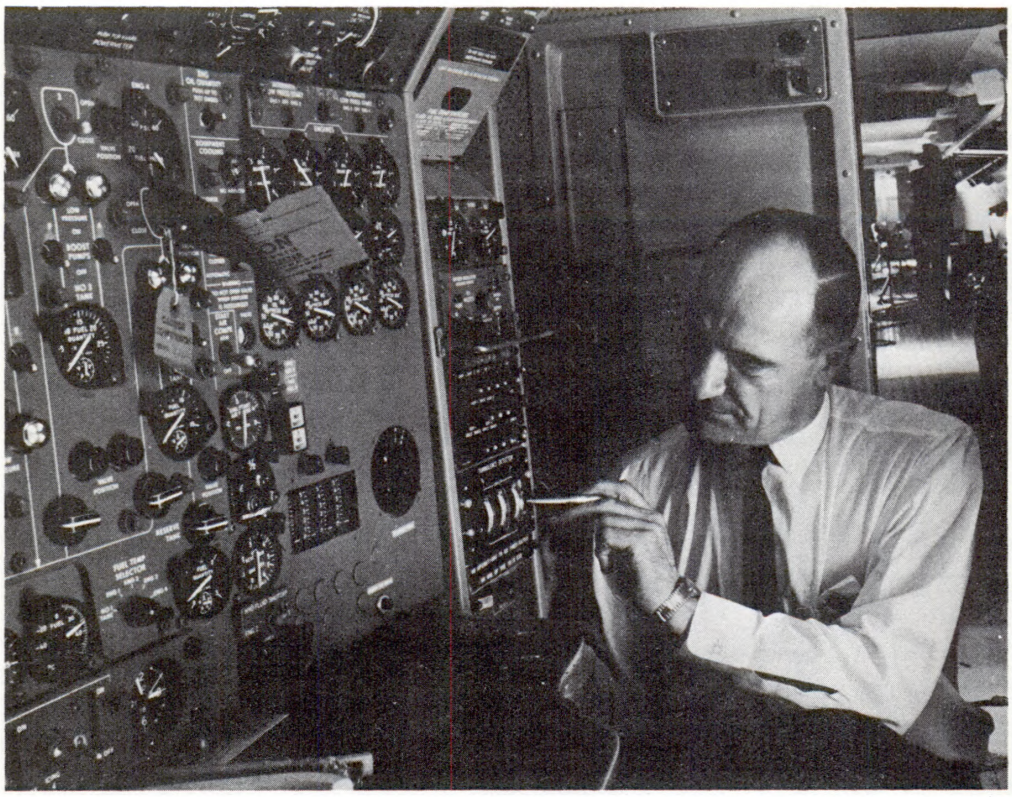
The Autonetics infrared approach to the problem was based on evidence that turbulence in clear air, or in cirrostratus clouds, is associated with thermal, density, or ice-crystal concentration changes. High altitude atmospheric studies were begun and studies made of the big jet streams, where most turbulence is found. Although infrared radiation emission data were available at low altitudes, no such data were available from actual horizontal measurements made near the tropopause altitude. Lacking such data, the only choice available was to design for computed values of emission and trade-off detector sensitivity, beam field of view, and filter spectral bandwidth as necessary.



IR sensor being installed by Autonetics engineers

Autonetics' IDIS was designed for carbon dioxide emission from a 50-mile-range horizontal beam at 35,000 feet altitude. The goal of the system was to provide a CAT warning to the pilot when a 4-6°C thermal change occurred 24 to 32 miles ahead of the aircraft, thus allowing an alert time of three to four minutes. The forward sensor beam would be swept 45° left and right on the flight test programs, and radiation would be recorded through a 90° horizontal angle mounted on the front of the aircraft. The sweep would be made every three seconds, which is the time period roughly equivalent of 0.4 mile of Boeing 707-type-aircraft travel, and was expected to provide useful data right and left of the flight path for future evaluation.

The development leading to the current IDIS Clear Air Turbulence Detection System has progressed through four test programs. The first program was conducted with the cooperation of the U.S. Air Force during the period June-September 1966. The equipment, IDIS Model 5X1, was installed in a USAF C-135 and flown 72,000 miles over the Atlantic and Pacific Oceans and the Continental United States. Over 96,000 photographs were taken of radiation signals at altitudes between 29,000 and 40,000 feet on the display-unit scope. By analyzing these photographs, it was possible to determine that radiation changes were associated with both clear air turbulence and wind shear turbulence in cirrostratus clouds. The rate changes in



Indicator installation in flight engineer's station

radiation were established and verification of the infrared concept of turbulence detection prior to penetration was documented. After this first flight-test program, the 5X1 system was modified by changing the scope display processing system to an electronic digital processing system and by including a pilot's indicator panel.

The second flight-test program was flown by Pan American World Airways. Before the IDIS-5X2 system could be installed in the PanAm aircraft, permission had to be obtained from the Federal Aviation Administration. This program consisted of ten observed flights with approximately 70 observed-flight hours accumulated in May-June 1967. During these flights, which were made over the North Atlantic and North Pacific at altitudes between 31,000 and 35,000 feet, two significant turbulent areas were penetrated. Outputs from the system were recorded on a seven-channel magnetic tape recorder, and included acceleration data. From these flights, it was concluded that the system had the sensitivity necessary to provide a three-to-four minute warning of significant clear air turbulence.

Test programs three and four were a continuation of the PanAm flights. For the third program, model 5X2A was used, which included the introduction of roll-pitch cut-off circuitry and an updated processor and indicator. This program covered 17 observed flights, including one round-the-world flight, during November 1967. When it was completed, the processing system was removed and modified for a

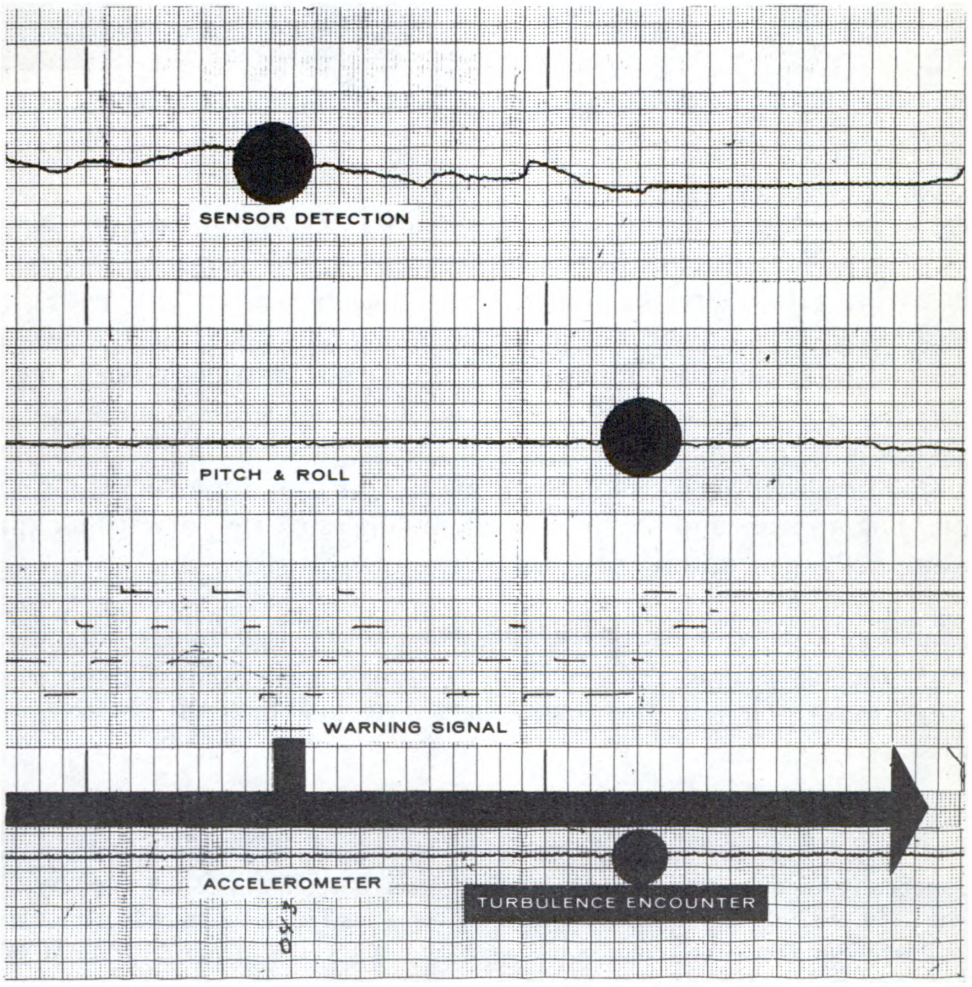
straight-ahead field of view. Also, the alarm levels were scaled and recorded on the same channel as the pitch-roll cut-off signal.

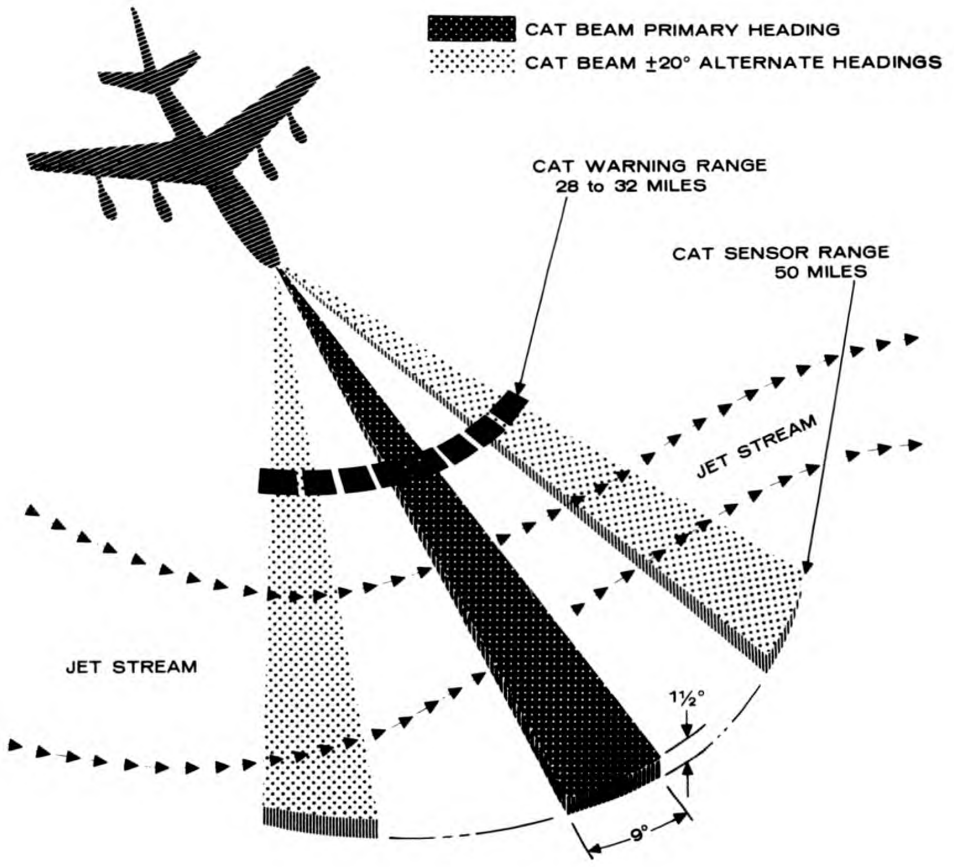
Test program four used model IDIS-5X3. It consisted of four observed flights during December 1967.

The Latest Model

The IDIS 5X3A is the latest updated model resulting from the flight tests and is the fifth configuration. Like its four configuration forerunners, it uses a passive infrared radiometer for sensing atmospheric turbulences at average distances of 32 miles ahead of the aircraft, whether in clear air or in cirrostratus clouds. The beam length is 50 miles. Once the thermal variations are detected, they are fed into the system's electronic data processor which processes and analyzes the data. Within 31 seconds after detection, or four miles, the processor's

Tracing recording the detection and encounter of moderate turbulence 35,000 feet above Colombia, South America. Note that the signal from the IR sensor—indicated on the tracing at top—detects the turbulence area four minutes in advance of the CAT encounter, as indicated by the accelerometer signal seen at bottom, and the pitch and roll signal at center.





results are translated into warning signals and displayed on the pilot's instrument panel. The display tells the pilot whether the CAT is to the right, left or straight ahead, and indicates the possible degree of turbulence. Because he has an average warning time of 28 miles or between three and four minutes, he can, within air traffic control regulations, maneuver the aircraft to evade the turbulence or to lessen its possible dangers. The system is effective night or day. When the aircraft is headed directly into the sun on the horizon, the pilot's indicator "off" flag appears and the pilot can manually move the forward looking beam ±20° in azimuth from the sun and, with flag "on," detect approaching CAT.

Further testing at Autonetics may well result in a model capable of detecting air turbulence at increased ranges, thus allowing the pilot ample time to bypass the turbulence. The hostile CAT no longer is invisible.

The Eighth Annual National Conference on Environmental Effects on Aircraft and Propulsion Systems will be held at the Holiday Inn, Bordentown, New Jersey, October 8-10, 1968. Additional information on this conference, which is sponsored by the Naval Air Propulsion Test Center, may be obtained from Mr. J. L. Palcza, NAPTC, P.O. Box 176, Trenton, New Jersey 08628.

The Effect of Culture Training on Leadership, Organizational Performance, and Adjustment

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Americans, whether as members of the armed forces, officials, or representatives of business, increasingly come into work contacts with members of other cultures. Many of these contacts require extended and close working relations, and, very frequently, the success or failure of the entire mission depends on how the individual gets along with his counterpart in the host culture. This is particularly true in traditional cultures which blur the distinctions between the personal and the business relationship. In many of these cultures, it is commonly assumed that "you can't trust a man in business unless you know and trust him as a person."

It has been clear for some time that it requires training and preparation to work successfully in another culture. A number of training programs have been developed for this purpose. Some of them, like Foreign Service or Peace Corps training programs, require several months; others, such as those used in some business organizations, involve orientation courses of several weeks. There is, however, also a need for the type of orientation which can be compressed into the space of a few hours. The need for such a program is particularly acute for the officer who suddenly finds himself en route to a foreign assignment, or for the government official or business executive who simply cannot spare the weeks or months to prepare himself for each and every culture within which he must perform effectively.

An attempt to cope with this problem has been the development of a culture training program which can provide the individual some familiarity with the host culture within the space of hours—if necessary on the plane while flying to his destination.

Work at the University of Illinois was begun in 1960 under contract with the Office of Naval Research, and later with funds of the Advanced Projects Agency. Assistance was also provided by the Office of the Army Surgeon General. The project was conceived as an integrated series of investigations consisting of three interlocking phases:

a. The identification of culturally critical concepts and behaviors—*i.e.*, differences in the meaning of words, ideas, customs, and unspoken assumptions between the host culture and the American culture.

b. The development of a "Culture Assimilator," which is a self-instructional manual of programmed material, to enable the individual to understand critical cultural differences and to respond to them appropriately in a work context.

c. Laboratory and field studies to determine the effect of the programmed instruction in improving the performance in different tasks and under different leadership conditions.

Identification of Culturally Critical Concepts and Behaviors

This aspect of the program has been the primary responsibility of Harry C. Triandis, Department of Psychology. The basic aim of the subproject has been to develop a theory of "subjective culture," *i.e.*, the characteristic ways in which a cultural group perceives and responds to its social environment.* Triandis and his coworkers have developed a series of methods for eliciting important differences between cultures. One method permits the determination of differences in behaviors which are appropriate for persons occupying specific roles in each culture. For example, in Eastern countries, college-educated men do not perform manual labor. Hence, an engineer who trouble-shoots a machine lowers himself to the status of the workman, and loses the respect of his peers and his subordinates. Also, in these cultures the worker sees his supervisor as someone who gets paid for his skill and knowledge. Hence, if a supervisor asks a workman for his opinion, it "shows" that the supervisor does not know as much as he should, and the worker may feel that he is being imposed upon by having to do his boss's job.

Likewise, concepts have different meanings and implications. For example, when Americans are asked the typical consequence of "love," they respond with such terms as "marriage" or "happiness." When Greeks were asked about the consequences of love, a substantial number responded with the word "death." This answer reflects the Greek folk custom which requires the brother to kill a sister who has become involved in an illicit love affair and who has thus dishonored the family. Many other cultural differences have been found in a surprisingly large number of concepts. Although these differences are usually less dramatic, they may be more important in work relations.

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*Osgood, C.E., "Speculation on the Structure of Interpersonal Intentions." ONR Technical Report No. 39, Group Effectiveness Research Laboratory, 1966.

Triandis, H.C.; Vassiliou, V.; and Nassiakou, M., "Some Cross-Cultural Studies of Subjective Culture." *Journal of Personality and Social Psychology Monographs,* in press.

Triandis, H.C.; Vassiliou, V.; and Nassiakou, M., "Some Cultural Differences in the Perception of Social Behavior." *Journal of Personality and Social Psychology Monographs,* in press.

Triandis, H.D. and Vassiliou, V., "A Comparative Analysis of Subjective Culture." ONR Technical Report No. 55, Group Effectiveness Research Laboratory, 1967.

The "Culture Assimilator"

Data obtained by the previously mentioned investigations have guided the theory and construction of the Culture Assimilators. The specific contents of the Assimilators are based on "critical incidents" reported by individuals who have been involved in intercultural situations.* The respondents are asked to describe some occurrances which markedly changed their perception and understanding of, or their attitude toward, the host culture. The incidents are then written as an interrelated series of episodes, each with four alternative responses with appropriate feedback based both on anthropological data and our findings about subjective culture.

The idea for the construction of these Culture Assimilators originated with Professor L. M. Stolurow, previous co-investigator, now at Harvard University. The programs were originally intended to be prepared for computer-based instruction. The current versions are, however, written in book form which makes them easy to handle and to ship. A typical Culture Assimilator consists of 70 to 100 "items," each comprised of

- An episode which briefly describes an intercultural encounter;
- Four alternative answers; and
- Four statements, indicating the correctness of the answer, an explanation of the cultural basis for the correct answer, and further instructions to the trainee.

The entire program requires approximately four to six hours of the trainee's time. Culture Assimilators have now been prepared for Thailand, the Arab countries, Iran, and Central America. A program for Greece is currently being prepared. An example of an item from the Iran Assimilator, developed by M. Chemers, is shown in the illustration.

Sample item from the Iran Culture Assimilator

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An American Peace Corpsman was working as an agricultural advisor in a small Iranian village. He often felt confused by the behavior of the villagers. At times a villager would ask for some advice on a certain technique. After thoughtful consideration, the Corpsman would give his opinion only to find later that it was ignored. In one particular instance, a peasant named Fereydoun, who owned a small piece of land, asked for some advice on plowing methods. The Corpsman was not sure of his answer and wanted to consult a few manuals, so he told Fereydoun to come to his office the next morning, and he would tell him what to do. However, the next morning Fereydoun did not come, and when the Corpsman sought him out, he found that Fereydoun had already started the plowing his own way.

What do you think is the best explanation for Fereydoun's actions?

*Stolurow, L.M. and Santhai, Suthita (with assistance of Koopman, R.), "Critical Incidents With Heterocultural Interactions." ONR Technical Report No. 42, Group Effectiveness Research Laboratory, 1966.

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Alternatives

A. When the Peace Corpsman said he was not sure of the plowing method, Fereydoun dismissed him as a valuable source of information.

Go to page 100

B. Fereydoun was offended by being asked to come to the Corpsman's office and felt that the Corpsman should come to his farm.

Go to page 101

C. The average Iranian is very impatient, even with short delays, and Fereydoun wanted to begin his plowing.

Go to page 102

D. Iranian peasants believe that traditional ways are the only ways and will not listen to any advice.

Go to page 103

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You chose A: When the Peace Corpsman said he was not sure of the plowing method, Fereydoun dismissed him as any valuable source of information.

Correct. Very good! This was a subtle problem, but a very important one for anyone who lives or works in Iran. Since the Peace Corpsman was sent as an expert advisor, in the eyes of his subordinates, the village peasants, he is expected to know everything about his field. Any hesitation or delay to seek further knowledge is taken as a sign of weakness and lack of knowledge. Thus, a person who has no special knowledge need not be listened to. A more successful method for the Peace Corpsman might have been to provide a tentative answer which would have occupied the villager until the Corpsman could be sure of the definitely correct procedure. Indeed, his hesitation with other peasants, in an effort to give the best possible answer, may have been interpreted by them as uncertainty, and thus the advice ignored.

Go on to the next passage on page 104

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You chose B: Fereydoun was offended by being asked to come to the Corpsman's office and felt that the Corpsman should come to his farm.

Incorrect. In the evaluation of this alternative you should draw on your knowledge of the importance of status and role in such a situation. Since the Peace Corpsman is, in essence, a resident expert, his status would be higher than that of a peasant. Furthermore, the peasant was seeking a favor in the form of advice. Considering both of these facts, it would not be at all likely that Fereydoun was offended by the request, but rather that he considered it quite natural.

Reread the passage on page 98, and make another choice.

102

You chose C: The average Iranian is very impatient, even with short delays, and Fereydoun wanted to begin his plowing.

Incorrect. You have made the common error of attributing American characteristics to the Iranian. In fact, the average Iranian is not greatly concerned with time and rigid schedules and is not usually impatient over a short delay. There is another, more important, factor which accounts for Fereydoun's actions.

Reread the passage on page 98, and make another choice.

103

You chose D: Iranian peasants believe that traditional ways are the only ways and will not listen to any advice.

Incorrect. Although this answer seems possible at first glance, it is not completely accurate. While it is true that in most countries, the peasants are quite traditional and have a tendency to cling to the old ways, other factors must be taken into account. Agricultural advisors have generally been fairly well received by the Iranian peasants and their ideas put to use when feasible. Furthermore, the passage relates that Fereydoun *asked* for the Peace Corpsman's help, and probably really wished to use it.

Reread the passage on page 98, and make another choice.

Validation

The construction of Culture Assimilators was considered a problem in basic as well as applied research. This problem involves not only the development of a theory of subjective culture and the principles underlying the transmission of this culture, but also questions concerning the utilization of this material in task situations. The development of these teaching programs has, therefore, been closely integrated in research on leadership and organizational performance. A number of laboratory experiments were conducted which compared trained and untrained Americans who were teamed up with students from various foreign countries. In addition, one field experiment was conducted in Iran,* and two in Central America.† Findings show that the culture-trained leaders tended to develop more effective interpersonal relations than did untrained leaders or those trained with culturally irrelevant control materials. Moreover, culture assimilator

*Chemers, M.M., "The Effects of Training on Interpersonal Bargaining as a Function of Situational Variables." Paper presented at the Midwestern Psychological Association in Chicago, May 1968.

†Fiedler, F.E.; O'Brien, G.E.; and Ilgen, D., "The Effect of Leadership Style Upon Performance and Adjustment in Volunteer Teams Operating in a Stressful Foreign Environment." Urbans, Ill.: Group Effectiveness Research Laboratory, University of Illinois, 1967.

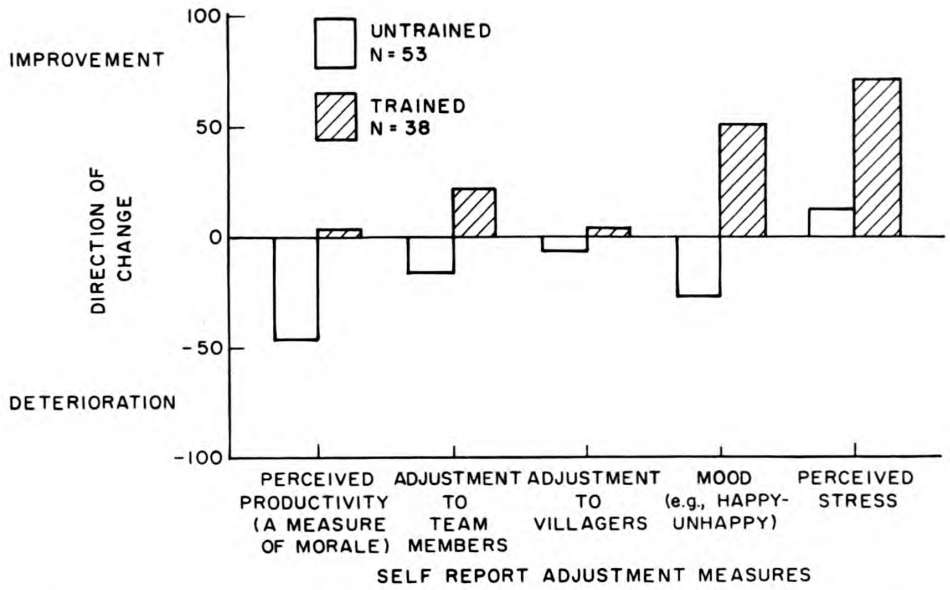
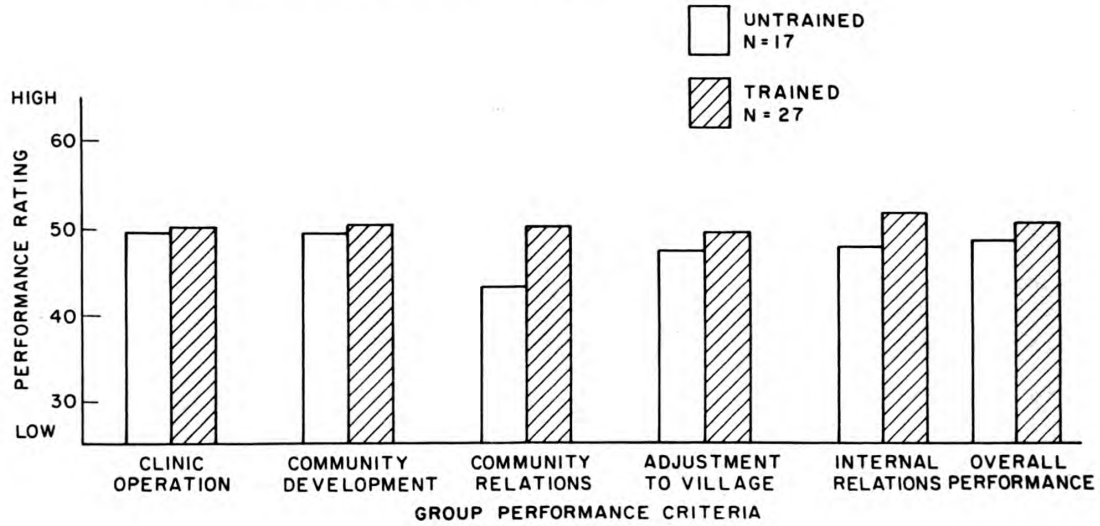


Figure 1 - Change in personal adjustment scores obtained by means of daily team member reports during the first and last week of the project overseas.

training, even though it was in some cases embedded in other culture training programs, materially contributed to the adjustment and performance of Americans working with members of the indigenous populations.

For example, in a field study made in Central America, assistance was provided in the training of teenage volunteers who performed public health services in isolated villages. Measures of personal adjustment were obtained during and after the overseas experience. It was found that individuals who had received culture training appeared to be

Figure 2 - Ratings by supervisors and headquarters staff of the performance of culture trained and untrained teams on different aspects of their mission.



happier, under less stress, and generally healthier and better adjusted than did untrained volunteers. Figure 1 shows scores obtained from daily reports and from self-esteem questionnaires obtained early and later in the overseas experience. Moreover, it was found that teams consisting of culture-trained individuals performed more effectively, especially in community development work and in interactions requiring cooperation with villagers, than did teams of untrained personnel. Figure 2 shows group ratings made by supervisors and headquarters staff.

Considerable further research remains to be done in this area. It is hoped that our research will be extended to the Armed Forces and government agencies working overseas in order to learn more about the type of culture training required in various situations, and the methods to provide this training more effectively.

Random Noise

Mr. James M. Snodgrass, of the Scripps Institution of Oceanography, recently received the Navy Distinguished Public Service Award for his contributions to the Navy in the field of oceanographic communications and instrumentation. The award was presented by RADM T. B. Owen, Chief of Naval Research, for the Secretary of the Navy.

Mr. John W. Sherman, III has recently been appointed head of the Naval Oceanographic Office's Spacecraft Oceanography Project. Mr. Sherman was formerly employed by the Institute of Defense Analysis.

CAPT T. K. Treadwell, USN, has been recently named as the new Commander of the U.S. Naval Oceanographic Office, Suitland, Md. He will succeed CAPT L. E. DeCamp, USN, who is scheduled to retire this summer.

Dr. Arsham Amirikian, Chief Engineering Advisor to Commander, Naval Facilities Engineering Command, received the National Capital Award as outstanding engineer on Engineers and Architects Day 1968.

Dr. Lewis B. Wetzel, an expert in the field of electromagnetic wave propagation, has been named Superintendent of the Radio Division at NRL. In his new position Dr. Wetzel administers a broad program of research and development in satellite communications, radio communication, radio navigation, radio propagation, precise frequency and time, and centralized electronic control.

A Symposium on Altitude and Cold will be held at Aspen, Colorado, September 2-6, 1968. Additional information on this symposium, which is sponsored by the Office of Naval Research, may be obtained from Miss Suzanne Kronheim, ONR Physiology Branch.

Flow-Excited Underwater Cable Vibrations

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R. A. Holler
G. Goss
Naval Air Development Center
Johnsville, Warminster, Pa.

The fluid mechanics of cable strumming, or flow-excited vibration, is of interest to the Navy in many areas. Air-launched sonar equipment picks up false readings because of the effects of water flow relative to hydrophone-supporting cables; anchor cables require a high strength margin because of the fatiguing vibration effects; aircraft towlines frequently fracture under high vibrational stress; propeller blades "sing" and periscopes vibrate because of flow-excitation. Applied research in this area currently being conducted at the Naval Air Development Center, Johnsville, Pa., shows promise of alleviating many of these problems.

Investigations at NADC were motivated by the problem of false or spurious signals from air-launched sonar systems. These systems suspend a hydrophone to a predetermined water depth by means of flexible cables. Since conventional hydrophones are inherently sensitive to motion, any periodic acceleration causes a spurious signal which may interfere with the successful operation of the sonar device. Such acceleration occurs because of cable vibrations induced by the indigenous periodic fluid forces acting on the sides of a cable. This flow-excited vibration is commonly termed "cable strumming."

Cable Strumming Concept

As the name indicates, the strumming of a cable is analogous to the plucking of a banjo. The musician plucks the banjo to produce sounds of different frequencies depending on the tension and length of the strings.

To further illustrate, a common physics experiment is to apply a tuning fork of known frequency to a stretched wire. If the frequency of the tuning fork is the same as the fundamental natural frequency of the wire, a single standing wave is maintained along the wire for as long as the fork continues to vibrate. If a tuning fork with twice the frequency is used, two standing waves are produced along the wire with a node or stationary point at the center. This is the second harmonic for the wire. Each multiple of the fundamental frequency results in a higher harmonic with the appropriate number of standing waves.

In the same manner, a hydrophone-supporting flexible cable subjected to water flow is excited into standing waves. Figure 1 shows the lower suspension of an AN/SSQ-28M hydrophone vibrating in its second harmonic with a node at the center. Spurious signals will emanate from the hydrophone because of these vibrations. The mechanism of this excitation is the phenomenom of "vortex shedding."

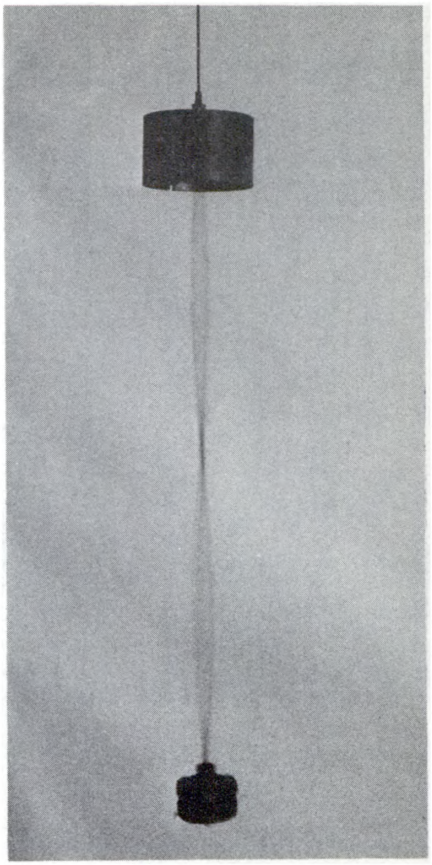

Figure 1 - Flow-excited hydrophone cable

When fluid flows past a cylindrically-shaped body such as a flexible cable, vortices or tiny whirlpools form in the wake of this body. These vortices form on and shed from alternate sides of the cable with a frequency which depends directly upon the flow velocity and inversely upon the cable diameter. Vortices shedding from opposite sides of the cable circulate in opposite directions. Thus, they apply oppositely directed side forces on the cable, and cause it to vibrate transversely to the flow. When this flow-induced vibration is in sympathy with the harmonic of the cable's natural frequency, resonant standing-wave vibrations occur.

Figure 2 is an artist's conception of vortex shedding in the wake of a strumming cable. Water flows from right to left past a flexible cable with a terminal sphere and causes it to vibrate in standing waves. The circles (vortices) which appear in the wake at the water's surface are cross-sections of the vortex filaments, or lines, which shed along the entire cable length. The varying diameters of the vortex lines have been exaggerated to illustrate the effect of the cable amplitude on the vortices.

Areas of Research

In the case of a flexible cable which is excited to standing-wave vibrations by vortex shedding, the amplitude of the vibration varies from a maximum at the antinode to a minimum at the node. This amplitude has a profound effect upon the correlation of vortex shedding along the cable. However, prior to the studies being conducted by NADC, the exact nature of this effect could only be surmised.

Figure 2 - Artist's concept of vortex shedding from a vibrating flexible cable

In this regard, NADC has developed a hydrogen-bubble flow-visualization technique to study the spanwise correlation and the vortex stabilization in the near wake of the cable. Small bubbles of hydrogen are formed on the flexible cable by the process of electrolysis. These bubbles are swept from the cable surface by the flow and collect within the vortices that are shed from the cable, creating a visual effect similar to that seen in figure 2. By the use of photographic methods, both the formation and shedding processes of vortices can be recorded; and, as a result, the dependence of the vortex shedding on the amplitude of vibration can be determined.

When the vibration amplitude is low (less than approximately ten percent of the cable diameter), the shedding vortices are not phase-correlated along the span of the cable but are shed at random. Figure 3 illustrates this phenomenon. Notice that the line vortices are not shed as straight lines but, rather, as a series of loops. Since the forces acting at the sides of the cable are related to the formation of the vortices, this geometry implies that the forces are out of phase. Accordingly, they do not have the ability to force the cable to strum with high amplitude. In other words, the hydroenergy transferred to the cable is *low*.

When a fundamental standing-wave vibration occurs with an appreciable amplitude (greater than approximately ten percent of the cable diameter), as happens when the shedding frequency is equal to the natural cable frequency, an organized wake exists. The cable now sheds the vortices in lines along the entire span of the standing wave, as illustrated in figure 4. Notice that the lines of vortices in the wake of the cable are unbroken, and adjacent lines have shed from alternate sides of the cable. The vortices are now dependent on the cable's vibratory motion with the side forces acting in phase, thus causing a high resonant type amplitude. This results in a *high* transfer of hydroenergy.

Research conducted at NADC has also demonstrated that there is an innate characteristic of vortex formation that limits the vibration

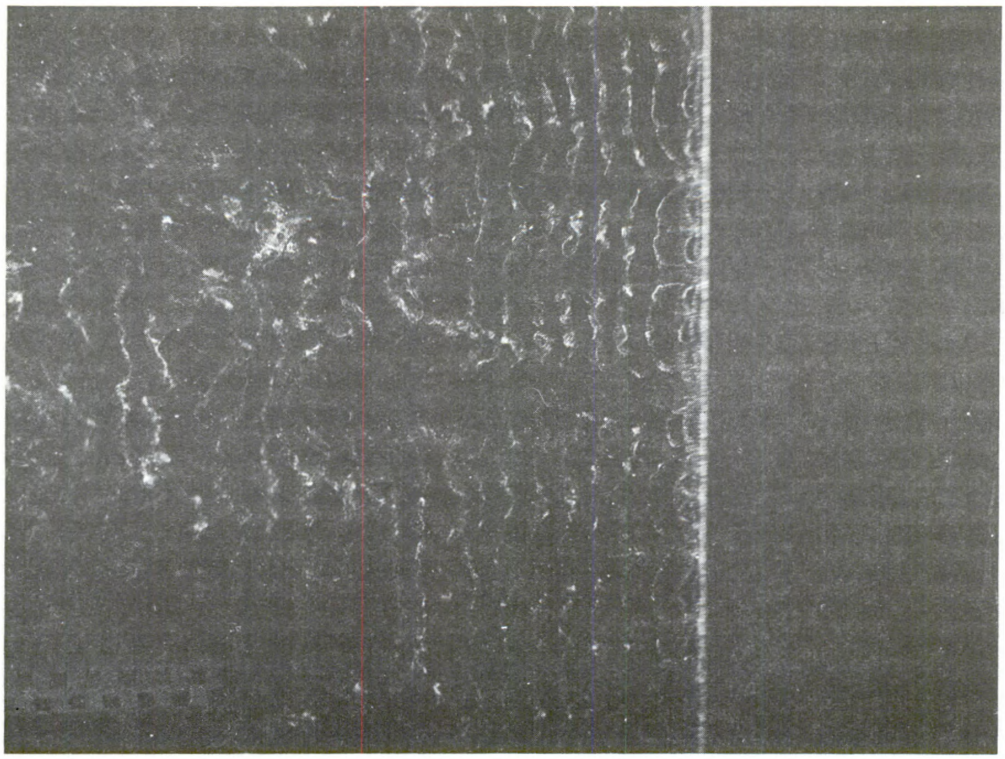

Figure 3 - Spanwise vortex shedding in the wake of a non-vibrating cable

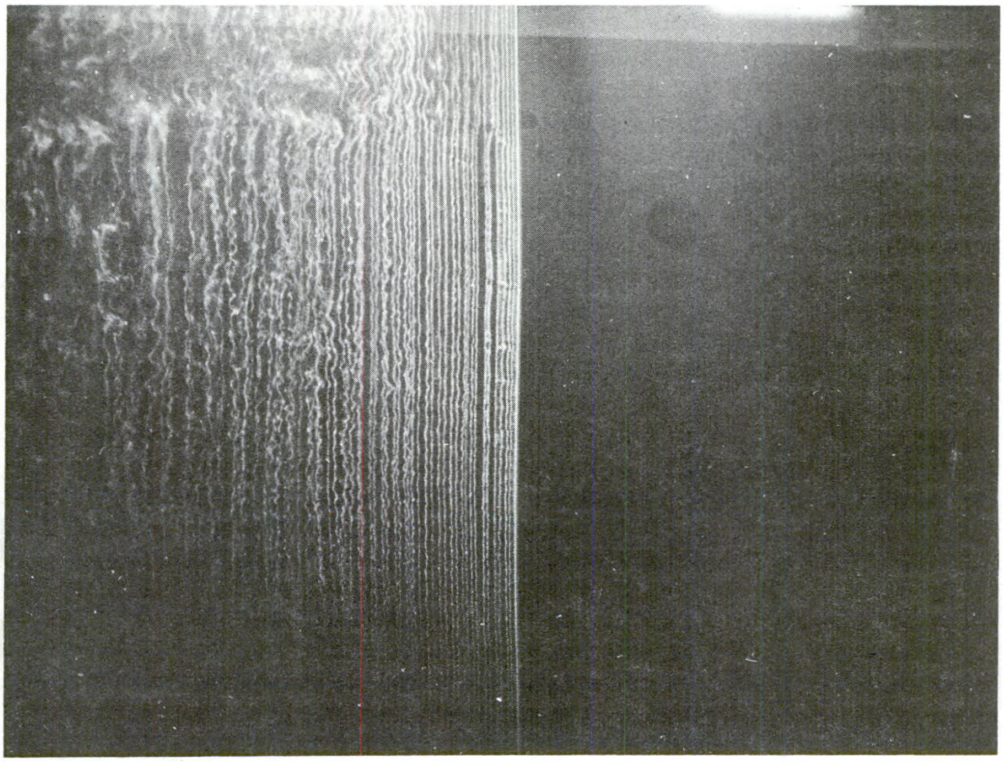

Figure 4 - Spanwise vortex shedding in the wake of a flexible cable vibrating in its fundamental mode

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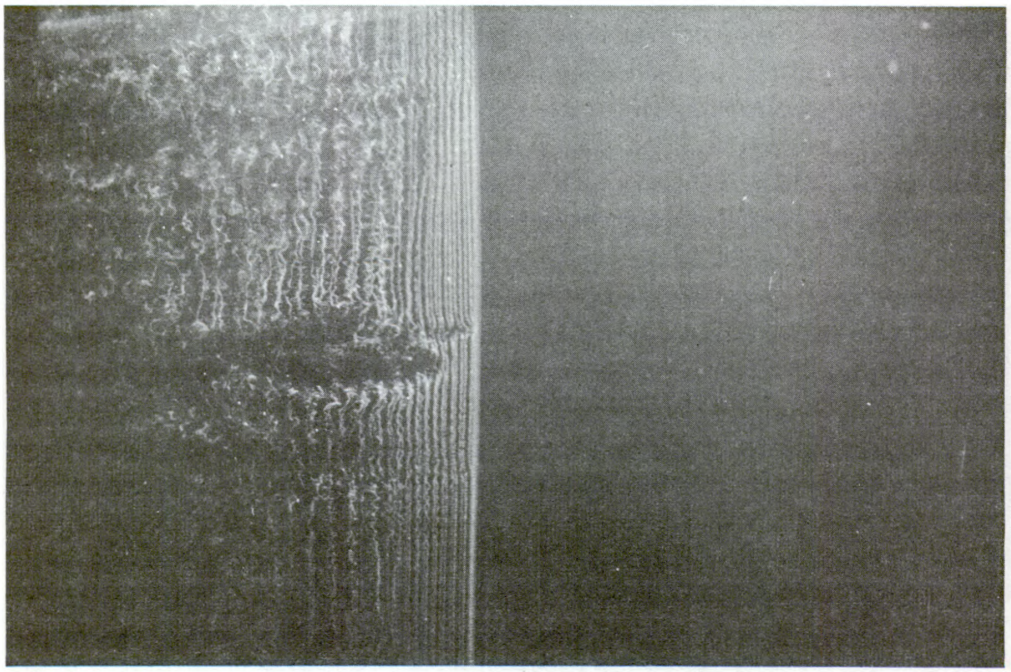
amplitude and therefore the hydroenergy imparted to the cable. When an increased water flow causes the frequency of vortex formation to exceed the frequency of vibration, the vortices again shed at random and the associated forces attenuate the vibration amplitude. This frequently occurs at the antinode of a vibrating cable segment.

Further, when the cable is vibrating in a higher harmonic, a gross phase shift of the side forces relative to the motion occurs at each nodal point. This effect is seen in figure 5 which shows a flexible cable vibrating in its second harmonic. Notice the distinct discontinuity at the node between the two standing waves. Although the vortex lines above and below the node are shed simultaneously from both sides of the cable, they circulate in opposite directions. Thus, they apply oppositely directed forces on the cable, and create the discontinuity in the wake.

Interesting results have also been obtained from investigations being made on the effect of strumming on the water drag characteristics of cables. When water flows relative to a cable-suspended hydrophone, the water drag forces cause the system to stream. This water flow can range from a fraction of a knot to several knots. The streaming effect causes the hydrophone to rise toward the surface of the water. The resultant level of suspension is frequently outside of the design requirement and thus impairs the system performance.

Figure 6 shows AN/SSQ-28S single element hydrophone and AN/SSQ-41 line hydrophone suspensions streaming in a one-knot flow. The streaming effect is particularly detrimental for line type hydrophones

Figure 5 - Spanwise vortex shedding in the wake of a flexible cable vibrating in its second harmonic mode



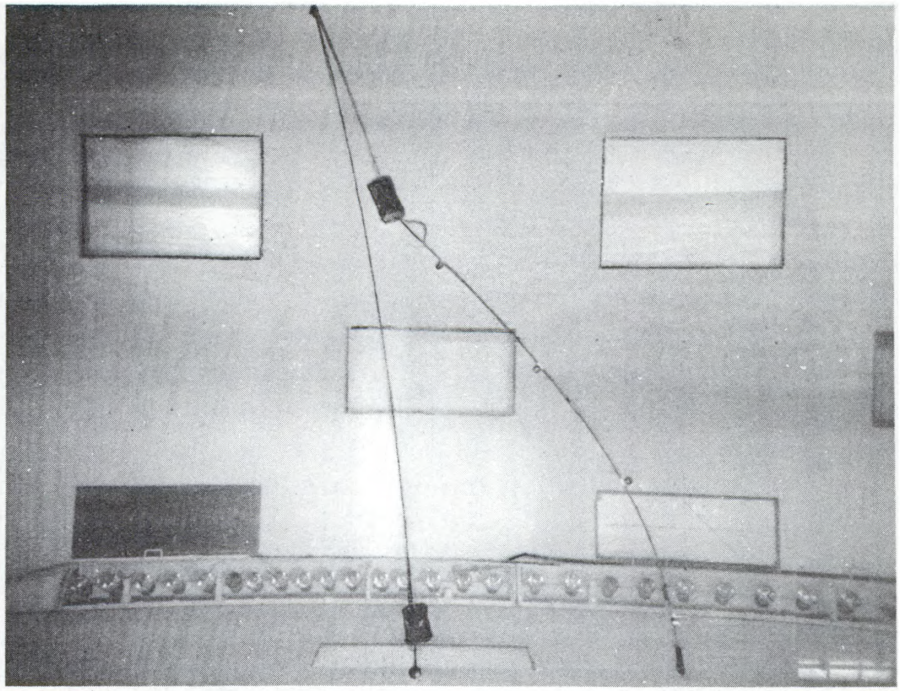


Figure 6 - Hydrophone suspensions streaming in a one-knot flow

since they are made up of four or more elements suspended on a line which must remain nearly vertical for optimum performance. This performance is compromised when the line hydrophone streams in the manner shown on the right side of figure 6.

Studies have demonstrated that the flow-excited cable vibration increases the water drag forces. Thus, they may effect the fatigue life and therefore the strength of the cable. All ocean cables are prone to these adverse effects because of *in situ* currents that vary diurnally with the tide or flow constantly as prevailing currents. This is true whether the cable is several inches in diameter and is used to tether a ship or is a fraction of an inch in diameter and is used as a fishing line.

Since the flow-induced vibration or strumming of a flexible cable is transverse to the direction of flow, there can no longer be a simple relationship between the cable diameter and water drag. The vibrating cable appears to expose a broader area to the flow than a non-vibrating cable of the same diameter. As a result, when cable strumming occurs, water drag increases. Different vibrational modes present different faces to the flow, and the drag varies accordingly. However, experiments conducted at NADC with smooth flexible cables of circular cross-section have led to a method of describing the drag on a cable of known diameter and mass per unit length. Findings from these experiments indicate that cable strumming increases the conventional drag coefficient by about 38 percent, enough to cause a significant increase in cable tension. Also, adverse lateral and vertical motion of the cable may occur with changes in strumming.

New Cable Designs

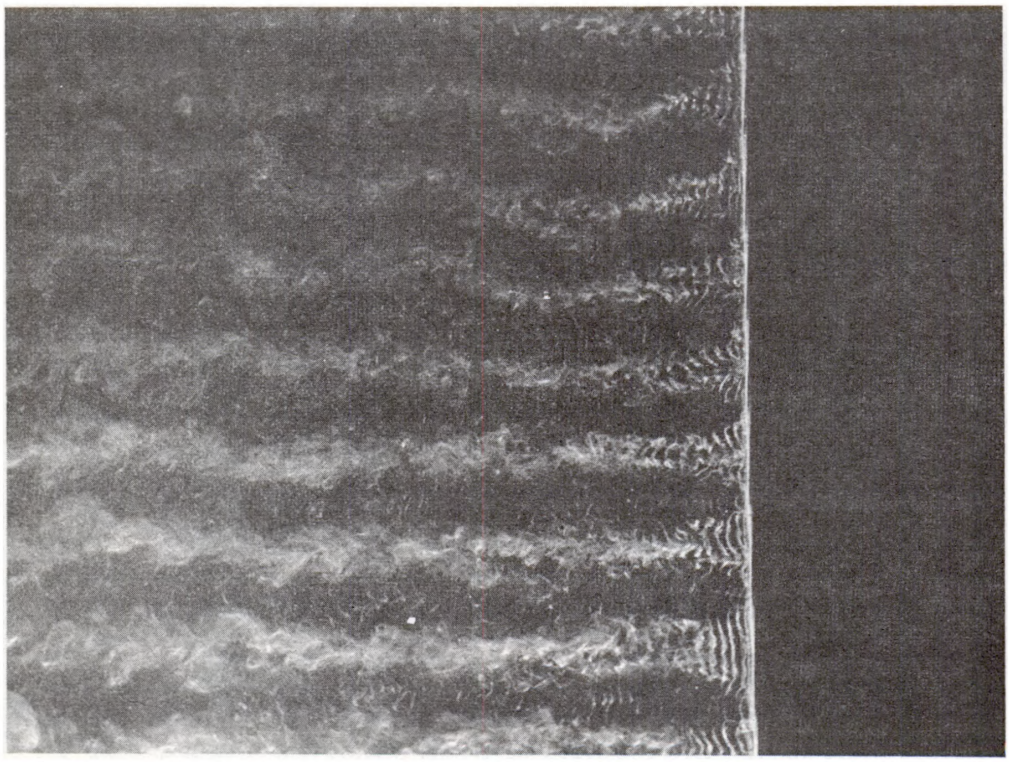
Various cable designs are currently under development in an effort to reduce the adverse effects of cable strumming and water drag. These designs attempt to eliminate the periodic vortex forces by inhibiting the initial vortex formation or by causing uncorrelated vortex shedding along the length of the cable.

One design being evaluated features a pair of cables twisted together. This design has been found effective in reducing strumming because the different frontal areas of the cable cause vortex shedding at different frequencies. The spanwise forces, therefore, are not correlated and the strumming amplitude is reduced. This effect is shown in figure 7 in which the vortex lines are dominant at the broad-face-forward sections.

As indicated earlier, when strumming is reduced, a corresponding reduction in water drag should occur. Observations confirm that the twisted pair of cables, in addition to suppressing strumming, does reduce the water drag from ten to 20 percent.

Other designs include a cable with hairs woven or cemented into it and a cable with vibration inhibitors fastened locally at the predicted antinodes of the standing wave. Continued research at NADC should increase current knowledge of the physics of flow excitation and lead to the development of better designs for naval equipment now plagued by the adverse effects of cable strumming.

Figure 7 - Spanwise vortex shedding in the wake of a twisted pair of cables



Dedication Address: E. O. Hulburt Center*

Donald F. Hornig
Special Assistant to the President for Science and Technology

It is a great pleasure for me to participate with you in the dedication today of the new home for the Hulburt Center for Space Research. This occasion marks yet another milestone in the fruitful and distinguished career of the Naval Research Laboratory. But its significance is truly much broader. This is because the Hulburt Center, its program, and the several functions it performs for the government and the scientific community jointly express in an essentially ideal way, it seems to me, the role that governmental laboratories should play in our society.

There is an ever present, and historically well established, tendency for Americans to criticize the federal government, to object to its growth and to take exception to its undertaking activities which have counterparts in the private economy. As a result, and without substantive criticism of their importance and productivity, government laboratories in general tend not to receive the recognition they deserve in comparisons with research and development activities and accomplishments in universities and in industry. This dedication is an appropriate occasion to help redress the balance.

All federal laboratories have programs related to the missions of their parent agencies and departments, and their principal activities center about some or all of the following functions:

First: Providing the parent organization with permanent capabilities for solving new problems on a much shorter time scale than would be possible if the government had to contract with industry on each occasion that such needs arose;
Second: Through their expert staffs providing an effective and direct route for the parent organization to take quick advantage of progress in science and technology all over the world; and
Third: Provide a capability within the parent organization for expert supervision and evaluation of the scientific and technical services and products supplied to the government by industrial research, development and production.

It is easy to see that such activities are essential if agency missions are to be expeditiously carried out, and that the use of in-house governmental aid to these ends is not only the most appropriate route but is

*An address given by Dr. Donald F. Hornig at the dedication of the E. O. Hulburt Center for Space Research of the U.S. Naval Research Laboratory, Washington, D.C., April 17, 1968.

also the one most likely to be cost effective in the long run. But there is an important condition which must be satisfied if cost effectiveness is to be realized, and this is that the laboratory's scientific and technical staffs must be fully competent to understand and to apply the new knowledge being constantly generated at the frontiers of the applicable disciplines. And to insure that such continuing competence exists is possible in only one way—the laboratory's staff must itself be directly and personally involved in frontier research and development.

Although the last conclusion is perhaps obvious to most of us here, there are many skeptics to whom it seems contradictory that mission-related laboratories should be concurrently engaged in frontier research and in the more mundane support activities needed by the parent agencies and departments.

But there is no such contradiction, and to understand this it is only necessary to know that the great bulk of the best research almost everywhere is a part-time activity of the staff—the remaining time and energy also generally going into much more mundane and less glamorous occupations. This is certainly true of the research being done by the faculties in our universities. Teaching is, and is likely always to remain, the principal obligation of the university's staff and it is this activity which is the university equivalent of the mission-related support government scientists and engineers provide to their agencies when not engaged in research. And the important point is that to teach well, inspiringly and convincingly at the university level is no more possible if the teacher is not himself doing related research than it is reasonable for a government or industrial laboratory scientist to provide sophisticated, up-to-date technical guidance and advice to his management if he is not personally deeply involved in work at the shifting boundary between science and technology on one side and ignorance and mystery on the other.

The Naval Research Laboratory in general and the Hulburt Center for Space Research in particular provide outstanding examples of what enlightened management and first-rate scientists and engineers can jointly accomplish in a government laboratory. The Navy's sound and persistently maintained policy of encouraging research in fundamental sciences in parallel with direct mission-related work has insured an environment to which talented people have been attracted for careers permitting not only significant contributions to national defense but also, and equally importantly, meaningful additions to the growth of science and technology in general.

It is probably unnecessary for me to discuss before most of you the brilliant history of the Naval Research Laboratory. However, I would like to note for those in this audience who are here for the first time that its contributions to the development of radar and missile technology, to communications engineering, to several branches of chemistry,

and to space science and technology have earned for the Naval Research Laboratory a secure place among our most distinguished laboratories.

Of the greatest interest to us today, of course, are NRL's space related programs. The origins of these programs go back to the beginnings of major U.S. interest in rocketry and high altitude and space experiments. NRL's work in these areas began in 1946 when "liberated" V-2 rockets first became available for space research. Although NRL made important contributions to the development of American rocket technology through the Vanguard program, its major forte has always been in development of instrumentation for space aeronomy and astronomy. However, the Vanguard program also provided the vehicle—in at least two important senses—for the development of NRL's space research capabilities which we now see so well integrated in the Hulburt Center for Space Research. The talents and expertise now in this Center were then responsible for the design of America's first space payloads for astronomical research. And, by general recognition of the scientific community, they are still in the forefront of astronomical space research. The work of Dr. Herbert Friedman and his associates in studies of the sun in the UV and X-ray regions of the spectrum, and, more recently, in X-ray astronomy generally, has received worldwide recognition. No other governmental space research laboratory in the U.S. has the distinction of having two members of the National Academy of Sciences among its active scientific staff.

But there is another aspect to which the outstanding group of scientists at the Hulburt Center for Space Research is making a major contribution to the growth of American science. And this is through its program, in cooperation with the National Science Foundation, and the National Aeronautics and Space Administration, to provide graduate level training in astrophysical research. This program provides opportunities for university graduate students, doctoral candidates and post-doctoral résearch fellows to acquire first-hand experience in space research. Understandingly, this program is well regarded not only within the Navy and the government, but also within the academic community. Since 1963 it has provided space research opportunities to some twenty scientists, and serves as a brilliant example of Navy-NRL leadership in making unique government research facilities available for use by the academic community. In this connection I would like especially to point out that the academic support phase of the Hulburt Center's program has from the beginning had the full support of the President's Science Advisory Committee which in 1960 urged increased cooperation between the universities and governmental laboratories in graduate education.

Again the skeptic might ask, why should the Navy support research in astrophysics? In addition to the general answer I have given earlier to questions of this kind, I would like to reiterate: because frontier

scientific work in a field so complex and demanding from the instrumentation and measurement points of view will eventually lead, in addition to the direct usefulness of its scientific results, to new developments in ideas and in sensor-related technologies which will be useful in many fields other than astronomy; and because the scientists involved in such work have the training, the capabilities and the insights to help the Navy, the government and the U.S. economy more broadly in the fields in which they will be asked to help and to advise.

So you can see why I consider it such a privilege to be here today to express my respects to Dr. Hulburt, whose scientific leadership at this laboratory led to the establishment of the Center for Space Research which now bears his name; to congratulate Dr. Friedman in the many successes he and his associates have had since the Center's founding; and to pay my respects to the Navy for its understanding of the importance of basic science and for its generous support of the Center and of the Naval Research Laboratory in general. My best wishes to you all. (See *Naval Research Reviews* issue of May 1968, "E. O. Hulburt Center for Space Research: A NRL Experiment.")

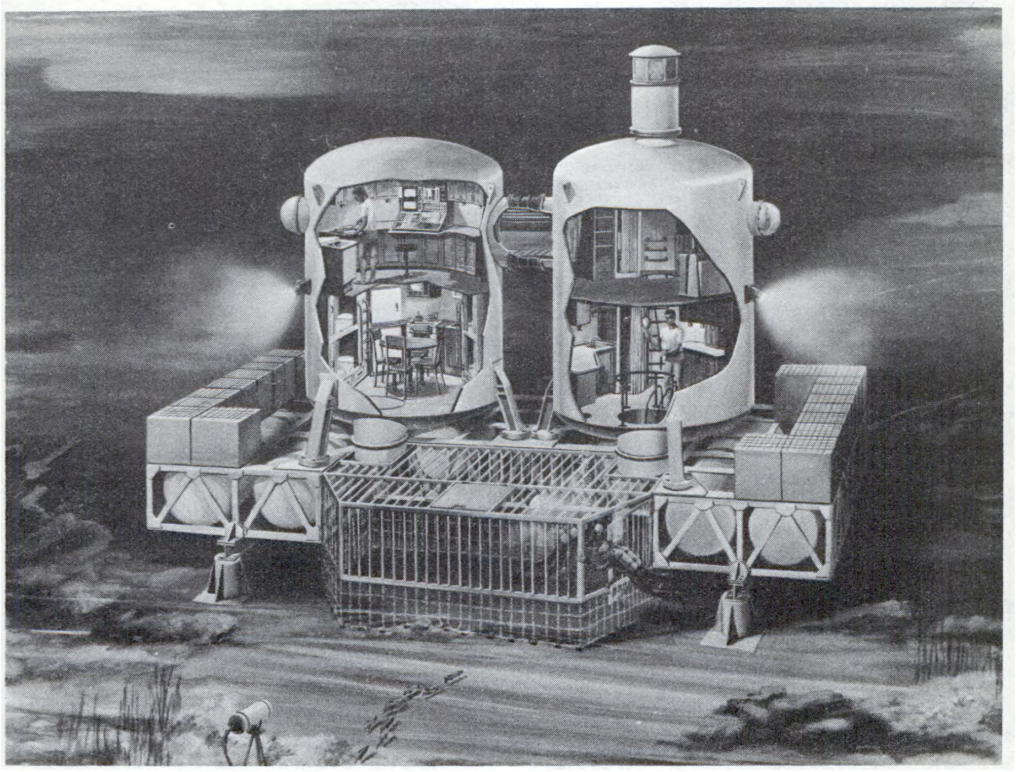
NRL Isochronous Cyclotron Facility

The first extracted alpha beam of the NRL Isochronous Cyclotron was achieved on 12 February 1968. This was preceded by extensive magnetic field measurements coupled with the development of computer programs to predict the operational parameters (knob settings) for the currents in the various coils needed to achieve an acceleration field. Ion orbit theory is used to calculate the proper magnetic field, and the necessary currents are obtained through linear programming techniques. Innovations introduced in the NRL programs include taking into account trim coil interpendence and the change of flutter parameters with trim coil currents, as well as first harmonic minimization and the influence of the beam extraction elements on the magnetic field. Internal beam studies have proven that the computational techniques developed provide correct trim coil currents for successful acceleration and extraction of the ions at full radius, thus eliminating the thousands of hours usually necessary for beam development.

Alpha beams have been accelerated over the full design range of 9 MeV to 90 MeV. Other ion beams will include protons with energies up to 70 MeV, deuterons up to 45 MeV, He^3 up to 120 MeV and various heavy ions with maximum energy depending upon the mass and charge state. The ion energies are variable from about 15 percent to 100 percent of maximum with an inherent energy spread of 0.4 percent. This energy spread can be reduced to 0.02 percent for precision experiments by an $n = 1/2$, nine-foot radius, double-focusing analyzing magnet. High intensity irradiations with the non-analyzed beam are also possible.

The first experiment was performed with a 22 MeV proton beam achieved by accelerating a negative hydrogen beam, and then extracting this beam by passing it through a thin foil which stripped the electrons from the ions and thus reversed their radius of curvature. These energetic protons were used by the Rocket Spectroscopy Branch to study spectral deterioration in spectroscopic film produced by the radiation expected during Apollo space experiments.

Research Notes



Plans Announced for Four Scientists to Live on Ocean Floor for 60 Days

Plans are being made for a major ocean bottom study involving the longest continuous undersea stay of a diving team yet attempted. In this effort, four U.S. scientists will live and work for 60 straight days on the ocean floor at a depth of 50 feet.

Operation TEKTITE I, as the program has been named, will involve the U.S. Navy, the National Aeronautics and Space Administration, the Department of the Interior, and the General Electric Company. It will take place early next year below the surface of Greater Lameshur Bay, Virgin Islands National Park, offshore from St. John Island.

The program's overall objectives are to conduct extensive marine science studies on the ocean bottom, and to study and observe the behavior of men living in relative isolation in an alien environment under stress. Such data can be applied both to future undersea missions and extended duration space missions.

The ocean floor habitat is being constructed by GE's Missile and Space Division, Valley Forge, Pennsylvania. It will consist of two vertical structures 12 feet in diameter by 18 feet high connected by a four-foot diameter tunnel. Each structure will have two living compartments, one above the other.

The twin-chamber dwelling will be the home and laboratory for two full months for a team of four Interior Department scientists. Their contact with the outside world will be limited to voice communication. Behavioral scientists and physicians will observe the diver scientists both inside and outside the habitat *via* closed circuit television throughout the operation.

The program is the first of its kind to be undertaken by a group of government agencies in cooperation with private industry. Such programs are possible because of earlier research by the Navy which resulted in the development of saturation diving techniques.

A saturation dive is one in which the body tissues become saturated (approximately after 24 hours) with the gases in the breathing mixture. Although this technique permits divers to live on the ocean floor for long periods, they must go through an extended decompression period before returning to the surface.

Food supplies will be stored in the capsule before its descent. Water and the breathing mixture of oxygen and nitrogen will be supplied through a lifeline linking the capsule with a shore-based complex. Separate cables will provide power and communications.

A small two-man wet submersible unit will be used by the scientists for short field trips away from their temporary home on the ocean bottom.

The sponsoring government agencies hope not only to gain a wealth of data on marine sciences and the behavior of small groups while in close confinement for long periods, but also to refine the technology of saturation diving at relatively shallow depths.

The Navy is interested in the engineering, marine science and human behavior aspects of the program. Technical direction will be provided by the Office of Naval Research. Other Navy activities involved include the Navy Facilities Engineering Command, Bureau of Medicine and Surgery, Naval Oceanographic Office, Deep Submergence Systems Project, Naval Ship Engineering Center, and Seabee units of the Atlantic Fleet.

NASA's Office of Manned Space Flight and Office of Advanced Research are concerned with the behavioral data of the crew, with the view of extrapolating them to an extended duration manned space mission.

The Department of the Interior, which is interested in a number of marine scientific issues and in studying the techniques involved in such open-sea missions, will direct the marine research phase of the program. Interior agencies participating are: Bureau of Commercial Fisheries, Bureau of Sport Fisheries and Wildlife, the Geological Survey, and the National Park Service. Although ocean bottom studies will include a broad range of oceanographic research, major emphasis will be on behavior and habits of marine animals and how they interact with their environment. Additional areas of study will include marine geology, underwater mapping, and monitoring various oceanographic phenomena.

General Electric will provide specified planning, training, scientific and engineering support as well as systems analysis for the entire operation.

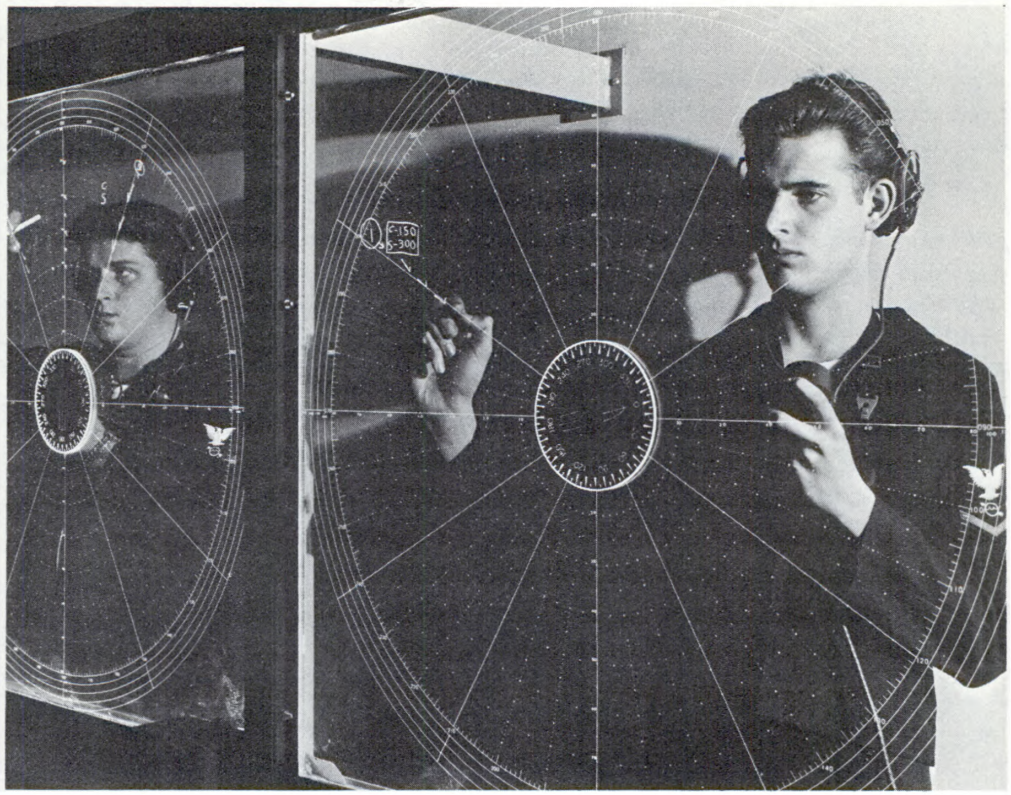
The project name, TEKTITE, was inspired by the combination of apparently divergent factors—space and ocean. Tektites are small mineral objects found both on land and in the ocean and are thought by geologists to be of extraterrestrial origin.

The Greater Lameshur Bay site was chosen because of its extremely clear, warm waters and its lush tropical plant and animal life. Since its abundant coral reefs support prodigious reef-fish population, plus spiny lobsters and other species, an excellent opportunity is provided for direct biological and oceanographic studies.

The shore-based support complex will be constructed by Navy Seabees adjacent to the Ecological Research Station operated by the College of the Virgin Islands in the National Park. Park Service officials stressed that all possible precautions will be taken to preserve the ecology and the natural resources of Greater Lameshur Bay.

Anti-Sub Trainer Dedicated in Newport Ceremonies

The U.S. Navy dedicated an advanced training facility designed to further strengthen U.S. sea defenses against submarine attack at the Fleet Training Center, Newport, Rhode Island on March 29. The $5-million facility will enable surface-ship sailors to sharpen their anti-submarine warfare (ASW) tactics and skills under combat-like conditions at the Training Center.



Twin plotting boards give crewmen in electronic trainer's combat information center a progress report on overall tactical situation in anti-submarine battle. Range and bearing information on submarines is reported by sonar in another room. Surface vehicles are tracked by radar.

Navy officials, in accepting the surface-ship attack center, said it represented "an important extension of the Navy's shore-based capabilities to maintain the readiness of anti-submarine forces of the Atlantic fleet." The electronic battle simulator, built by Honeywell Inc. at its Marine Systems Center, West Covina, Calif., for the Naval Training Device Center (NTDC), Orlando, Fla., is the first of its type installed on the East Coast. The anti-sub trainer is designed to instruct ship crews in the operation and tactical use of the Anti-Submarine Rocket (ASROC) and Mark 46 torpedo, and other ASW systems such as Drone Anti-Submarine Helicopter (DASH). It provides instruction in equipment-operating procedures, personnel proficiency, improved shipboard anti-submarine defense and in the evaluation of tactical situations. Also, it may be used in developing and planning advanced naval undersea defense tactics.

The trainer occupies over 3000 square feet of floor space, divided into six operating areas: Conning Station, Combat Information Center, Underwater Battery Plot, Problem Critique and Display Room, Launcher Captain's Control Station, and Computer and Projection Equipment Room.

Combat situations are worked out and controlled by instructors, who select the appropriate ocean problem area (16, 32, 64, or 128 square miles); wind direction and velocity; and course and speed of the target submarines, support units and aircraft. A training problem may involve one ASROC ship (a destroyer); two support units, which may be destroyers or cruisers; two target submarines, conventional or nuclear; and three aircraft units, either fixed-wing or helicopter, one of which may be a DASH vehicle.

To provide instructors with a total "picture" of the progress of the problem, an automatic projector—receiving multiplexed inputs—displays on an 8-by-8 foot screen distinctive moving images for each vehicle or weapon in the "battle." Another projector adds reference grids and other fixed data such as land mass.

The instructor's console is equipped with devices showing radar and sonar data, support and target vehicle position information and weapon operations. The instructor can alter the complexity and progress of the problem at any time to challenge students as appropriate. He monitors the team performance in accomplishing specific segments of the training problem and may "freeze" the problem at any point for a critique. Target-hit assessment also is provided by the instructor at his console.

To broaden the scope of training and increase realism, the instructor also can simulate various malfunctions of the ASROC missile, its payload or launcher cells. Crews thus are trained to react quickly to correct malfunctions under emergency conditions.

A feature of the design of the ASW trainer is that it provides for addition of new equipment or weapons with minimum disruption of training, and at less expense. Later modifications, which alter ship or weapon characteristics, can be included in the trainer by computer program changes.

Direct Free Energy Measurements for Solid-Liquid Systems

NRL scientists have obtained the first direct measurements of solid-liquid interfacial free energy in metals. The new measurements will permit a more critical assessment of a number of theories concerning the interaction of solid and liquid metals, particularly those regarding liquid-metal embrittlement, grain-boundary melting, and nucleation and growth of metals from melts.

The new measurements are based on a recent NRL discovery that the equilibrium form of a pure-metal bicrystal boundary in contact with its melt can be studied at magnifications above 100,000 X with the electron microscope. This technique permits direct observation of the equilibrium between the known surface tension of the bicrystal boundary and the unknown interfacial tension of adjoining solid-liquid surfaces. This equilibrium is completely characterized by measuring two quantities during the high-temperature microscopy, *viz.*, the misorientation angle across the bicrystal boundary, and the angle subtended by the adjoining solid-liquid interfaces. A simple equation relating the two measured angles is used to compute the value of the solid-liquid free energy. Whereas previous measurements were always of a more indirect type—resulting in data of unknown precision—the high magnification studies at NRL now directly yield free-energy values of known accuracy.

Dislocation Pipe Diffusion in Silver Single Crystals

Measurements of diffusion rates in metals at low temperatures have a practical importance in the interpretation of radiation effects. Data on low temperature diffusion also are useful in the theory of dislocations, a fundamental defect in crystalline materials, since diffusion at low temperatures is mainly along the core or pipe of the dislocation. In order to extend diffusion measurements to low temperatures where diffusion distances are very short, metallurgists at the Naval Research Laboratory have developed a chemical sectioning technique utilizing the metal-iodine reaction. The diffusion and analysis consists of plating a layer of radioactive Ag^{110} onto a silver single crystal and then diffusing the Ag^{110} into the crystal. After diffusion the crystal surface is reacted with a dilute solution of iodine in alcohol to form a thin layer of silver iodide which is dissolved off and counted radiologically. Layer thicknesses of 100 Angstrom units have been obtained with this technique. A self-diffusion coefficient of 10^{-17} cm^2/sec has been measured at 258°C. This is four orders of magnitude lower than the coefficients obtained at the previous lowest temperature of 500°C.

An equation proposed in the literature by Hart contains a term for the dislocation density. Using the measured dislocation density in the silver crystals studied in the NRL work in conjunction with Hart's equation, a coefficient for diffusion along a dislocation pipe was calculated and agrees well with a value, published in the literature by Turnbull and Hoffmann, obtained for diffusion in low and medium angle grain boundaries. Other investigators have written that the equation taken from the literature is not valid for short diffusion distances; however, the NRL work supports the validity of the equation for even very shallow penetrations.

Gulf of Mexico is Target for Marine Geologists

Scientists of the Geological Survey, Department of the Interior, and the U.S. Naval Oceanographic Office will team up in conducting a geologic study of the Gulf of Mexico.

In announcing the one-year project, RADM O. D. Waters, Jr., Oceanographer of the Navy, and Dr. William T. Pecora, Director of the U.S. Geological Survey, said that the joint effort is aimed at "obtaining new and significant knowledge of the major earth structures that underlie the Gulf, and the mineral resource potential of sea floor sediments and sub-seafloor rocks."

The joint Navy-USGS project is described as the most comprehensive effort yet planned to obtain new information about the nature and properties of a major part of the Gulf floor—which has a total area of more than 600,000 square miles.

Geological and geophysical surveys will be conducted aboard the Navy's newest oceanographic research vessel, the 300-foot ELISHA KANE, which is capable of obtaining continuous sea surface temperature, bathymetric data, "sparker" subbottom profiles, and magnetic measurements. Facilities and personnel aboard the vessel will handle and process data from a wide range of physical, biological, chemical, meteorological and photographic programs. The USNS KANE is under the technical direction of the Naval Oceanographic Office.

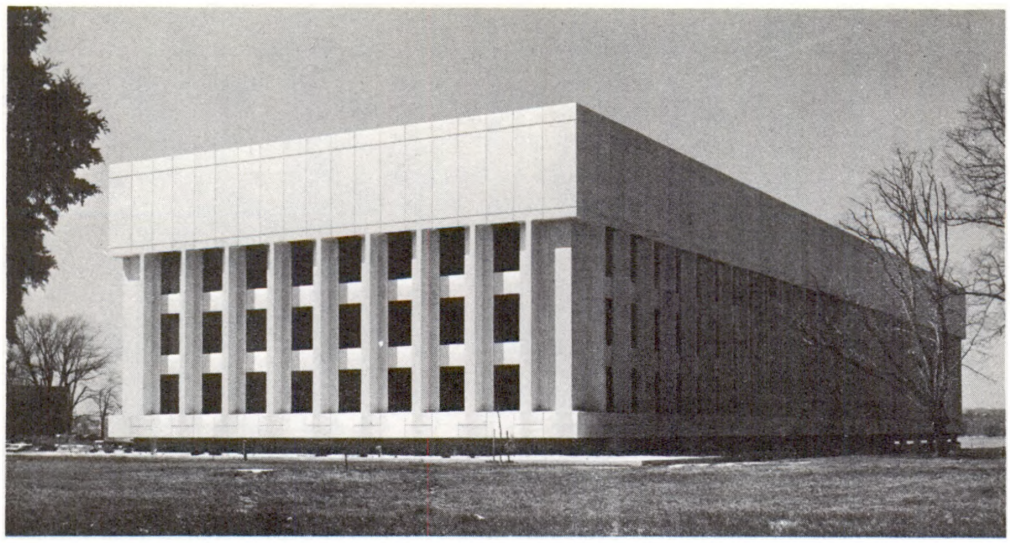
About 20 U.S. Geological Survey earth scientists will participate in various parts of the program, with scientists of the Oceanographic Office, to provide research support in such disciplines as marine geology, geophysics, geochemistry, paleontology, and hydrology. Land-based laboratories and other facilities will be involved in these support activities.

The project will facilitate the preparation of a tectonic map for the entire Gulf of Mexico to supplement data from the adjacent land areas as shown on the Tectonic Map of North America recently published by the USGS. It would show various features of the submerged lands of the Gulf such as folds, faults, and thicknesses of sediments. This map will help fill in a major unknown area in knowledge of the geologic structure of North America.

There will be a geochemical laboratory aboard the KANE with the capability to determine even trace amounts of minerals present in cores collected from the sea floor during the cross-Gulf cruises. Hundreds of analyses of sea floor sediments will provide for the first time a synoptic picture of the geochemistry of the entire Gulf.

Admiral Waters and Dr. Pecora said that "both the Navy and the Geological Survey wish to encourage participation from all scientific groups concerned with the geology of the Gulf of Mexico," and that "discussion will be held with interested parties in universities and industry to assist in the formulation of this comprehensive study."

Members of the scientific community interested in the investigations are encouraged to contact either the Naval Oceanographic Office, ASW/USW Surveys, Code 9310, Washington, D.C.; or the Office of Marine Geology and Hydrology, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California.



Space Science Division Laboratory Dedicated

The Naval Research Laboratory dedicated its new $5 million Space Science Division Laboratory Building on April 17, 1968.

Dr. Donald F. Hornig, Special Assistant to President Johnson for Science and Technology, delivered the main address at dedication ceremonies. Captain James C. Matheson, Director of NRL, introduced Dr. Hornig and other participants who included: Dr. Robert A. Frosch, Assistant Secretary of the Navy for Research and Development; RADM Thomas B. Owen, Chief of Naval Research; RADM W. M. Enger, Vice Commander of the Naval Facilities Engineering Command; Dr. Alan Berman, Director of Research at NRL; and Dr. Herbert Friedman, Superintendent of the Space Science Division and Chief Scientist of the E. O. Hulburt Center for Space Research.

A seminar on "Directions in Space Research at NRL" was held in conjunction with the dedication. Dr. T. A. Chubb, Mr. E. F. McClain, and Dr. R. Tousey led a series of discussions.

The new four-story facility houses offices and laboratories of the Space Science Division and the E. O. Hulburt Center for Space Research. It also includes a 160-seat auditorium which is separate from the main structure.

The 352 ft × 112 ft building of precast concrete has a welded steel frame with concrete encasement for fireproofing and a concrete floor. It was built under the auspices of the Chesapeake Division of the Naval Facilities Engineering Command.

NRL's Space Science Division conducts research, development, and testing in upper air physics, astronomy, and astrophysics. Satellites and rockets are used to obtain information on radiation from the sun and celestial sources, and to study the composition and behavior of the ionosphere. Radio telescopes are used for astronomical observations. Results are important for radio communications, for utilization of the space environment, and for a fundamental understanding of natural radiation phenomena.

The E. O. Hulburt Center for Space Research conducts a program which allows graduate and post-graduate students as well as visiting faculty members to cooperate with the Naval Research Laboratory in space research. The program involves the three branches—Upper Air Physics, Rocket Spectroscopy, and Radio Astronomy—which comprise the Space Science Division. (See *Naval Research Reviews* issue of May 1968, "E. O. Hulburt Center for Space Research: A NRL Experiment.")

Construction of the Space Science Division Laboratory Building is another step in the long-range development plan designed to continue modernization of the Navy's Corporate Laboratory.

Improved Resistance to Radiation Embrittlement Developed for Higher Strength Steel Weldment

Studies at the Naval Research Laboratory on radiation effects to structural metals have shown superior radiation resistance in selected high strength steels. One steel (ASTM A543, 100,000 psi yield strength) in plate form was shown to be markedly superior to current reactor pressure vessel steels under conditions simulating extreme exposure in a light water service environment. This observation stimulated the study of the companion weld metal to this steel plate material since application in large light water reactors requires welded structures. Gross embrittlement of the weld metal was observed, forestalling hopes for the exploitation of this steel in nuclear service.

Experimental efforts were initiated to demonstrate that adjustments of the alloy and impurity contents could result in a weld of superior radiation resistance. Applying data developed in studying the causes of irradiation embrittlement in lower strength steels, it was possible to directly specify an experimental weld electrode composition which demonstrated a radiation resistance that even surpassed that of the plate. This development, when extended to commercial practice, will open the way for the use of this higher strength steel in nuclear reactor pressure vessels, thereby offering the nuclear engineer the options of increasing the size, improving the efficiency, or reducing the weight of reactor containment vessels. Of equal importance, the demonstration of direct applications of research information to the solution of a practical problem indicates the maturing of irradiation effects studies to pay-off status.

Navigation Satellite to Synchronize Time Standards

The National Bureau of Standards, the Naval Observatory, and the Naval Research Laboratory will conduct tests using NRL's experimental navigation satellite, Timation, to synchronize time standards for the United States. Precise determination of time is essential for navigation.

Navy and NBS radio stations regularly transmit time signals governed by ultra precise time standards. All standards for the United States are synchronized through a procedure known as time transfer.

Currently, time is transferred *via* airplanes which fly amazingly accurate time pieces from the Naval Observatory to sites where other standards are located. This procedure is reliable but costly.

Timation has been proposed as a time transfer vehicle. Its high speed, high altitude, and lack of vibration make it ideal for this purpose.

The satellite emits signals at very precise, known intervals. A particular signal can be expected to reach the site of a standard at a precise moment. An inaccurate standard would indicate that the signal arrived before or after that moment.

A Naval Research Laboratory scientist cited the following example to illustrate the time transfer procedure using Timation: A particular signal is expected to reach the site of a standard at exactly noon. If the standard reads one second after noon when the signal arrives, that standard is known to be in error by a second.

In actual operation, present day standards have not deviated by more than a few thousandths of a second for several years. Timation's signals can be used to detect variations much smaller than this. The signals are spaced sufficiently to avoid confusion.

The experimental Timation satellite was built by NRL personnel and placed in orbit on May 31, 1967 to verify principles of a new satellite navigation technique with which a ship or airplane can instantaneously obtain a highly accurate fix of its position. The satellite weighs 85 lbs and is powered by solar cells. The Naval Air Systems Command sponsors the project.

NRL Develops Technique for Reducing Eye Hazard

A technique for reducing the eye hazard to unprotected personnel at target range, a limiting factor in the application of range-finding laser systems, has been devised at the Naval Research Laboratory.

P. W. Wyman of the Laboratory's Radar Division has suggested using a series of laser pulses with intensities gradually increasing from a level known to be too low for detection. In this manner the operator could arrive at the lowest intensity needed to find the range. Excessive intensity only increases eye hazard.

Current laser range-finding systems use a single pulse or multiple pulses of constant intensity. Often, the intensity of the pulse (or beam) exceeds the level needed to do the job, thereby creating an unnecessary hazard.

A limitation of the technique's effectiveness would be the distance from transmitter to target. For targets beyond certain ranges, for example, no eye safety guarantee exists, according to Wyman. He also emphasized that the technique is of maximum effectiveness when the personnel to be protected are at target range or beyond.

Wyman's suggestion was one of several conclusions he drew from an analysis of laser-radar eye hazards, part of a NRL laser-radar research effort. The work is sponsored by the Office of Naval Research.

Navy Tests Buoyant Body Armor

The Navy's experimental "buoyant flak jacket"—a combination life preserver and body armor—has received favorable reports from Vietnam after being tested by crews of river patrol boats.

The buoyant flak jacket is made of several layers of nylon fabric, polypropylene felt, and polyethylene plastic foam. The nylon and polypropylene provide protection against fragmentary ordnance such as grenades and mortars; air in the closed cells of the plastic foam keeps the man afloat. This buoyant body armor is expected to solve the problem of how to provide a single item which will not only protect a man from enemy fire but which will keep him afloat in water. Conventional body armor worn by field troops would act as an anchor to a man overboard. Conversely, an ordinary life preserver, even the glass-fiber-filled type, provides no real protection against exploding fragments.

A second type of buoyant body armor is also being developed. This type, which would provide protection against small arms fire, *i.e.*, projectiles up to 30 calibre, is made of hard, very heavy ceramic material enclosed in plastic foam. Although the ceramic-foam armor will weight about 30 pounds compared to nine pounds for the buoyant fragment-protection type, it will still keep a man afloat.

Buoyant body armor is the result of contract research sponsored by the Naval Supply Systems Command and carried out at Mellon Institute, Pittsburgh, Pennsylvania. Follow-on development work was completed by the Navy Clothing and Textile Research Unit, Natick, Massachusetts.

Symposia on Advanced Planning Briefing for Industry on "Naval Ordnance and Missiles" will be held at the Naval Amphibious Base, Coronado, California, September 18-19, 1968. Additional information on these symposia, which are cosponsored by the Naval Material Command and the American Ordnance Association, may be obtained from CDR A. D. Sullivan, USN (Ret.), American Ordnance Association, 17th & H. Streets, N.W., Washington, D.C. 20006.

On the Naval Research Reserve

Promotion Selections

There were 1127 Naval Reserve line officers selected for promotion to Lieutenant Commander by the Fiscal Year 1968 Reserve Selection Board. Fourteen were members of the Research Reserve Program.

	NRRC		*NRRC*
Backer, John M.	5-4	Rigone, John L.	4-4
Barton, Alexander J.	5-10	Taylor, Robert B.	3-4
Boosman, Jaap W.	5-9	Wall, Robert M.	9-15
Buell, Byron W.	3-4	Walsh, Edward A.	1-3
Gilmer, David S.	9-6	Wayland, Henry P., Jr.	6-3
Launer, Robert L.	5-2	Weir, William Boyd	12-3
Reddicks, Donald A.	6-1	Zuccoli, Franco	3-8

Seven of the officers selected were from the new field and seven from the old. Other statistics based on the records of the Research Reservists selected for promotion are:

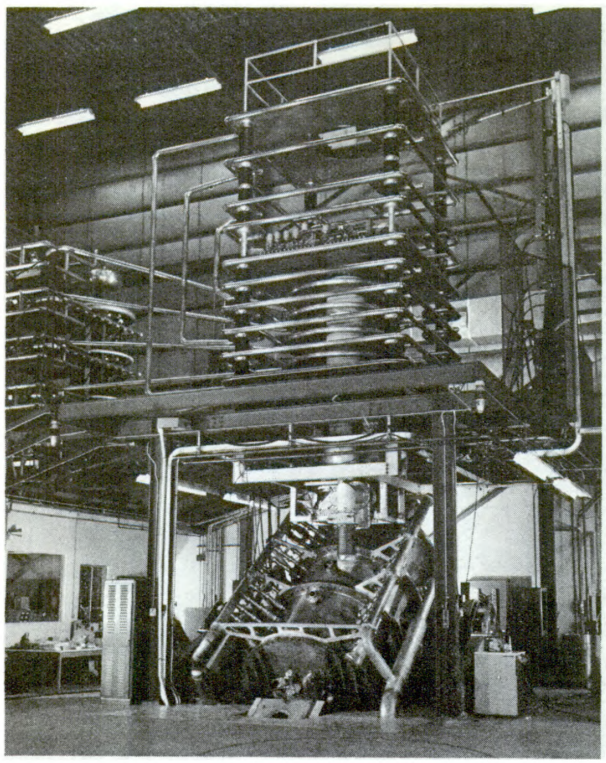
Year of Birth	*Date of Rank*	*Designator*
Earliest 1922	Earliest 7-2-54	1105:12
Latest 1937	Latest 1-1-64	1355: 1
		1535: 1

NRRC 12-2 Visits Controlled Thermonuclear Project

NRRC 12-2 of Livermore, California normally meets at the Lawrence Radiation Laboratory, one of the nation's two nuclear weapons development facilities. On February 3, 1968, however, the company jointly participated with NRRC 12-5 of the University of California, Berkeley on a field trip to the Aerojet-General Corporation at San Ramon, California. The only U.S. Government-sponsored controlled thermonuclear research (CTR) project being conducted in an industrial laboratory is located at this facility.

The photograph on page 34 shows the principal experiment of the project, which was toured by the company members. The naval reservists closely examined all components of the experiment and its 6-megawatt power supply system, including the 600-kilovolt, 1/4 ampere beam current molecular ion injection accelerator and the 80-ton cryogenically-cooled adiabatic magnetic mirror-cusp plasma containment machine. The facility, and the associated research, are funded by the U.S. Air Force.

The Commanding Officer of NRRC 12-5, CDR G. W. Hamilton, a Principal Physicist on the Aerojet CTR project, made the arrangements for the meeting and conducted the technical presentation.



The principal experiment being conducted at the project was toured by NRRC 12-2 members

After touring the facility, the research reservists viewed the most recent film report describing the concepts and objectives of this particular approach to the controlled nuclear fusion power problem. Dr. Hamilton then delivered a lecture, describing in detail the operation of the equipment and the physics of the experiment. The lecture was conducted in the laboratory so that the attendees could visually relate the technical details being discussed directly to the experimental apparatus.

In subsequent regular meetings, NRRC 12-2 heard lectures by Dr. T. K. Fowler and Dr. R. F. Post of the Lawrence Radiation Laboratory's controlled fusion research project. They presented the theoretical and experimental aspects of the work being done in this national laboratory, thus rounding out the picture of the U.S. CTR program.

CDR Bernard G. Olsen, of the Lawrence Radiation Laboratory, is the Commanding Officer of NRRC 12-2.

Local Industry Sparks Programs

NRRC 12-3, which has been meeting at Stanford University, California since October 1954, is located in the very heart of the San Francisco Bay Area electronics complex. Thus, it is able to keep abreast of many of the latest research activities through noted speakers from nearby schools and industry.

As a supplement to the Naval Reserve Research leadership training program, meetings have been held as field trips as well as on campus. At a recent meeting held at the Biological Sonar Laboratory of Stanford Research Institute, research on sea-lion acoustics, including related experiments with human hearing mechanisms, was discussed. Much research in this area has been done at Anna Neuve Island just off the San Francisco coast: hydrophone tape recordings are made to study animal communication and sonar sounds.

Also, NRRC 12-3 members visited the planitarium at Foothill College in Los Altos. Projection techniques for presenting a stellar display as would be seen from other planets in our solar system were displayed and discussed. Such techniques would be suitable for conditioning astronauts to sights they can expect to see during extra-terrestrial travels.

At a third meeting, a local ex-Naval Reservist, Dr. Hunter L. Little, M.D., discussed current applications of laser beams for the treatment of "leaks" in the human eye. A pulse of energy from a small hand-held laser instrument pinpoints light energy and causes coagulation of a defective blood vessel in a patient's eye.

Observations of Martian and Cytherean Atmospheres

At a recent meeting of NRRC 12-3, Stanford, California, Professor Von R. Eshleman, department of Electrical Engineering, Stanford University, discussed observations of Martian and Cytherean atmospheres by Mariner spacecraft.

The method of operation is to observe—by means of the doppler effect—the refraction of VHF radio signals as they pass through the planet's atmosphere. The refraction is directly related to atmospheric density: by a rather complicated analysis the variation of the density with height above the surface can be deduced.

Observations of both the neutral atmosphere and the ionospheres (ionized layers in the atmosphere) of Mars and Venus were carried out by the Mariner spacecraft. Several very interesting, although not entirely unexpected discoveries, were made. First, the fact that neither planet has a magnetic field means that the ionosphere is in direct contact with the solar wind or stream of ions and electrons flowing outward from the sun. Evidently the solar wind entrains the ions near the interface between the two regions and sweeps them away. The result is a rapid drop with increasing height of the electron and ion number densities in the vicinity of the boundary. This effect was observed on Venus by Mariner V.

A second very interesting effect occurs in the lower atmosphere of Venus. The density causes light rays to bend around the surface of the planet so that they cannot escape. In other words, the radius of curvature of the ray is equal to or smaller than the radius of the planet. In principle, an observer at the correct altitude could look off into the distance and see the back of his head.

More complete analysis of the data from Mariner V is now underway.

NRRC 12-4 Provides Science Fair Judges

Members of NRRC 12-4, Fresno, California, acted as judges in the 15th annual California Central Valleys Science Fair which was held April 15-20, 1968 in Fresno. The judges selected principal and alternate winners of the Navy Science Cruiser Award.

Research Company 12-4 has provided judges each year for the Science Cruiser Award since 1959. Prior to that time, several of the members had participated as individuals in the Science Fairs. The Company is proud of previous winners selected. Last year's winner, Elaine Yamaguchi, the first girl selected for the Navy Science Cruiser Award, went on to win top honors in the National Science Fair.

This year the principal winner is George L. Kerber, a senior at Fresno High School. He built and exhibited an operational helium-neon gas laser—the first operational laser entered in the Science Fair.

NRRC 12-4 members congratulate Science Fair winner

The project exhibit included the gas laser (without the associated power equipment); a diagram demonstrating how the laser operates; and photographs illustrating the high-energy power packs needed to operate the laser, the laser in operation in the laboratory, and the laser beam produced. Also included was a presentation demonstrating the feasibility of a very-high-volume multiple-information modulation system utilizing a laser beam.

George Kerber also received the Science Fair first prize, a Fresno State College scholarship, and awards from the Air Force and the Army Aviation Association. His exhibit was shown in the National Science Fair in May in Detroit.

This year's alternate winner was Richard Lee, who presented a project on "biological prospecting." He obtained soil samples from a number of locations and prepared cultures to determine the antibiotic producing capabilities of the soils.

STYX Expedition Begins

The third extended expedition during 1968 by ships of Scripps Institution of Oceanography, University of California, San Diego, began April 2, when the 180-foot, 825-ton Alexander AGASSIZ sailed from San Diego on the STYX Expedition to the Central Pacific for investigations scheduled in the Hawaiian, Samoa, and Society Islands.

Dr. William A. Nierenberg, director of Scripps, said the research will cover several phases of deep-sea oceanography, including mainly studies of water characteristics, topography, and sediments in the Central Pacific; the past and present animal life on Mid-Pacific seamounts and guyots; and the circulation around oceanic islands. The expedition is being funded by the National Science Foundation, the Office of Naval Research, the Atomic Energy Commission, and the State of California.

The AGASSIZ cruise is designated STYX, which in Greek mythology is the deep, dark river surrounding Hades that was crossed by those entering the world of the dead. The oceanographic connotation refers, however, to a submarine river of water flowing two and a half miles deep from the South to the North Pacific, between the Samoa Islands and the Tuamoto Islands.

According to Scripps oceanographers, the general distribution of properties in the Pacific has long been taken to indicate a northward flow of ocean bottom water from the South to the North Pacific. In a limited area between the two eastward-westward ridge systems that separate the North Pacific from the South Pacific, this bottom river is constricted and may accelerate as it cascades across a ridge.

Scripps scientists will measure the near-bottom velocity, temperature, salinity, and oxygen in the constricted area to learn the relative strength of the tidal flow and the mean flow, and to relate the information to the deep transport of water and sediments. Also, two greatly separated bottom areas will be investigated to determine the nature of scouring processes that leave hardened and unexpectedly old surfaces on the sea floor.

The area under investigation is some 100 miles wide, 500 miles long, and 16,000 feet deep. It consists of a hardened, pitted, bottom surface swept free of sediments and stained black by manganese and iron oxide. To the north and south of this area, sediments are soft and clay-like, consisting partly of ash from volcanic islands of Hawaii. Measurements to be taken will help determine whether submarine currents are keeping the area free of sediments.

Selected Contract Research Reports

The contract research reports listed below have been extracted from U.S. Government Research & Development Reports 68, No. 6 of March 25, 1968 and No. 7 of April 10, 1968. Government agencies and their contractors who are registered with the Defense Documentation Center of the Defense Supply Agency may obtain *free* copies from the Center at Cameron Station, Alexandria, Virginia 22314. Abstracts of the reports are found in USGRDR 68, Nos. 6 and 7.

AERONAUTICS

Comparative Flight Evaluation of Longitudinal Handling Qualities in Carrier Approach; Princeton; Eney; AD-487 660

Bibliography of the Air Cushion Vehicle Technology, With a Guide for Design and Analytic Engineers; Kansas U.; Bratanow; AD-664 505

Subjective Reaction to Dual Frequency Vibration; Boeing Co.; Brumaghim; AD-664 510

Study of Rotor Configurations for Minimum Power and Rotor-Wake Pressure Distributions; Cornell; Tung and Brady; AD-664 689

Display Requirements Study for Helicopter IFR Formation Flight; Honeywell, Inc.; Nicholson *et al;* AD-665 277

ASTRONOMY AND ASTROPHYSICS

A Mechanism for Quaser Continuum Radiation, With Application to 3C 273B; Stanford; Sturrock and Feldman; AD-664 692

New Measurements of the Cosmic Microwave Background at Lambda = 3.2 CM and Lambda = 1.52 CM – Evidence in Support of a Blackbody Spectrum; Princeton; Stokes *et al;* AD-664 843

Solar Oblateness and Fluid Spindown; Princeton; McDonald and Dicke; AD-664 864

Radioisotope and Radiation Techniques for Terrestrial and Planetary Gas and Solid Measurements; Parametrics, Inc.; Ziegler and Sellers; AD-665 225

On the Origin of the Solar System; Calif. U.; Alfven; AD-664 238

An Unsuccessful Search for Circular Polarization in Radio Sources at 10.6-cm Wavelength. Upper Limits to the Degree of Circular Polarization of the Integrated 1418-MHz Radiation From Radio Galaxies; CalTech; Seielstad and Weiler; AD-664 243

ATMOSPHERIC SCIENCES

The Scale of Non-Adiabatic Heating as a Factor in Cyclogenesis; Kelsey-Hayes Co.; Doos; AD-664 532

Launch Facility Study; Winzen Research, Inc.; Hoover; AD-664 833

Aerial Surveys of Hudson Bay Surface Temperature-1967; Wisconsin U.; Wendland and Bryson; AD-664 817

Tentative Climatic Patterns for Some Late Glacial and Post-Glacial Episodes in Central North America; Wisconsin U.; Bryson and Wendland; AD-664 835

A Study of the Onset of Whitecapping With Increased Surface Wind Speeds. A Report on a Continuing Drift-Bottle Study of the Surface Currents of Lake Superior. A Laboratory Study of Simulated Whitecaps; Northern Mich. U.; Monahan and Zietlow; AD-664 960

BEHAVIORAL AND SOCIAL SCIENCES

Note on an Application of LP II, a Goal Programming Model for Media Planning; Carnegie-Mellon U.; Charnes et al; AD-665 008

Cost and Production Functions; Princeton; Shephard; AD-665 160

An Analysis of Contractual Incentives; Calif. U.; Berhold; AD-665 276

Communication, Cooperation, and Negotiation in Culturally Heterogeneous Groups; Ill. U.; Fiedler and Triandis; AD-664 681

Effects of Prior Agreement From Others on Task Confidence and Conformity; St. U. of N.Y.; Julian *et al;* AD-664 819

Behavior in Groups; Pittsburgh U.; Bass; AD-664 302

A Goal Programming Model for Manpower Planning; Carnegie-Mellon U.; Charnes *et al;* AD-664 501

Decentralization, Resource Allocation, and Demand Theory; Minn. U.; Hurwicz; AD-664 260

The Thought of Mao Tse-Tung: Communications Analysis of a Propaganda Movement; Mental Research Inst.; Weakland; AD-664 484

Human Reliability Research; Operations Research, Inc.; Beek *et al;* AD-664 495

Orienting Reflex Related to Impulsiveness and Anxiety; Texas U.; Barratt; AD-664 101

The Relationship of Anxiety and Impulsiveness Factors Among High School Males; Texas U.; Barratt and Fruchter; AD-664 102

Bases and Consequences of Systems of Communication; Duke U.; Back; AD-664 256

Reinforcement in Human Learning; Stanford U.; Estes; AD-664 458

Development of Performance Evaluative Measures. Personnel Psychophysics: The Relationship Between Structure of Intellect Scale Values and Job Complexity; Applied Psychological Services; Pfeiffer and Siegel; AD-664 476

The Effect of Time Pressure, Time Elapsed, and the Opponent's Concession Rate on Behavior in Negotiation; St. U. of N.Y.; Pruitt and Drews; AD-664 492

Generalized Scale-Free Matrix Approximation With Variable Loss Function; Wash. U.; Horst; AD-664 506

Situational and Interaction Factors in a Process Model of Conformity; St. U. of N.Y.; Haaland; AD-664 515

BIOLOGICAL AND MEDICAL SCIENCES

Mossbauer Studies of the Iron Atom in Cytochrome c; Ill. U.; Cooke and Debrunner; AD-664 519

Studies on Succinate Dehydrogenase, 14, Intracellular Distribution, Catalytic Properties and Regulation of Fumarate Reductases in Yeast; Calif. U.; Hauber and Singer; AD-664 639

Learning to Recognize Patterns Without a Teacher; Stanford; Fralick; AD-464 022

Hemolytic Plaque Formation by Mouse Spleen Cells Producing Antibodies Against Rabbit Immunoglobulin G1; Ill. U.; Segre and Segre; AD-664 231

Studies With Hydroxyuera. Effects of Hydroxyurea on the Metabolism of Sensitive and Resistant Strains of Escherichia Coli; Columbia U.; Rosenkranz *et al;* AD-664 417

Role of the Reticuloendothelial System Interferon Tolerance; Istituto Nazionale Di Ottica (Italy); Considine and Starr; AD-664 611

Uncoating and Development of Vaccinia Virus in Miniature Cells Induced With an Extract From Marine Algae; Notre Dame U.; Starr and Hotermann; AD-664 614

Accumulation pH (131I) Triiodothyronine in Neurons and Other Tissues Following Intravenous Injection of the Labeled Hormone; State U. of N.Y.; Ford and Rhines; AD-664 232

Protection of Shipboard Personnel Against the Effects of Severe Short-Lived Upward Forces Resulting From Underwater Explosions; Civil Aeromedical Inst.; Swearingen *et al;* AD-664 468

Enzyme Studies Using the Mossbauer Effect; Ill. U.; Cooke; AD-664 665

The Accumulation of Amino Acids by Plasmodium Lophurae (Avian Malaria); Calif. U.; Sherman *et al;* AD-664 745

Adenosine 3',5'-Cyclic Phosphate: Stimulation of Steroidogenesis in Sonically Disrupted Adrenal Mitochondria; Calif. U.; Roberts *et al;* AD-664 844

Malaria Infection (Plasmodium Lophurae): Change in Free Amino Acids; Calif. U.; Sherman and Mudd; AD-665 247

Carbon Dioxide Fixation in Malaria. Kinetic Studies in Plasmodium Lophurae; Calif. U.; Ting and Sherman; AD-665 248

Pharmacological and Chemical Investigations of Certain Venomous Marine Animals; U. of S. Calif.; Saunders; AD-664 674

Mangrove Ecology and Deltaic Geomorphology: Tabasco, Mexico; La. St. U.; Thom; AD-664 836

On the Numerical Classification of Nominal Data; Carnegie-Mellon U.; Majone and Sanday; AD-665 006

Circadian Systems. The Driving Oscillation and its Assay in Drosophila Pseudoobscura; Princeton; Pittendrigh; AD-665 164

Biosynthesis of Biotin in Microorganisms. Further Evidence for Desthiobiotin as a Precursor in Escherichia Coli; Cincinnati U.; Pai and Lichstein; AD-664 809

Dependence of the Magnitude of the Stiles-Crawford Effect on Retinal Location; Calif. U.; Westheimer; AD-665 216

H3 Accumulation in Spinal Cord Neurons Following Intravenous Injection of Adenine-H3 as Determined by Liquid Scintillation Counting Procedures on Dissected Neurons; St. U. of N.Y.; Ford and Rhines; AD-664 972

CHEMISTRY

The Heat of Formation of the Compound AuSb2 and the Partial Enthalpies and Enthalpy Interaction Coefficients of Antimony and Gold in Liquid Tin; M.I.T.; Jena and Bever; AD-664 489

Adsorption at the Ruttle-Solution Interface: Thermodynamic and Experimental Study; M.I.T.; Berube and de Bruyn; AD-664 507

Decomposition of Chemically Activated Trichlororethyl Radicals; Washington U.; Tardy and Rabinovitch; AD-665 231

Reactions of Triplet Methylene Radicals With Alkanes; Wash. U.; Rabinovitch; AD-665 232

The Admittance of the Ideal Reversible Electrode With Adsorption of Reactants (Analysis of Theoretical Aspects); N.Y. U.; Delahay; AD-664 980

Zeeman Scanning of Absorption Line Profiles in Flames; Calif. U.; Hollander and Broida; AD-664 982

Vibration-Internal Rotation Interactions in Molecules Containing a Symmetric Top Group; M.I.T.; Swan, Jr. and Strandberg; AD-665 218

Magnetic Resonance in Radiating or Absorbing Atoms; M.I.T.; Bitter; AD-665 223

EARTH SCIENCES AND OCEANOGRAPHY

The Temperature at the Ocean-Air Interface; Woods Hole; Saunders; AD-664 105

An Investigation of the Deformation and Breaking of Solitary Waves; Stanford; Camfield and Street; AD-664 249

Geography and the Properties of Surfaces. The Continent Problem—Geography and Spatial Variance; Harvard; Warntz; AD-664 511

R/V CHAIN Cruise No. 61, North Atlantic Ocean, Mediterranean and Red Seas, Summary Cruise Report Prepared by Chief Scientists. Track Charts, Bathymetry, and Location of Observations, July 11, 1966 - December 17, 1966; Woods Hole; Sohlberg and Allstrom; AD-664 214

Measurement of the Cosmic Microwave Background at 8.56-MM Wavelength; Princeton; Wilkinson; AD-664 863

On the Weak Reflection of Periodic Water Waves Over Bottom Obstacles; M.I.T.; Mei; AD-664 683

The Gulf Stream; Woods Hole; Warren; AD-665 045

Notes on Translatory Movement of Rings of Current With Application to Gulf Stream Eddies; Woods Hole; Warren; AD-665 046

A Scheme for Sampling Deep-Sea Currents From Moored Buoys; Woods Hole; Webster; AD-665 048

Measurements of Subsurface Currents Off the Oregon Coast Made by Tracking of Parachute Drogues; Oregon St. U.; Wyatt *et al;* AD-665 296

Geography and the Properties of Surfaces Distances and Land Values as Data for Introducing Problems Associated With Spatially Continuous Fields of Correlation Coefficients; Harvard; Warntz; AD-664 948

Geography and the Properties of Surfaces. Space Straightening and Flattening; Harvard; Lindgren; AD-664 949

Radiocarbon Isochrones of the Retreat of the Laurentide Ice Sheet; Wisconsin U.; Bryson and Wendland; AD-664 816

Suspended Load in the Colville River, Alaska, 1962; La. St. U.; Arnborg *et al;* AD-664 840

Index Charts to Cruises Conducted by Members of the Geophysics Department; Woods Hole; Hays; AD-486 848

Oceanography Using Remote Sensors; Texas A and M U.; Capurro; AD-664 660

Synoptic Measurements of Geomagnetic Field Spectra; Lamont; Heirtzler and Davidson; AD-665 037

ELECTRONICS AND ELECTRICAL ENGINEERING

Excess Noise in Semiconductors; IIT Research Inst.; Brophy; AD-664 513

Two-Conversational Languages for Control-Theoretical Computations in the Time-Sharing Mode; Harvard; Newbold and Agrawala; AD-664 221

Evaluation of Three Content-Addressable Memory Systems Using Glass Delay Lines; Oregon St. U.; Rux; AD-660 792

A Slide Scanner Input for Paramatrix; Ill. U.; Ryan; AD-664 669

A Low-Cost Graphic Display for a Computer Time-Sharing Console; M.I.T.; Stotz and Cheek; AD-664 673

A Cellular Threshold Array; Stanford; Kautz; AD-664 865

Canonical Forms for Information Lossless Finite-State Logical Machines; M.I.T.; Huffman; AD-665 219

Anhysteretic Magnetization and Flux Reversal in Tape Cores, and An Analog Core Memory; Purdue U.; Friedlaender and McMillen; AD-664 233

A Nonparametric Approach to Pattern Recognition. The Locally Disjoint Case; Information Research Associates, Inc.; Owen *et al;* AD-664 218

A Projection Method for Signal Detection in Colored Gaussian Noise; Stanford; Kailath; AD-664 245

Low Pass Filter Design; Stanford; Akaike; AD-664 130

ENERGY CONVERSION (NON-PROPULSIVE)

An Experimental and Theoretical Study of the Non-Equilibrium Plasma in Thermionic Discharges; Sperry Rand; Curry *et al;* AD-664 494

MATERIALS

Exploration and Evaluation of New Glasses in Fiber Form; Solar; Schmitz; AD-464 261

Modes of Failure of Glass Fiber Reinforced Plastics Under Compressive Loads; Ill. U.; Gillman and Corten; AD-664 688

Superplasticity in Lead-Tin Alloys (The Fracture of Ductile Metals); M.I.T.; Backofen and Zehr; AD-664 823

Twinning and the Low Temperature Mechanical Properties of Polycrystalline Columbium Molybdenum and CbMo Alloys; Westinghouse; Shaw; AD-664 830

Dynamic Measurement of the Hardness of Plastics; Harvard; Walking; AD-664 658

Infrared Dichroism of Oriented Dehydrochlorinated Polyvinyl Chloride; Mass. U.; Stein *et al;* AD-664 953

Dynamic X-Ray Diffraction From Polyethylene; Mass. U.; Kawaguchi *et al;* AD-664 955

Polarized Infrared Studies of Amorphous Orientation in Polyethylene and Some Ethylene Copolymers; Mass. U.; Read and Stein; AD-664 962

Optical Characterization of the Orientation of Amorphous Polymers and Amorphous Parts of Crystalline Polymers; Mass. U.; Stein and Read; AD-664 963

Elastomeric and Mechanical Properties of Poly-m-Carbornylensiloxanes; Princeton; Sperling *et al;* AD-474 092

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An Arithmetic Property of Certain Rational Powers; N.Y. U.; Forman and Shapiro; AD-664 731

The Theorem of Coles on Uniform Distribution; N.Y. U.; Ungar; AD-664 732

A Newton-Raphson Method for the Solution of Systems of Equations; Northwestern U.; Ben-Israel; AD-664 743

Matrices of Zeros and Ones All of Whose Pairs of Rows are Isomorphic; Calif. U.; Hurwitz; AD-664 818

Matrix Inversion Using Parallel Processing; Stanford; Pease; AD-664 866

On Convexity Preserving Families of Probability Distributions; Calif. U.; van Zwet; AD-664 951

On Iterative Methods for Solving Nonlinear Least Squares Problems Over Convex Sets; Northwestern U.; Ben-Israel; AD-664 974

An Application of Newton's Method to the Euler-Lagrange Equation; Calif. U.; Tapia; AD-665 005

Minimax Linear Predictor Under Lipschitz' Type Conditions for the Regression Function; N.Y. U.; Takeuchi; AD-665 279

A Generalization of Bayesian Inference; Harvard; Dempster; AD-664 659

Some Ladder Processes in Continuous Time With Applications to Queues; Cornell; Worthington; AD-664 678

Selection Procedures for Restricted Families of Probability Distributions; Calif. U.; Barlow and Gupta; AD-664 950

Error Bounds for Quasi-Harmonic Oscillations: Resonant Case; Harvard; McLaughlin; AD-664 222

Selection Procedures for Restricted Families of Probability Distributions; Purdue; Barlow and Gupta; AD-664 474

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A New Technique for Producing Ultra-High Purity Silver

Scientists in the Metallurgy Division of the Naval Research Laboratory have succeeded in developing a procedure for producing ultra-high-electrical-purity single-crystal silver. The measure of the obtained purity, the ratio of the electrical resistance at room temperature (where phonon and impurity scattering takes place) to that at liquid helium temperature (where impurity scattering of electrons predominates), is 1×10^4 which is a factor of five times higher than any previously reported result.

The technique employed consists of induction melting moderately high-purity silver shot in a graphite crucible under a flowing, purified argon atmosphere. Void-free single-crystal rods are obtained from the melt by unidirectional solidification. These are then sealed in quartz under high vacuum and annealed at 900°C for approximately 150 hours. At this step in the treatment the strain-free crystals may have a ratio of electrical resistivity at room temperature to that at helium temperature of only 140. The critical stage of the newly developed technique is to anneal these crystals at 900°C for approximately one week under a dynamic vacuum into which a small controlled partial pressure of oxygen is leaked. The oxygen pressures used are 4.0×10^{-5} to 2.0×10^{-4} torr, and the oxygen annealing times are related to sample thickness.

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From Attack Console, operator can practice tracking enemy sub and selecting and firing either ASROC missile or over-the-side torpedoes or sending out a torpedo-carrying DASH-helicopter for the kill. *See page 26.*

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