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NAVAL RESEARCH REVIEWS

NOVEMBER 1963

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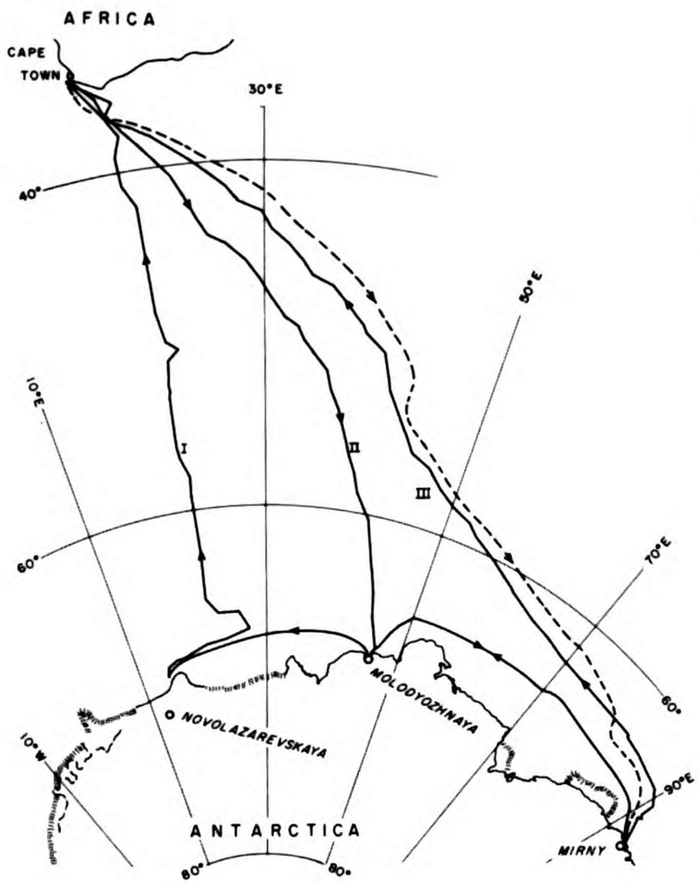
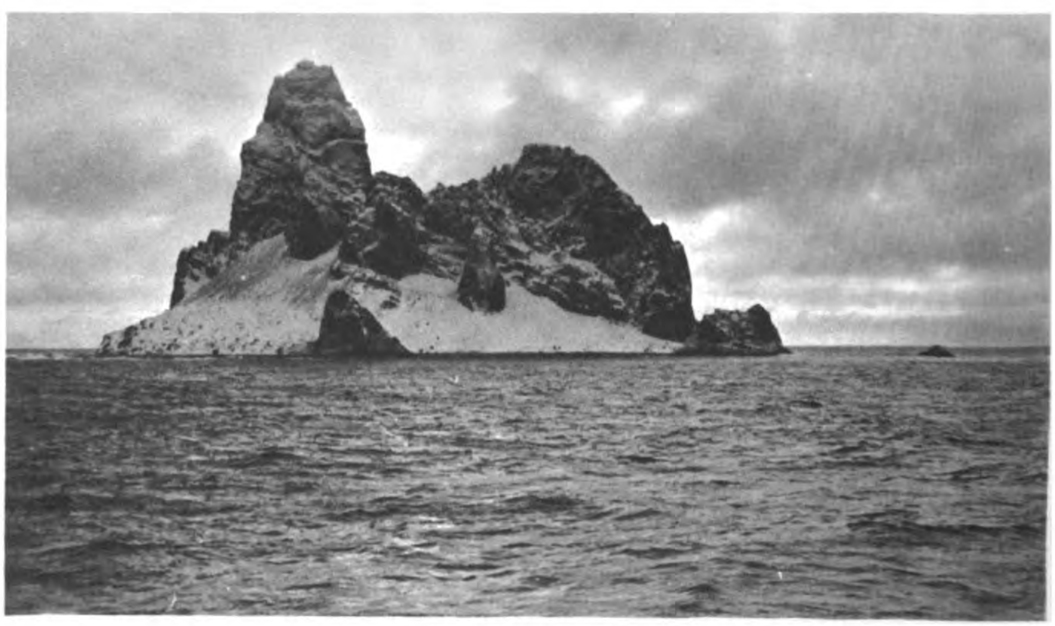
VOL. XVI NO. 11



Dr. Sherwin

Exchange in the Antarctic

On pages 5 through 15 of this issue are presented accounts of an exchange of oceanographers between the U.S. and Russia that took place recently in the antarctic. Shown above is the track of the Russian research ship OB during the exchange period (dashed portion is track of ship before U.S. oceanographer boarded her). Below is an antarctic island visited by the USNS ELTANIN while a Russian oceanographer was a member of her scientific party.



A Challenge to the Scientific Community*

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The Management of Science and Technology in the Public Interest

While sorting over some old records recently, I ran across an album of songs written by Art Roberts (a physicist who, incidentally, did much of the early work on microwave beacons at the Radiation Laboratory at MIT). These songs gave me a wonderful nostalgic twinge. One of them, "Take Away Your Billion Dollars," is particularly revealing. It was written in 1946, before the Atomic Energy Commission was formed, and when what was to become Brookhaven National Laboratory was been planned. In the first part of this song the physicists at their Washington meeting are told of a plan to build a 10 billion volt accelerator "on an ancient Army base," which was to cost one billion dollars. Everyone cheers, except for one man who remains aloof, then rises and thunders forth.

"With love and string and sealing wax was physics kept alive,
Let not the wealth of Midas hide the goal for which we strive.
Take away your billion dollars, take away your tainted gold,
You can keep your damn ten billion volts, my soul will not be sold."

This was only 17 years ago, and yet how quaint sentiment like this sounds to our ears today. Just image any physicist turning down a billion dollars for a super accelerator in 1963. This song, however, dramatically characterizes the ending of an era when science (and much of technology) was a small private matter of individuals or small groups of individuals. It highlights a fundamental change which has come to our modern society within our own generation: Science (and its companion, technology) are no longer small-scale private matters, but have become an integral part of public policy. This is the scientific revolution so eloquently described by C. P. Snow. Its beginning, says Snow (in his December 19, 1961, article in LOOK MAGAZINE) came with "electronics, new-style electrical engineering, and modern industrial chemistry, somewhere about 1920."

Even so, in the late '30's the activities of science and technology only concerned a small fraction of a percent of the G.N.P. Today, however, two decades later, the Federal R&D alone consumes nearly 15 billion, or about 3 percent of the G.N.P. This is a bigger sum than the total Federal budget before Pearl Harbor, and it represents a management problem of at least as great complexity. When I was a graduate student in the late '30's, Ph.D. stood half-jokingly for "Post Hole Digger," illustrating the very low demand for scientists and engineers at that time.

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*Presented at the National Convention on Military Electronics on September 9, 1963, in Washington, D. C.

As Kenneth Boulding says in the BULLETIN OF ATOMIC SCIENCE, October. 1963, "We are living in the second great change in the state of man." (The first was the dual invention of agriculture and methods of exploitation which made it possible to support cities on the excess agricultural production.)

Within one generation, modern science and the complex, sophisticated technology which both springs from it and supports it, have suddenly become the primary basis of national wealth and military power and also a primary tool of social and economic revolution. The need to wisely develop and control this tool has produced a crisis in its management – particularly with respect to the public interest. The Federal Government, in particular, is every year finding itself more deeply involved in trying either to promote or regulate the consequences of science and technology. Indeed, the tentacles of Federal power have grown most vigorously along the lines of technology. After providing for the regulation of steam-boiler safety in the 1820's, and stimulating agricultural R&D through the Morril Act of 1862, the Federal Government moved on to the control of railroads, of telephone and telegraph, of radio and TV, of aircraft design and operations (and soon, it appears, even the development of commercial-type aircraft), of food and drugs (where the complexity of regulation is matched only by the subtlety and complexity of modern biochemistry), of atomic energy, of activities in space... The list is long. In addition, military R&D—and Arms Control—are dominated by technical considerations of the most advanced type, and gigantic new Federal institutions conduct and support research—the N.I.H., the National Science Foundation. The Department of Agriculture is with one hand continuing to feed the technological cornucopia started by the Morril Act and with the other trying to repair the ravages of excessive productivity.

Indeed, one may ask: Are there any parts of the Federal Government which are not concerned primarily with either the advance, the exploitation, or the regulation of the consequences of science and technology? In terms of size, there really isn't much. The State Department, the Judiciary, the Treasury Department, and the Post Office still operate much as they did a century ago.

The preoccupation of the Federal government in both promoting and regulating science and technology is not a sinister socialist plot to take over the country, but rather springs from simple necessity. For example, a great part of atomic energy, military weapons systems, space systems, and even transport aircraft development are just too dangerous, too big, or too expensive to be exploited by either individuals or corporations. In other areas, such as pharmacology, private advantage and public interest do not coincide closely enough. Thalidomide is a case in point.

There is then no alternative if we wish to keep the practical fruits and the intellectual adventure of the scientific revolution: We simply must solve the problem of the wise administration of science and technology in the public interest—and this, in practice, means in the Federal Government.

Now, except for a few penetrating observers, such as C. P. Snow, the scientific revolution and its new demands on public administration have sort of "sneaked up" on everybody. The business men (and the business schools) are not ready for it. The generals are not ready for it. The public is not ready for it. The Congressmen are not ready for it. But, most important of all, the scientists and engineers are not ready for it either, and that is the main point of my discussion. We, as a professional group, have been suddenly exposed to a role for which we are not prepared. We are prepared to practice science and engineering as the private attorney practices law, seeking only a successful end to a given technical task. But, what we *are not* prepared to do is devote our specialized technical knowledge in a professional way to the solutions of the many complex problems of public concern where scientific knowledge and experience are critical. We do not, for example, as yet have either a tradition or an established career pattern corresponding to that of the judges, who start their careers with specialized training, then obtain extensive experience, and later turn their energies to representing the public interest. Indeed, the lawyers have three career patterns, all honorable: attorney, judge, and law-maker. This is a natural consequence of a highly technical discipline whose wise public administration has been essential to civilized society for many centuries. I perhaps betray my parochialism when I suggest that in this regard science and technology as applied to many government problems are becoming as important and as intimately concerned with substantive technical content as is law.

What is needed for this new career pattern to develop?

First, the scientists and engineers must realize—as the protagonist of our song did not—that the old simple world where one practiced science quietly in the corner is gone forever. The scientific profession (by which I mean both scientists and engineers) must add to its traditional career pattern of pure technical professionalism, broad social, financial, and political understanding, and also management skills. In particular, the scientific profession must show its willingness, maturity, and ability to pick up its public responsibility wherever this is appropriate. It must get over its bad case of "advisoritis," whereby many members feel that their duty ends when they have given some advice to a Congressman or to a "general-purpose" government manager.

Incidentally, I define a "general-purpose" manager as one whose motto is: "You name it, I'll manage it." This type of person always has been and always will be essential to many parts of business and government. He is not, however, a suitable person either to operate the law courts or to direct modern technological enterprises (although he did quite well at managing the relatively simple technical operations of the industrial revolution, particularly operations based on mechanical devices).

Unfortunately, the slow pace and the relative simplicity of the industrial revolution have seriously misled the "general-purpose" managers—both in business and government—with respect to their ability to manage modern R&D operations. For example, a lawyer or a businessman can master in a few weeks the essential technical aspects of the operation of a railroad or a bus line. But, just let him try to rationally guide the development of an inertial guidance system, a laser communications system, or a radical new computer. The kind of technical knowledge needed in these cases along with the subtle skills of management which bring out the creative efforts of scientists and engineers simply cannot be "picked up" after hours or as part of a job. They can only be obtained one way: by a systematic, thorough technical education plus extensive professional experience in doing research and engineering. Unfortunately, the "lingo" of science is easy to pick up, and as any experienced technical person well knows, there is nothing so depressing as to listen to a "general-purpose" manager using all the right words, but without real comprehension.

Returning to the legal profession again, we note that judges are made neither from amateurs at law nor even from those merely educated in law. As a group, they are formed from successful *practitioners* of law.

Thus, the first requirement which must be met for the new career pattern to develop is that the scientific community itself must face up to the reality and the importance of its new public responsibilities.

Second, the scientific community must deliberately set about to build respected career patterns in public service. It must invent a system of nonmaterial rewards corresponding to those which make a judicial career desirable. Objectivity, impartiality, and broad technical competence must be recognized as desirable, in addition to the traditional factors of individual creativity in the practice of science, pure or applied.

The universities can help in this process of career preparation. They can insist, for example, on more social sciences and humanities, as well as more basic science and mathematics. Both categories of studies are needed, particularly for engineering students, to provide the breadth which new careers will demand. However, in the last analysis, this new function cannot excplicitly be taught in school, any more than one can take formal courses in law school on how to be a judge. It will be taught, rather, by tradition and by example.

Third, methods must be found to maintain technical competence in management functions.

The judges, incidentally, automatically maintain their technical competence by continuous and spirited technical legal discussions with the practicing lawyers. They retire to their chambers and look up cases, and come back and challenge the lawyers. In short, in their judgeship function they do not escape from or ignore the details of law.

Now, I well realize that the Office of the Director of Defense Research and Engineering has been criticized for an excessive concern for the minute technical details of weapons systems. But, just as in judicial cases, it is often the technical details upon which the whole matter hinges. Indeed, one can define the proper arena of the new-style scientific manager as that in which the technical details *are* critical. Thus, for example, the potential value of an ABM system hinges upon the details of aerodynamics and plasma physics. Similarly, the potential value of a laser weapon system hinges upon the details of atomic states, the optical-thermal properties of materials, the transmission characteristics of the atmosphere, etc.

Where technical details are the dominating factors, one simply cannot divorce authority and knowledge.

I believe that the scientific community has not realized the magnitude of the problem of keeping the managers "technically alive." Should government-supported research contracts, for example, be managed with the part-time services of research people or with the full-time services of specialists? We all know the hazards—the active research people are tempted to be biased, ride hobbies, and even to steal ideas. The full-time specialists, on the other hand, tend to lose the quality of their scientific judgment—at the rate of about 3 db per year.

Is job rotation or mid-career education adequate? Can some new form of professional recognition—other than technical-paper publishing—give adequate

— *Continued on page 32*

The Russian research ship OB.

EXCHANGE IN THE ANTARCTIC

Trigger on piston corer is set prior to lowering of corer from side of USNS ELTANIN.

In accordance with a treaty ratified in 1961 by the United States, Russia, and 10 other nations, the antarctic is being used for peaceful purposes only.

Among the provisions of the Antarctic Treaty is an article which specifies that ". . . to the greatest extent feasible and practicable . . . scientific personnel shall be exchanged between expeditions and stations." A number of such exchanges have been made since 1956, primarily during the IGY, but most of them have been at antarctic land bases. Not until last winter did a Russian and a U.S. oceanographer board a ship flying the flag of the other's country for cruises in antarctic waters.

The Russian, Dr. Nikolai Kudryavtsev of the Arctic and Antarctic Scientific Research Institute, Leningrad, took a berth aboard the USNS ELTANIN, and the American, Dr. Guy Franceschini, a contractor for the Office of Naval Research at Texas A&M University, joined the scientific party aboard the Russian research ship OB. Dr. Franceschini made the voyage on the OB under a National Science Foundation grant. Both men remained aboard these ships for more than 4 months during scientific cruises in the antarctic.

Accounts of the two voyages, as told by the exchange oceanographers, appear on the following pages. As Dr. Alan T. Waterman, Director of the National Science Foundation, has said, such exchanges are "working proof of the effectiveness of international cooperation in furthering the science of all nations."

The U.S. Antarctic Research Program is administered by the National Science Foundation (Office of Antarctic Programs). Operations in support of many of the scientific programs are planned and carried out by the U.S. Navy (Commander, U.S. Naval Support Force--Task Force 43).

My Visit on the ELTANIN

N. F. Kudryavtsev
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Leningrad, U.S.S.R.

In accordance with the treaty on the Antarctic, in which a provision was made for the exchange of scientific personnel on antarctic expeditions, I was assigned by the Arctic and Antarctic Scientific-Research Institute in Leningrad as a representative to the scientific antarctic expedition of the USNS ELTANIN.* I arrived on board the ELTANIN on January 29, 1963, at Punta Arenas, Chile, and participated in the work conducted on voyages 7 and 8.

First of all, a few words about myself. After World War II (1941-1945), in which I took part (I was born in 1925), I completed the Higher Arctic Marine School in Leningrad, and obtained a position with the Arctic and Antarctic Scientific-Research Institute there. Prior to my arrival on the ELTANIN, I participated in the work of six arctic expeditions, so that the expedition of the ELTANIN was the seventh in my life, but the first one in the antarctic waters.

The basic problem of my research on board the ELTANIN was to study the conditions under which layered variations of the water density are formed in connection with the vertical structure of the field of drifting current velocities in the ocean. In addition to this, I had to familiarize myself with the organization and methods of various types of research conducted by scientific expeditions of the U.S.A.

Investigations of the problem of interest to me necessitated setting up simultaneous instrument measurements of the elements of waves, currents, and

*The USNS ELTANIN is the U.S. Antarctic Research Program vessel operated by the Military Sea Transportation Service for the National Science Foundation. See insert.

Voyage to the Weddell Sea

The Russian oceanographer Nikolai Kudryavtsev boarded the USNS ELTANIN at Punta Arenas, Chile, late in January 1962 and disembarked at Talcahuano, Chile, 4-1/2 months later. During this period, the ELTANIN worked chiefly in the Weddell Sea and in the vicinity of the South Orkney and South Sandwich Islands.

Aboard the ship were 48 crewmen and 32 scientists and technicians. The scientific party included a Brazilian, two Chileans, and a Canadian, in addition to the Russian and U.S. members—in all, representing more than a dozen universities and government and private organizations.

In the field of biology, studies were made of insect distribution (by means of nets attached to the rigging); marine microbiology, including analyses of chlorophyll contained by marine plant life; vertebrate and invertebrate fauna; plankton communities; and comparisons were made of the numbers and kinds of small organisms living in the sea ice and in the surrounding water.

Geological work aboard the ELTANIN included coring and dredging of the ocean bottom and the measurement of temperature gradients in the upper layers of sediments.

vertical distribution of the water density in the ocean. It is understandable that if the large assemblage of measuring instruments available at our Institute were to be delivered on board the ELTANIN via air transport, certain difficulties would have been involved.

According to the information about the work carried out on board the ELTANIN that was at my disposal prior to my departure from the USSR, I planned in advance to use the instruments that were already on board the American vessel. Besides the convenience of this arrangement, it would enable me to familiarize myself with those instruments and get a definite idea as to their properties, which, as one knows, is a problem in any scientific exchange intended for deriving mutual benefit from the experimental scientific investigations.

Unfortunately, the program of oceanographic investigations during the 7th and 8th voyages of the ELTANIN did not provide for the instrumental measurements of the elements of waves and currents. Therefore, on the 7th voyage, which lasted 40 days, I was obliged to revise my program so as to adapt it in the best possible manner to the investigations which could be carried out, and also to those which were actually being conducted on board ship. During the 7th voyage, I also became acquainted with different kinds of investigations carried out by the American expedition, and overcame certain difficulties, including getting used to and understanding the American speech.

On the 8th voyage, owing to the fairly broad program for the study of the vertical water temperature distribution in the layer ranging from 0 to 900 feet in depth, conducted by the American oceanographers with the aid of bathythermographs, and hourly measurements of the wind velocity and of the height and direction of the wave propagation, I succeeded in obtaining very interesting results concerned with the above-mentioned problem, which I disclosed to the American scientists and which I intend to publish upon my return to my native land. For these results I am much indebted, first of all, to the ship's officers, including Captain Sven Rydberg, who carried out a group

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These investigations are expected to yield clues to the early history of the Antarctic continent.

Because of the world-wide implications of weather, and the effects of the antarctic on weather patterns, meteorology is given more attention than any other subject in the U.S. Antarctic Research Program. Aboard the ELTANIN, determinations of wind speed aloft were made by radiosonde balloon tracking; measurements were made of the ozone; air samples were obtained for analysis of carbon dioxide content; and numerous weather maps were compiled.

Upper atmosphere studies included observations of airglow, cosmic rays, ionospheric absorption, radio noise, and of the propagation of electromagnetic energy of very low frequency.

Routine and special oceanographic data were collected at 70 stations. Such observations are particularly interesting in the antarctic because in that region the ocean currents follow a path around the globe that is not interrupted by continental land masses; thus the antarctic waters serve as a relatively uncomplicated model of oceanic circulation. Dr. Kudryavtsev's study, described in general terms on these pages, should contribute to our understanding of this water movement.

USNS ELTANIN

In the early summer of 1962, after undergoing several shakedown cruises in the North Atlantic Ocean, the 3800-ton, 266-foot-long USNS ELTANIN was considered fit for a series of expeditions in a large, rather forbidding region – the antarctic. She was young, having been built only five years earlier; she was sturdy (her hull had been strengthened to prevent damage by ice); she was a desirable size – able to accommodate 32 scientists and technicians; and she was equipped for conducting investigations in many scientific disciplines. Thus, when she departed the United States for the antarctic in July 1962, she was well qualified for the rigorous research assignments she would be given.

On the forward portion of the main deck are facilities for carrying out investigaions in hydrography, marine biology, meteorology, and the radio sciences. Above these laboratories, on the forecastle, is a scintillation counter. Just behind the cosmic ray facility is a large antiroll tank which stabilizes the ship in rough seas. Below deck are the staterooms, a radio science laboratory, photographic dark room, chartroom, machine shop, electronics workshop, gravimeter room, microbiological laboratory, scientific stores, and a magazine for explosives. Located at the stern of the ship are a balloon-inflation shelter, launching platform, and photometer-riometer and radionoise instrument areas. Other equipment aboard includes a balloon-tracking radar, hydrographic winches, and a deep-sea coring winch.

The ELTANIN is operated by the Military Sea Transportation Service for the National Science Foundation, which conducts the U.S. Antarctic Research Program.

The ELTANIN smashes through a high sea during its passage to the antarctic.

A trawl is lowered over the side of the ELTANIN to capture marine organisms.

Dr. Kudryavtsev, second from right, poses with members of the scientific group aboard the ELTANIN. The others, left to right, are Paul Hale, Ernesto Calderon, Shannon Cory, Edwin McB. Williams, and Juan Quintana.

The USNS ELTANIN.

of hourly observations of the height of the waves during the entire trip of the vessel, and also to my colleagues, the American oceanographers, with whom I came in contact in my work.

I spent about 4-1/2 months on the American vessel, during which time it covered more than 17,500 miles. It gives me pleasure to mention that the majority of the scientific expeditionary personnel as well as the ship's crew were friendly and well-disposed toward me. During this time, I had a good opportunity to get acquainted with American scientists, to hold discussions with them on various subjects, so as to be convinced of the benefit of such contacts. I am indeed deeply convinced that these contacts are not only beneficial from the viewpoint of enrichment through the experience of scientific investigations, but that they also contribute to a better mutual understanding and establishment of friendly relations between the peoples of the Soviet Union and of the United States of America.

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Four Months Aboard the OB

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Crewmen dig ice from the deck of the OB after a storm.

Each year since the beginning of the IGY, the United States and the Union of Soviet Socialist Republics have arranged exchanges of scientists as part of their antarctic research programs. During 1963 these arrangements extended to the field of oceanography. Under the existing agreement (The Antarctic Treaty), Dr. Nikolai Kudryavtsev of the U.S.S.R. joined the group aboard the USNS ELTANIN, and the writer joined the group aboard the Russian vessel M/V OB. Each investigator pursued his own research interests within the framework of the scientific program of the host vessel. [A summary discussion of the ELTANIN cruise is presented in the preceding article]. An account of experiences aboard the M/V OB during the 8th Soviet Antarctic Expedition, under direction of Dr. M. M. Somov, is given here.

During the expedition, the M/V OB served a dual purpose. Its primary mission was to transport men, equipment, and supplies to and from Soviet bases in the antarctic. Its secondary mission, although paramount to the scientific crew, was to enable oceanologists to pursue field programs in physical, biological, chemical, and geological oceanography. The vessel, under the able command of Captain Vodenko, performed admirably these dual roles under adverse conditions of sea and weather encountered on the journey.

The immediate scientific aim of the observational program conducted aboard the M/V OB by the writer, was to obtain measurements, on a continuous basis, of an effective radiation-temperature of surface waters by means of a remote-sensing optical radiation thermometer. The surface skin, as the topmost water layer is called, is on the order of a centimeter in thickness. The instrument, produced by the Barnes Engineering Co., was mounted in the bow, about 15 meters above the water, so as to be shielded from direct effects of spray and precipitation. Measurements so obtained are intended to furnish a basis for the delineation of mesoscale patterns of this parameter, and for comparison of these surface-skin temperature values, under varying ambient conditions, with those obtained by standard methods. This effort was made possible by a grant from the National Science Foundation. Similar investigations of air-sea interactions were conducted previously at Texas A&M University under sponsorship of the Office of Naval Research, and since the writer's return from the antarctic, that work has been continued.

The 136-day journey began December 20, 1962, at Cape Town, R.S.A., aboard the M/V ESTONIA, a Russian passenger ship. The ESTONIA, which carried 185 scientists and technicians plus equipment, rendezvoused with the OB at 63° S., 95° E.—the edge of the ice that skirts the continent. The meeting at sea was a joyous occasion, calling for the firing of skyrockets, the blowing of horns, and much shouting. After two days of playing "follow the leader" through the sea ice, the ESTONIA "anchored" on the ice about 10 miles from Mirny, the main Soviet station in the antarctic. For the next 27 days, supplies and men were transferred from the ESTONIA to sleds, tractors, airplanes, and to the OB for the short haul to the station. Some of the provisions were destined for Vostok, the inland Soviet base. In the meantime, the OB chipped a channel through the sea ice, which was from 1 to 2 meters thick, to a point about 1 mile from Mirny. This move was necessary because heavy equipment could not be hauled over the dangerous sea ice.

The arrival of the party at Mirny was the signal for a gala celebration, enjoyed especially by "polarniks," the men who had spent the long winter there, but also by the newcomers from both vessels. One such "polarnik" was Dr. M. Pryor, a biologist from the U.S.A., who was the exchange scientist for the 6th expedition. Celebrations not withstanding, the formal turn-over of personnel at the station and preparations for the trip to Vostok were accomplished efficiently, with all hands contributing.

After witnessing demonstrative goodbyes, and escorting the homeward bound ESTONIA out of the ice field, the OB continued her journey westward to Molodyozhnaya on the Prince Olav Coast of Enderby Land. Here, again, following 3 days of breaking through sea ice, and some ice-dynamiting, men and equipment were put ashore for both summer and winter tours. Their chief objectives were to make geological studies and to establish geodesic marks. A crew of geologists transported in small airplanes conducted a highly successful survey and rock-collection program over the region during the summer. Unfortunately, during the latter part of the summer, their aircraft was damaged by a storm, resulting in some injuries among the small band of explorers. A rescue was made by planes based at Mirny.

Before leaving Molodyozhnaya, the water supply of the OB had to be replenished. Obtaining water on the continent does not present a problem, because ice and snow are plentiful, but at sea, such supplies are not so readily tapped. However, with the help of aircraft, which often performed ice reconnaissance along the coast, old overturned icebergs cradling small lakes of fresh water were located. Transferring the water by means of long hoses and gasoline-driven pumps from lakes to vessel was a simple task once ship and berg were united. The method is standard practice.

About 100 miles inland, near 12° E. longitude, is Novolazarevskaya, the next stop on the journey. By this time, February 28, summer was waning and storms were more frequent. A tractor-truck train loaded with supplies and men, including the writer, completed the trip to the inland station after waiting out a bad storm near the half-way mark. The station, which is nestled in the Schermacher Mountains and is surrounded by small lakes, was indeed a pleasant sight. Accommodations in a hut built on a tractor truck were comfortable and warm.

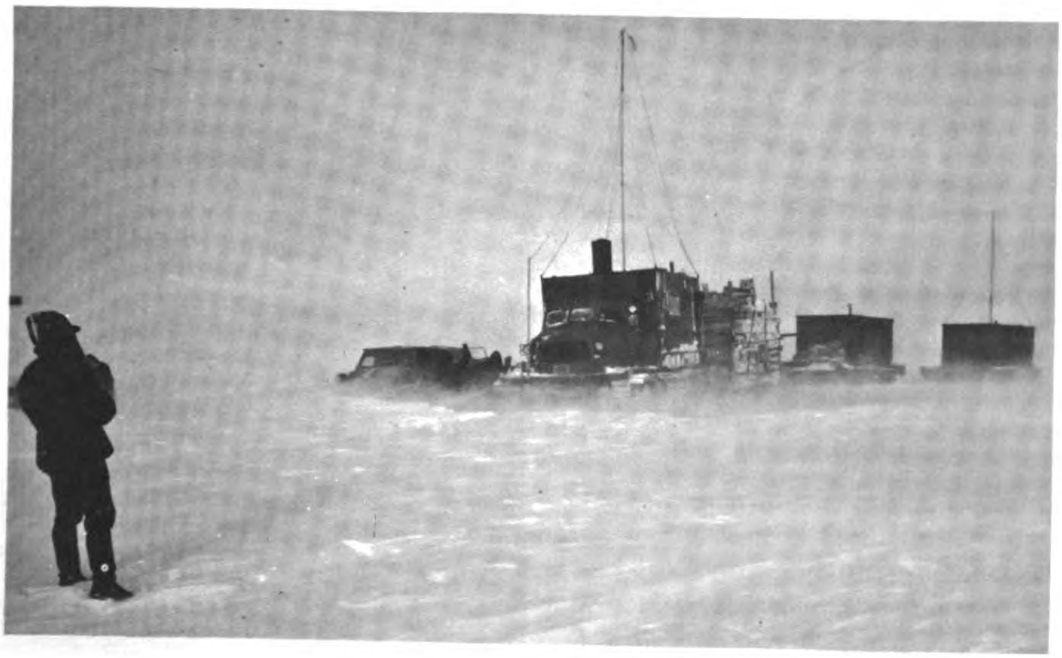
Wooden walk-ways connected the five major buildings, providing easy access to each. Steam-bath facilities were available, adding a touch of luxury. After a rousing send-off by the new station chief, Vyachislav Averianov, and his group, the train turned back toward the OB.

About 9 miles from the ship, during a violent and sudden storm, the train became stranded on the sea ice. Although visibility was near zero and hurricane-force winds prevailed, the train, which kept in radio communication with the OB, was guided slowly to safety by Captain Vodenko, who maintained radar surveillance on the tractor-train. After the last mile down a tongue of ice, the group wholeheartedly agreed that the OB was a most welcome sight, even through blinding snow! Fortunately, sea swells did not develop during the traverse. The captain was cognizant of this situation, so the venture proved safe, although somewhat harrowing. Within a matter of hours after the group boarded the OB, however, the train disappeared as the sea ice broke. Clothing, personal effects, and several scientific records joined the vehicle in its cold and watery grave.

With its temporary mission accomplished, the OB departed the continent in mid-March and returned to Cape Town, R.S.A., for more provisions, mainly vegetables and antifreeze. After transporting the cargo to Molodyozhnaya and Mirny, the vessel departed Antarctica for the season and headed for Murmansk, where it readied for an arctic expedition. However, before leaving, the vessel "rescued" an Australian scientist, John Greenhill, who had been stranded at Wilkes Station because of severe coastal ice conditions. Dr. Nikolai Tiabin, chief at Mirny, arranged to have the Aussie flown from Wilkes to Mirny before the OB arrived. When the ship finally left Mirny on April 20, it was the only scientific vessel known to be in the antarctic!

The oceanographic program during the journey was under the direction of Mr. Victor Ledyinov. Several hydrographic stations were occupied, and continuous depth recordings were made during the three traverses between Africa and Antarctica and during voyages in the coastal regions of Antarctica. Stations were more closely spaced on the section along 21° E. longitude and in the vicinity of the Antarctic Convergence Zone. (In this zone, water of relatively low salinity and low temperature sinks. Most of it then moves toward the north, where it can be traced great distances from the antarctic region.) While the ship was on station, wave recordings and visual measurements of water transmissivity were made; and when the ship was in ice-free waters, observations of surface currents and water temperatures were recorded. Current measurements were made with EMITOM (Russian version of the GEK), and surface temperatures were obtained with a towed thermistor. Geological work consisted mainly of coring and bottom-grabbing, especially near coastal antarctic regions. Several plankton-net and dredge hauls were made by the biological group, which was led by Dr. Vera Sergevnia. Other work included measurements of cosmic ray counts by Dr. Pavel Chaloupka, C.S.S.R., who was returning after a winter tour at Novolazarevskaya; photographing of clouds by Mr. Joachim England, G.D.R., who had wintered at Mirny; and measurements of natural radioactivity. All members aboard the vessel contributed willingly to all phases of the oceanographic effort, especially to the sorting of multitudinous biological specimens obtained with the dredge.

Left, whales off the stern of the M/V ESTONIA near Mirny; center, the tractor train enroute to Novolazarevskaya; bottom, the station at Novolazarevskaya.



Top, oceanographers retrieve sampling bottles; above left, the Barnes infrared thermometer mounted on bow of M/V OB; above right, a plankton net is lowered.

The skin-temperature measuring program of the writer proved successful, largely because of the fine cooperation of all aboard, especially Dr. Pavel Chaloupka and, in the early stage of setting up the equipment, Mr. Blagoslav Slavik, C.S.S.R., who is currently wintering at Vostok. Preliminary analyses of data obtained show large differences between surface-skin temperatures and temperatures measured by the towed thermistor and by standard bucket thermometers. In general, outside of precipitation areas, the surface skin was 0.5° to 1.5° C. colder than was indicated by the standard measuring devices. During rainstorms, on the other hand, the skin was invariably warmer. On the three traverses, rain or rain showers were encountered over the cold waters south of the convergence zone. At these times the surface skin became as much as 0.9° C. warmer than indicated by standard observations. Apparently, water of the "warm rain" formed a thin layer on the surface. This "layering" of warm water was also observed north of the convergence zone—but somewhat more dramatically: At times on traverse I, the surface skin was as many as 6° to 7° C. warmer! Implications of these results with respect to exchanges between sea and air are far-reaching, because interactions between the two mediums depend to a large extent on the temperature at their interface. As might be expected, these temperature differences diminsihed during periods when the wind was strong, but differences persisted even when the winds exceeded 30 knots. A tendency for the surface-skin temperature to be more nearly the same as that of the air than was the standard water temperature was also noted at times, as might be expected.

Unusually cold surface-skin water was observed close to Antarctica. Temperatures as low as -4° C. were recorded. As this water was colder than one would expect liquid water to be, considering its salinity (observations of gross salinity were made at a depth of 2-3 feet below the surface), the result furnishes grounds for speculation. Possibly drifting snow formed a thin, invisible layer at the surface, or invisible ice crystals may have been present, as the result of freezing caused by the very cold overlying air. On the other hand, cold, dry air may have induced evaporation at a rate sufficient to maintain a thin layer of high-salinity water at the surface. Such a surface layer, although statically unstable, could very well occur at the colder temperatures indicated.

Another interesting observation was made in the warmer waters at about 40° S. latitude. As the result of a rain shower accompanied by hail stones 1/2-inch in diameter, the surface-skin temperature dropped from 16.0° C. to 13.5° C., at which time it was 1° C. colder than the standard temperature value. On other occasions, as well, "cold rain" and snowfall caused skin temperatures to be lower. Further investigations are being conducted into the quantitative aspects of the phenomena and the implications of associated interactions.

The journey was an unusual experience from a social as well as a scientific standpoint. Meals aboard the ESTONIA and OB and at stations visited were wholesome and always enjoyable. The frequent serving of caviar, borscht, cabbage rolls, and black bread left nothing to be desired from the cuisine. Weekly laundry service was excellent. The barbering, although not professional, was unique. Social gatherings included dances, chess tournaments, and twice-a-day movies. Weekly classes were arranged for the ship's crew involved in correspondence courses covering all subjects. Music over the intercom, as well as news via Radio Moscow, was always welcomed. American music, especially in the Glenn Miller and Louis Armstrong manner, was appreciated by all members of the party. Messages dispatched by radiogram, at a word price of three kopeks (slightly more than three U.S. cents), kept the radiomen busy, but did much for the morale of the group.

Although stormy seas were the rule during the voyages of the OB, the forward friendliness and high esprit' de corps of the expedition members more than offset any unpleasantness the weather may have occasioned. As well as being gratifying in itself, this good feeling among the group created an excellent environment for the conduct of the writer's investigations.

As the ship turned homeward from the antarctic, everyone's thoughts began turning in that direction, too. Besides being pleased with the obvious success of the expedition, each "Sovietski" was warmed by the anticipation of a long leave—six workdays for each month away from home—at the end of his eventful journey.

Simulation in the Social Sciences

Partly with support from the Office of Naval Research, Dr. Harold Guetzkow and his colleagues at Northwestern University have been studying the application of simulation techniques in the social sciences. The appropriateness of this work to Navy interests rests with the fact that the Navy is a very large social unit involved in a great many important relationships, some of them vital to our National existence. The desirability of being able to predict the outcome of certain actions taken by segments of this unit or by the unit as a whole is obivious. However, so many variables, some of them unknown, affect the outcome, that one cannot now say with much assurance what will happen as the result of a given course of action.

In the following discussion, Dr. Guetzkow explains brieflly and in general terms how research into this problem—via simulation techniques—may guide the way to more accurate predictions. The fact that Dr. Guetzkow has chosen to experiment with groups representing nations does not mean that his technique is applicable only to international affairs. The method can be varied to encompass relations between groups in a number of fields, including Naval research, development, and operations. The discussion is presented here as an introduction to the article that follows it, "Reducing Tensions in a Test Tube World," which describes the application of the inter-nation simulation technique to a specific set of conditions.

A Use of Simulation in the Study of Inter-Nation Relations*

Events, as recorded in all their variety in historical and contemporary documents, are the usual basis for the development of theory about relations among nations. These international events our theory must explain, and these events we eventually hope to predict. Such theory building—consisting of the development of adequate concepts and the relations of these concepts to each other in propositions—must encompass the welter of facts from life situations. Our theories of international relations—be they implicit or explicit—are the stuff from which we compose our policies, and write our newspapers and textbooks.

Simulation is an operating representation of central features of reality. Simulations may take the form of war games, of pilot chemical plants, of ship-and-harbor scale models, of computer-inventory systems. There are a multitude of representations. Will a social simulation of inter-nation relations prove to be of value as a heuristic device for theory development in international relations research? May inter-nation simulation be arranged to allow live participants to play component units for training purposes?

Contrived face-to-face groups, even when they are created in the experimenter's laboratory, are more replications of reality than they are simulations. The component units—that is, the persons participating in the experiment—

— *Continued on page 32.*

*An excerpt from the book "Simulation in Social Science: Readings," edited by Dr. Harold Guetzkow, Professor of Political Science, Psychology, and Sociology, Northwestern University, and published by Prentice Hall, Inc., (C) 1962. The excerpt is from a chapter written by Dr. Guetskow. Portions of the material were published originally by BEHAVIORAL SCIENCE of the Mental Health Research Institute, The University of Michigan, under the title "The Simulation of Social Organizations," VI (1961).

ducing Tensions in a Test Tube World

Lawrence N. Solomon
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Could a series of friendly acts by one power toward another reduce international tensions? In a miniature world run by sailors, experimenters found that such acts did improve relations. The investigation is described in this article, which is reprinted from WAR/PEACE REPORT, *July 1963.*

The study described here was conducted solely for the purpose of determining the feasibility of the inter-nation simulation technique as a research tool (see the preceding page). No claim is made that the results "prove" anything, other than the usability of this procedure for research purposes. The practicability of one strategic doctrine over another, as it would be employed in a real world situation, remains a question that cannot be fully answered by social science research at this time.

There is today an increasing tempo in behavioral science research on the problems of peace and the reduction of international tensions. In research centers around the world, thoughtful scholars are currently engaged in full-time study of the many aspects of arms control and disarmament, the transition of "defense" oriented economies to peacetime economies, the social and psychological problems of developing nations, and ways to control and settle disputes by means other than force and threats.

Last summer, two West Coast psychologists attempted to bring the entire world into their experimental laboratory to answer a single question about international relations: Could a series of friendly acts by one major power toward another major power reduce tension and increase prospects for world peace? The following is an account of that experiment.

The Experiment

When Joe Donovan graduated from college in June and decided to join the Navy, he had little idea that in two months he would find himself directing the fate of OMNE, one of the two most powerful nations in the world. If during his boot training, someone had told him that soon he would be making decisions that could change the shape of the world, that he would be deeply concerned with the allocation of basic resources and the procurement of nuclear force capability, with the fluctuating level of consumer satisfaction and the likelihood of his retaining office, and with the balance of power in the international organization—he would have laughed incredulously and thought it all a good joke.

But Joe did find himself in just such a position during the summer of 1962, as one of 15 sailors from the San Diego Naval Training Center who participated in a unique psychological experiment. The Western Behavioral Sciences Institute at La Jolla, California, had received a contract from the U.S. Naval Ordnance Test Station at China Lake to conduct studies to determine the feasibility of using social science simulation techniques to help evaluate certain strategic doctrines.

This writer, with Wayman J. Crow, associate director of the institute, undertook the pilot studies with the cooperation of the Naval Training Center, the Navy Electronics Laboratory, and California Western University.

Using the inter-nation simulation technique developed by Dr. Harold Guetzkow and his colleagues in the political science department at Northwestern University, we created a miniature world of five sovereign nations, with each nation composed of three people. Each person in a nation played a decision-making role: one was the central decision maker (CDM) equivalent to the Chief of State; one was the decision maker for force, equivalent to the Secretary of Defense; and one was the external decision maker, equivalent to the Secretary of State, who also acted as delegate to an international organization which met periodically during the life of the model world.

The inter-nation technique is, by all standards, a rather complex and challenging game which is designed to create the kind of psychological, decision-making environment that exists for the representatives of nations in the real world. Placed in this environment, experience has shown that experimental subjects, whether they be college students, foreign service officers or naval recruits, become deeply involved in the "reality" of the game, that a certain kind of "nationalism" develops, and that soon previously mild-mannered and unworldly individuals begin to function as executives of large nations, begin to take on the characteristics of important decision-makers, and come to treat the "model world" with as much reality as they do the real world.

Fortunate Choice

Joe was an extremely fortunate choice for the central decision maker of OMNE. He was bright, articulate, and grasped the idea of the experiment with little difficulty. The plot was this: OMNE (the prototype of the United States in the simulation) was to follow a certain strategy in its dealing with the other nations. The strategy was designed to first *increase* tensions in the "world" and then to *decrease* tensions. The tension-reducing strategy was to be modeled after the suggestion made by Charles E. Osgood for a proposed strategic doctrine called GRIT: Graduated Reciprocation in Tension-Reduction.* Tension in the "world" was measured periodically by simple rating scales on which the participants in the simulation indicated their perception of the likelihood of war breaking out in the model world, the amount of trust that existed in the relations between nations in the world, and the amount of tension they felt existed in the world. These data were then plotted so that the experimenters could keep tabs on the tension level that existed at any given time and could instruct (in secret) the central decision maker of OMNE as to what his next move ought to be. It is important to note that the instructions to the CDM of OMNE were given in secret. Neither the other decision makers of the other nations in the "world" nor his own auxiliary decision makers in OMNE knew that he was being instructed by the experimenters to make certain decisions and take certain actions at given times. Thus, the actions of the CDM of OMNE were the independent variable of the experiment.

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*See "A Psychologist's Cure for the Arms Race," by Charles E. Osgood, War/Peace Report, Nov., 1961; also, "An Alternative to War or Surrender," University of Illinois Press, 1962.

Increasing Tensions

Through this technique the experimenters were able to increase tension in the "world" to a rather high level. The tension-increasing moves of OMNE consisted essentially of the following: continuing to increase the defense budget by committing more and more resources to the production of conventional and nuclear weapons; keeping one of the nations of the opposing bloc out of the international organization for fear that its admission would upset the balance of power, and remaining non-committal on most issues stressing the stability of the status quo.

By following this policy, OMNE was able to increase tension in the "world" over the first seven periods of the game (the simulation was played in periods of 70 minutes, each period being the equivalent in real world time to one year). Joe was able to control fairly well the activities and decisions of his auxiliary decision makers during his 10-minute cabinet meeting in each period. He spent most of his time instructing them on how to respond to anticipated messages from other nations and what the policy line for OMNE *must* be "under present world conditions." By the end of the seventh period, tension in the world had reached a peak which the experimenters felt was sufficient to provide the background against which to test the effectiveness of the GRIT strategy. Consequently, they instructed the CDM of OMNE to announce his new strategy in the "World Times" newspaper which was to appear at the beginning of the eighth period. Joe re-wrote a statement which Osgood had proposed for a hypothetical announcement by the President of the United States, and issued the following statement to the rest of the "world":

Decreasing Tensions

"OMNE challenges all nations to join it in a march to peace. OMNE will take steps especially designed to reduce world tension. OMNE will announce these steps before they are taken, and in the period set, they will be taken!

"Individually these steps may seem small in importance, but one will add to another and become more and more important if and when they are matched by other nations. Our actions will have the sincere purpose of reducing tensions. I ask the leaders of all nations, especially UTRO (major power of the opposing bloc), to support this effort, and join this march to a more peaceful world. If they are sincere in their expressed desire for disarmament and peace, they will be willing to take small but steady steps toward our common goal. Together we can move, step by careful step, away from the danger that threatens to destroy us all."

This shift in strategic doctrine resulted in an immediate drop in world tension, as indexed by the rating scales of period eight. But Joe soon realized that his "march toward peace" would not be easy. First, other nations did not respond with reciprocation to Joe's tension-reducing moves. True to the GRIT strategy, Joe undertook a series of pre-announced activities in the diplomatic, economic, military and cultural-scientific areas. He started with low-risk moves in each of these areas and then, as tension appeared to be subsiding, cautiously moved to moderately risky moves. However, he held his ground at this middle range of risk potential, pending some sign of reciprocation from the opposing bloc. But distrust and suspicion, built up over seven "years" of arms race and tension-increase, could not easily be removed. Even as the sincerity of Joe's intentions should have become more and more credible through fulfillment of announced tension-reducing activities, the CDM of UTRO continued to arm and showed no signs of considering a tension-reducing reciprocation.

Mounting Pressures

Also, pressures began to mount both within OMNE and between OMNE and its ally ERGA. Bill Wilson, Joe's auxiliary decision-maker for force, felt that Joe's GRIT strategy was suicidal. He had, over seven "years" of operation as the military advisor, come to rely on the concept of peace through power and saw continued nuclear build-up as the only defense against total annihilation. He strongly resisted Joe's insistence that nuclear force capability be maintained at a minimum deterrent level, and that resources be spent on nuclears only in quantity sufficient to compensate for depreciation and obsolescence.

Pete Marshall, OMNE's delegate to the international organization, caused a minor internal crisis within OMNE when he jumped the gun and invited previously-excluded INGO, an ally of UTRO, to join the international organization two periods ahead of the time that Joe had set for its admission. Joe, however, stood firm and indicated that he would not be pressured into taking any moves before he was ready for them. Pete was soundly reprimanded for his breach of policy and Joe had to recall him from the international organization meeting for the next period to indicate his firmness in not seating INGO until the period following.

Finally, ERGA, OMNE's weaker ally, began sending frantic messages to Joe that this "march toward peace" was giving the people of ERGA strong feelings of insecurity. Their satisfaction with national security began to drop because of OMNE's arms' curtailment, but their overall satisfaction was maintained at a relatively high level because the resources saved on armaments were plowed directly into consumer satisfaction. Nevertheless, the CDM of ERGA continued to put pressure on Joe to abandon his GRIT strategy.

In the face of all these pressures, both internal and external, Joe found that indeed he had to have grit to see the plan through. However, in period 13, six "years" after OMNE announced its "march toward peace," the CDM of UTRO announced that, for the next period, he would curtail arms buildup and concentrate solely on economic development and on helping the smaller nations of the world. This was the first sign of reciprocation from the opposing bloc since Joe changed his strategy. It later came out that the CDM of UTRO had until this time been considering world domination by UTRO as the most likely road to peace.

Better Relations

The "world" ended shortly after that, due to time limitations on the research. But the world ended on a happy note, with peace and prosperity apparently on the horizon, and all the nations engaged in continued tension-reduction. Pete, external decision maker of OMNE, sent a message to his former enemy in UTRO saying, "Is there anything my nation can do to help you out? Let me know if we can." Tension, after its initial drop in period eight, had held fairly

— *Continued on back cover (inside).*

INVENTIONS

This NAVAL RESEARCH REVIEWS *feature, which appears monthly, describes some of the more than 2000 invention disclosures handled each year by the Navy's patent organization, which is part of the Office of Naval Research. Patents are selected for reporting on the basis of their usefulness and novelty, as well as their importance to the Navy in terms of the technologies concerned.*

THE INVENTIONS BEHIND HYDRA

One of the most exciting outgrowths of research at the Naval Missile Center, Point Mugu, California, is Project HYDRA, an effort to develop techniques for launching large solid-propellant rockets from the ocean. Before HYDRA was initiated, little attention had been given to the perfection of sea-launching techniques, although there were a number of advantages in doing so: They would eliminate the need for large land-based facilities and the expensive support equipment which they entail—often costing three to five times as much as the rocket itself; they would allow 70 percent of the earth's surface to become a potential launch site, because rockets could be towed and erected for launch almost anywhere at sea; and they would be safer than present methods, because an explosion that might occur while a rocket was on the "pad" would be absorbed by the surrounding water.

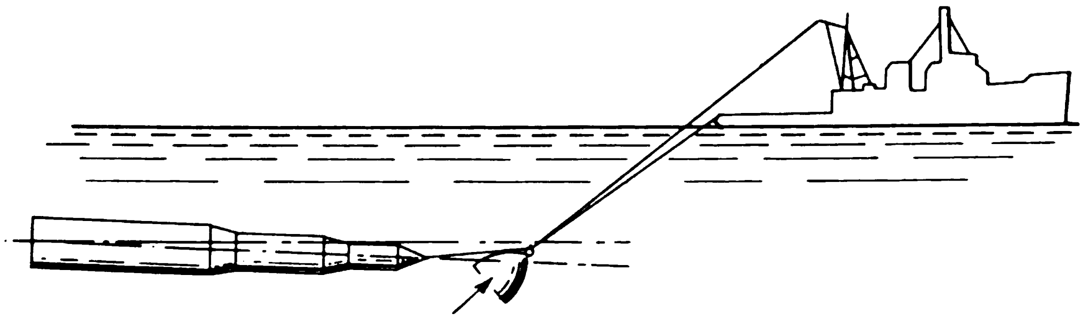
Several of the techniques that form the basis of Project HYDRA are now protected by patents which have been issued to the two men—both Navy officers at NMC—who are generally considered to have originated the concept: LCDR John E. Draim, USN, and LCDR Charles E. Stalzer, USN. Three of these patents are described briefly here, under the patent titles.

Water Launch of Floating Rocket Vehicles

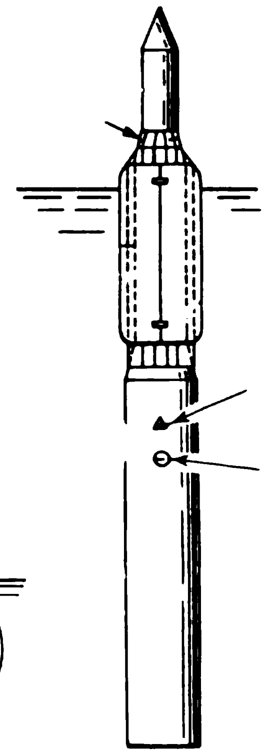
By designing and constructing a large rocket so that it has the characteristics of a spar buoy, the vehicle can be placed in the ocean in a vertical position, ready for launch, with only the nose portion protruding above the ocean surface. The technique is described in Patent No. 3,077,143, issued February 12, 1963.

Large solid-propellant rockets have a specific gravity (with sea water as a base) of about 1.0. By securing a small buoyant jacket to the nose portion of the rocket, the vehicle can be given an overall specific gravity which will make it buoyant with a positive metacentric height. An overall specific gravity of 0.95 is desirable so that five percent of the rocket will extend above the waterline. At the time of launch, the buoyant jacket is stripped from the rocket to avoid weight penalty during the rocket's flight.

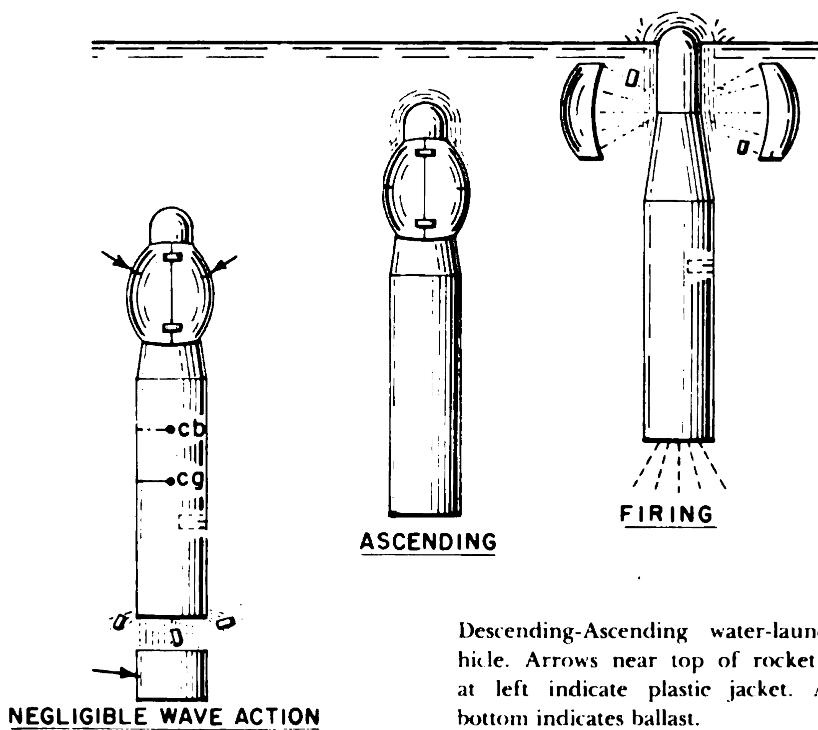
The rocket can be placed in the water just prior to launch (after pre-launch checkout is completed) from a barge or ship. Extremely large deep-space boosters can be towed submerged or afloat to the launch site, as disclosed in U.S. Patent No. 3,074,321, described in a following article. Upon arrival at the launch site, the rocket would be ignited either by radio command from the



A rocket being towed to launch site at sea. Arrow indicates ballast plug on towline.



The spar buoy launch vehicle. Arrow near top of rocket indicates buoyant jacket. Arrow pointing to small triangle indicates center of buoyancy. Arrow pointing to small circle designates center of gravity.



Descending-Ascending water-launched vehicle. Arrows near top of rocket pictured at left indicate plastic jacket. Arrow at bottom indicates ballast.

launching ship, in the case of strategic missiles, or by an umbilical cable for satellite and deep-space boosters.

The primary advantage of the floating spar-buoy launch method is its simplicity, which is achieved without a prohibitive sacrifice of rocket stability, even under widely varying sea-state conditions.

Descending-Ascending Rocket Vehicle

Another method of launching a large rocket at sea is described in Patent No. 3,093,033, issued June 11, 1963. It consists of placing a buoyant jacket on the rocket so that the vehicle floats vertically in a manner similar to that of the spar buoy, described in the preceding article. However, in this case, additional ballast is placed in the tail end of the vehicle so that the rocket is heavier than water and thus submerges.

The launch sequence is initiated by lowering the vehicle over the side of a ship or barge or by releasing it from a float. The vehicle then sinks to a depth of from 100 to 150 feet, where the wave motion is insignificant. At the time of launch, a hydrostatic pressure switch actuates a quick-release mechanism that jettisons the ballast. The rocket, now buoyant, rises vertically to the surface. It is ignited while it is traveling upward, preferably just as the nose of the vehicle breaks through the surface of the water. At the same time, the plastic jacket is thrown clear.

An important gain is realized by launching a rocket in this way. Not only is the vehicle more stable at its launch depth than the spar buoy, owing to the near absence of wave motion there, but it is also more stable when it breaks the surface of the ocean, because it has momentum, and thus spends less time under the influence of the waves at the surface.

Transportation of a Floatable Rocket Vehicle

One of the difficulties involved in launching a rocket at sea, in addition to that of getting the vehicle into the air on the proper course, is transporting it to the launch site and positioning it in the water. One method of doing this is described in Patent No. 3,074,321, issued January 22, 1963. According to this invention, the rocket is constructed in a horizontal position in a drydock. After it is completely assembled, and a buoyant jacket is attached to it, the drydock is flooded, causing the rocket to assume a horizontal position. Towing is done either on or beneath the surface of the water. Submerged towing is accomplished by downwardly biasing the nose end of the rocket by means of a ballast plug placed on the towline.

Upon reaching the launch site, tension on the towline is relieved by stopping the movement of the ship and lifting the ballast plug. The rocket then assumes an upright, stable position in the water. After removing the towline and attaching a control line to fire the engine, the vehicle is ready for launch.

RESEARCH NOTES

New Roadway for Amphibious Assault

A new, compact, inflatable causeway – a roadway intended for use during amphibious assault as a means of delivering supplies from ship to shore – was designed and constructed recently at the Naval Civil Engineering Laboratory, Port Hueneme, Calif., and is now being tested there. The principal advantage of the new causeway over the model currently in use is its shallow depth, which permits an LST to carry 8 sections at a time, instead of the maximum of 4 conventional sections.

The sections of floating causeways now in use measure 21 by 85 by 5 feet. They are carried at the side of an LST to the site where they are to be assembled, then launched and connected, end to end, to form a roadway over the sea. The new inflatable causeway has a steel superstructure of the same width and length as the conventional model, but it is only 2-1/2 feet in depth. It has self-contained inflatable cells which are drawn into the superstructure when deflated. When inflated, these cells extend approximately three feet below the superstructure to provide buoyancy. The cells are made of two-ply rubber-coated fabric of high tensile strength.

The new inflatable causeway is capable of supporting a 62-ton tank.

A Unique Radio Transmitter For Pilots and Mariners in Distress at Sea

Foremost among the thoughts of a pilot who is about to ditch a crippled airplane in the sea is getting off a signal to potential rescuers designating his position. The same urgency is felt by the crews of seriously disabled boats and submarines. If their radios become inoperative, as is likely to happen, the helpless men may drift for hours, days, or even weeks before rescuers can locate them and reach the scene. Equipping aircraft and boats with a device that will signal their positions automatically in such situations is therefore highly desirable: it would greatly increase the chances for survival of the unfortunate crews, and it would also simplify the rescue operations.

A device that may eventually answer this need has been designed and tested in the Naval Research Laboratory's Energy Conversion Branch. It is a compact, maintenance-free, long-life radio distress transmitter, the basic components of which are a high-current tunnel diode oscillator and a special battery that operates only under the influence of sea water. The high-current tunnel diode oscillator provides the radio frequency energy directly for transmission at 500 kc (the international distress frequency). Tunnel diodes have been produced with peak currents as high as 1000 amperes, but the size employed for various uses depends upon the power output required.

A battery and transmitter combination entirely satisfactory for distress signalling on the oceans has not been perfected in the past, primarily because of the approach generally taken to this problem. The aims of most studies have been to obtain the highest possible voltage per battery cell, so as to minimize the number of cells required in series, and to obtain the highest battery efficiency, so as to minimize size and weight. So far, achieving these goals has involved the use of expensive materials. If, on the other hand, the requirement for a high voltage per cell is eliminated—as is done when the tunnel diode oscillator is used in conjunction with the battery—cheaper, more common materials can be employed, thus permitting the manufacture of the signalling device at an acceptable cost. Another desirable feature of the sea water battery is that it will not deteriorate prior to use, thus allowing it to be stored for long periods.

Potential applications of the NRL combination, in addition to automatic distress signalling, are transmissions from short-range navigational buoys and from oceanographic instruments operating in remote regions.

Mr. J. M. Marzoff, who is responsible for the device, points out that it is still in the experimental stage and that much more needs to be done before it becomes standard equipment for tossing overboard in times of distress. When demonstrated at the National Convention on Military Electronics in September, the device worked fine with a single-cell battery of 10-ampere output at 0.25 volt. The eventual design will depend on the output voltage and power required for such a system. Right now, power output is limited by the efficiency and the peak current of available tunnel diodes.

Times Have Changed

An adjustment in the transmission of time signals by National Bureau of Standards and Navy stations was made on November 1 because of changes in speed of rotation of the earth, as determined by astronomical observations. The transmitting clocks were retarded 100 milliseconds. Such adjustments are made by international agreement, according to a plan whereby the times of emission of time signals are synchronized to about 1 millisecond. The last previous adjustment in phase of time signal pulses was made on August 1, 1961.

The countries participating in the coordination of time signal transmissions are Argentina, Australia, Canada, Italy, Japan, South Africa, Switzerland, United Kingdom, and the United States.

The U.S. stations include the NBS stations WWV, Beltsville, Md; WWVH, Maui, Hawaii; and WWVB, Fort Collins, Colo.; and the U.S. Navy stations NBA, Canal Zone; NPG, San Francisco, Calif.; NPM, Lualualei, Hawaii; NPN, Guam; and NSS, Annapolis, Md.

Flying Officer Joins ONR's Chicago Staff

The present Commanding Officer of the Office of Naval Research Branch Office, Chicago, is a man with a long and impressive record of Naval service. He is CAPT C. L. Dillard, a World War II and Korean War veteran who flew dive bombing and reconnaissance missions that won him some of the Nation's top service awards—among them the Navy Cross, the Distinguished Flying Cross, several Air Medals, and the Presidential Unit Citation.

CAPT Dillard came to ONR Chicago in September from the Office of Legislative Affairs, in the Office of the Secretary of the Navy, where he spent three years as one of the group which maintains liaison between the Navy and Congress. He replaced CAPT Charles Schroeder, who served as the Branch Office's Commanding Officer for the three previous years, and who is now with the Office of Naval Material, Washington, D.C.

The captain's first introduction to the Navy, which turned out to be the beginning of a career in uniform which has now lasted 23 years, was the Navy's V-5 Program, which he joined the year the U.S. entered World War II. He graduated from the flight training school at Pensacola late in 1941 and was sent almost immediately to Pearl Harbor. His missions, flown from a battleship and several aircraft carriers, consisted primarily of checking on the accuracy of the firing of the main batteries of battleships during engagements, and searching out and attacking enemy submarines.

CAPT Dillard also saw action during 13 months of the Korean War, serving as Air Officer aboard the carrier USS TICONDEROGA, and as a staff member of the United Nations Command in Korea.

His assignments during peacetime have included, in addition to his liaison work for the Navy's Office of Legislative Affairs, that of Assistant Branch Head of the Attack Design Branch, Aircraft Division, Navy Bureau of Weapons.

Recording the Heart Activity of Free-Swimming Sharks

The first electrocardiograms of a free swimming marine animal have been obtained by members of the Zoology Department and the Medical College of Cornell University. The investigators, Perry W. Gilbert (Zoology Department) and Steven D. Douglas (Medical College), working under contract for the Office of Naval Research, made their experiments over a three-year period on 12 lemon sharks, all about 40 inches long, recording the heart activity of each animal while he swam freely in a cement pool, 13 feet in diameter. Electrocardiograms had been taken of lemon sharks previously, by Dr. Warren Wisby of the Institute of Marine Sciences, University of Miami, but in those experiments, the sharks were contained in tanks not much larger than their bodies. Dr. Wisby is also an ONR contractor.

Free-swimming sharks were studied by Gilbert and Douglas to help the Navy recognize this animal's behavioral responses to sensory stimuli in open water. One interest the Navy has in pursuing such studies is understanding the shark's reaction to various repellents.

Signals from the heart were picked up by electrodes implanted beside that organ, and transmitted via cables to recording equipment set up at the side of the pool. Over the three-year period more than 200 electrocardiographic recordings were obtained, each shark being studied repeatedly on two or more successive days. As reported by the two investigators in SCIENCE, *June 28, 1963*, "The cardiac rate ranged between 30 and 65 beats per minute as the temperature of the water varied. The rate was relatively fixed for a given shark and did not change significantly with various stimuli: tapping the side of the pool, waving the hand, splashing water, or placing dye in the water."

The method of preparing a shark for study consisted first of anesthetizing the animal, removing it from the water, and strapping it to a restraining board. An electrode in a plastic jacket was then implanted near the heart, the approach being made from the underside of the fish. Leading from the electrode was a flexible cable, 3 feet long, which was sutured to the skin on the right side of the shark and at the base of the first dorsal fin. This cable terminated with an insulated waterproof connector, to which was attached a larger cable that passed to a swivel above the center of the pool, then to the recording equipment.

After capture and insertion of the electrode, a procedure taking only about 20 minutes, the shark was returned to the water, where he regained consciousness almost immediately and then acted in the normal manner. Two hours later, the first heartbeat tracings were recorded.

Gilbert and Douglas reported in SCIENCE that their technique "facilitates the study of cardiac function in elasmobranchs and other marine vertebrates under conditions approaching more closely those found in nature than when the animal is restrained, anesthetized, or removed from the water."

Basic Research at an Unusual Level

The Office of Naval Research is currently sponsoring a research project at an institution whose academic level is sharply offset from that at which support is habitually extended for basic research by the Federal Government. The institution is the Culver Military Academy, Culver, Indiana—a secondary school.

The project, which is under the overall supervision of Dr. Ronn N. Minné, Chairman of the Science Department at Culver, is part of a major program of the ONR Chemistry Branch to elucidate factors affecting the thermal and chemical (hydrolytic) stability of the bond between two adjacent atoms in a molecule. This research, which concerns what are called "coordination polymers," has been in progress at Culver since January 1962. Selected students in Dr. Minné's advanced chemistry course perform essential laboratory work on much the same basis as graduate students at universities. Dr. Minné's course is part of the Advanced Placement Program, the purpose of which, in this case, is to introduce students to a more challenging approach to chemistry—on a college-level basis.

Dr. Minné has been a member of the Culver faculty since 1954. His doctoral research was in the field of silicone chemistry under Professor Eugene Rochow of Harvard. At Culver, Dr. Minné is continuing the work he did under Dr. Rochow, in which the donor properties of nitrogen in polymeric silazanes and silylamines are investigated. The nitrogen atoms in the polymer chain coordinate with certain metal ions to give coordination polymers. Through this research, Dr. Minné hopes to clarify the nature and magnitude of interatomic binding forces, and to synthesize prototypes of materials which will increase the service life of components of defense systems.

The uniqueness of this Federal sponsorship of scientific research at a secondary school has occasioned an unusually close relationship between the Government and the contractor. It has also served to instill a proper perspective in the minds of the student assistants of the value of advanced education, and the recognition which such an education can provide.

The students participating in the program are obtaining unusual experiences in laboratory techniques and other aspects of chemical research, because they are exposed to more sophisticated procedures than are usually encountered by beginning chemistry students.

— O. D. Hughes and S. H. Herzfeld
ONR Branch Office, Chicago

ON THE NAVAL RESEARCH RESERVE

CAPT Mooney

CAPT Mooney is New Special Assistant (Research Reserve)

On September 25th, CAPT Daniel J. Mooney, Jr., USNR, reported as Special Assistant to the Chief of Naval Research (Research Reserve). Prior to reporting to ONR, CAPT Mooney was Assistant for Naval Reserve Training and Mobilization in the Office of the Assistant Chief of Naval Operations (Naval Reserve).

CAPT Mooney entered the Navy in 1942 as a Reserve ensign, having received his commission as a Naval Reserve Officer Training Corps graduate of the USS PRAIRIE STATE. During World War II he first served aboard minesweepers and then in submarines.

Since World War II, CAPT Mooney has had duty afloat and ashore. His sea duty has included command of the USS STAFF (MSF 114); Commander, Mine Division 84; and Executive Officer, USS CADMUS (AR 14). His service ashore included Commanding Officer, Naval Reserve Training Center, San Francisco, California; duty in the training section of the Bureau of Naval Personnel as Naval Reserve Submarine Coordinator; and COMSIX Headquarters Staff as Surface and Submarine Program Officer.

CAPT Mooney has been awarded the following medals: American Defense, Asiatic-Pacific with two battle stars, World War II Victory, European Occupation, National Defense Service, Armed Forces Reserve Medal, and the Naval Reserve Medal.

CAPT Mooney is a native of Pawtucket, Rhode Island, and was educated at Saint Raphael Academy, Pawtucket; Rhode Island College, Providence; and he received his M.A. in personnel management from George Washington University, Washington, D.C. He is well known in the Naval Reserve, both among active duty and inactive duty Reservists.

New Reserve Company Activated in California

Another company in the Research Reserve Program has been established in the Twelfth Naval District at Sacramento, California. The company is designated Naval Reserve Research Company 12-9. CAPT Arthur T. L. Fox, USNR, will serve as the first Commanding Officer, and CDR Charles A. Vencill, USNR, has been designated Executive Officer. The company held its first meeting on September 10, 1963, with an initial membership of 15 officers. Drill meetings for the company will be held in the Conference Room, Administration Building, Aerojet-General Corporation, Sacramento, California.

Welcome aboard!

LCDR Coers Reports on Columbus Seminar

All members of Naval Reserve Research Company 8-5, Austin, Texas, benefited from the attendance of their Commanding Officer, LCDR Roy H. Coers, USNR, at the Seminar in Research Methods, Columbus, Ohio, June 16-29, 1963. After his return to his home at the conclusion of the seminar, CDR Coers wrote a comprehensive report on the presentations made at the seminar and distributed this report to members of the company. In addition to an outline of the presentations made in the course of the seminar, CDR Coers included reproductions of handout material provided by various speakers. CDR Coers is congratulated on this excellent report, which served to share his active duty training with members of his company.

NRRC 1-1 has Distinguished Visitors

When CAPT Glenn W. Okerson, USN, new Commanding Officer of the Office of Naval Research Branch Office, Boston, Massachusetts, made his first official visit to Naval Reserve Research Company 1-1, Boston, CAPT Carl O. Holmquist, USN, recently arrived Commanding Officer of the Naval Training Device Center, Port Washington, New York, was the featured speaker. CAPT Holmquist, a noted authority on aerodynamics and holder of a doctorate in aeronautical engineering, gave a classified slide-illustrated lecture on the "Development and Future of the Guided Missile."

The Company, which meets at Massachusetts Institute of Technology, was also given a short, interesting description of current Research Reserve events and trends by CAPT Okerson who, like CAPT Holmquist and CDR Adami, Executive Officer and Reserve Assistant of ONR Boston, is a Naval aviator.

As Commanding Officer of the ONR Branch Office, Boston, CAPT Okerson supervises the technical side of the Research Reserve program in the First Naval District. He is a graduate of the University of Oklahoma in electrical engineering. He earned his wings as a Naval aviator at Pensacola and served with several aircraft squadrons and aircraft carriers until the end of World War II. After the war he worked with the Navy's guided missile program in the former Bureau of Aeronautics and at the Naval Missile Center, Pt. Mugu, California. After a three-year tour of duty with the Armed Forces Special Weapons Project at Sandia Base, Albuquerque, New Mexico, he returned to the Bureau of Aeronautics as assistant director of armament and as the programs and budget officer for the Research and Development Group. His most recent duty assignments have been as the Bureau of Naval Weapons representative at Lockheed Aircraft Corporation, Burbank, California, and at General Dynamics/Convair Division in San Diego, California.

Additional Research Reserve Seminar

The Research Reserve is pleased to announce the scheduling of an additional Research Reserve seminar for this fiscal year—the Nuclear Sciences Seminar in Health Physics, Brookhaven National Laboratory, Upton, New York, which convenes March 2, 1964. Quotas for this seminar have been allocated to the following Naval Districts: 1, 3, 4, 5, 6, 8 and 9. Quotas may be given to the West

Coast Naval Districts upon request of the respective Commandants. Reservists who request this duty should have at least a bachelor's degree in one of the sciences or in engineering.

The profession of the health physicist developed out of necessity with the coming of the nuclear age. The term "health physics" is sometimes equated with radiation safety, but this definition is inadequate. The health physicist thinks of his profession as being concerned with the study, evaluation, and control of radiation hazards. The modern nuclear-age Navy needs reservists who have been indoctrinated in the basic tenets of the health physics profession. The program of the 10th Brookhaven Seminar has been laid out with this in mind.

The program will cover the health physics profession – special attention being given to the needs of the Navy and its reservists. Subjects considered will include interactions of radiation and matter, biological effects of radiation, personnel monitoring and radiation surveys, together with practical applications of problems concerning reactors, laboratories, and hospitals. The facilities and personnel of Brookhaven National Laboratory will be augmented so that adequate coverage will be given to these subjects as associated with shipyards, naval vessels, nuclear energy, and man in space. Tours of Brookhaven's nuclear facilities will be included.

Electronic Computers Seminar Presented at Newburgh, New York

Forty-five Reserve officers from the Navy, Army, and Air Force, coming from sixteen states, attended the Third Research Reserve Seminar on Electronic Computers and Their Applications at Stewart Air Force Base, Newburgh, New York, from October 6-19, 1963. The seminar was sponsored by the Office of Naval Research and was planned and conducted by members of NRRC 3-14, Poughkeepsie, New York, commanded by CDR Norman J. Smith, USNR. Key members of the planning and administrative staff for the seminar were CAPT James D. Quale, who served as Commandant's Representative, and CDR William W. Lang, Executive Officer of NRRC 3-14, who served as seminar chairman. COL James W. Lancaster, USAF, Commander of Stewart Air Force Base, and his staff provided the necessary and vital logistic assistance which contributed significantly to the successful completion of the seminar.

The opening of the seminar was highlighted by a luncheon held on Monday, October 7, where the attendees were welcomed to Stewart AFB by COL Lancaster and received a warm welcome to the Third Naval District from RADM Redfield Mason, USN, Commandant, Third Naval District. At the luncheon, greetings from RADM L.D. Coates, USN, Chief of Naval Research, were brought to the conferees by CAPT W. E. Berg, USN, Assistant Chief for Research, ONR. CAPT Berg then challenged the seminar participants by a stimulating and thought-provoking keynote address. In his address, CAPT Berg reviewed developments and plans for computer research sponsored by ONR and emphasized the critical requirements which all military services have for imaginative use of computers with high speeds and high capacities. He further stressed the Navy's hope that electronic research will continue to be expanded to fill the apparently endless development of the role to be played

Reservists Tour NAFI

Through the generous cooperation of CAPT J. C. Wootton, USN, Commanding Officer of the U.S. Naval Avionics Facility at Indianapolis, Indiana, a briefing and tour of NAFI was provided to Research Reserve officers on Saturday, September 7. Before reporting to his present duty at NAFI, CAPT Wootton served as Assistant Chief for Research at the Office of Naval Research. In addition to Research Reserve officers, participants included members of local WEPTU companies. In charge of arrangements for this one-day group training was Naval Reserve Research Company 9-25, Indianapolis, with CAPT Wendell Calkins, USNR, commanding.

The participants were advised that NAFI is geared to a job-line organization rather than production. Highlights of the tour were visits to such facilities as a new R/F absorption chamber, a space chamber which can simulate controlled altitude conditions up to 600,000 feet, a portion of the new calibration standards laboratory, a working model of the Walleye air-to-ground missile, some advanced launching equipment for Sidewinder, an optimizing digital computer, guidance systems for advanced Polaris missiles, some innovations for new radar capability for ASW helicopters, and a pilot line production capability for microminiturization through vacuum deposition of thin films.

Electronics Computers Seminar — Continued

by computers and other electronic devices. The speaker said that "virtually every major weapon system or piece of equipment in the Fleet today requires a reliable electronic nervous system for its operation". In closing his remarks, CAPT Berg expressed his gratification over the fact that Reserve officers were participating in such activities as the Computer Seminar and were keeping themselves informed and abreast of developments and new applications in the field of electronic computers.

This Electronic Computer Seminar, the third to be conducted by the Poughkeepsie Company, was characterized by CDR Lang, seminar chairman, as a "working seminar". Whereas the two previous seminars were essentially theoretical in nature, this year's program centered on applications of electronic computers and combined lecture-discussion sessions, field trips, programming laboratory sessions, and actual computer usage to provide a meaningful experience of learning by participation. The discussion sessions were concerned with up-to-the-minute developments and future trends in computer usage in military, business, and scientific applications. Leadership discussion for each session was provided by recognized authorities in each field, and the following topics were considered: "Block Analysis of Computer Functions and Machine Organization," "Programming: Its Uses, Status, and Future Development," "Business Applications of Computers," "Scientific Applications of Digital Computers," "Military Applications of Digital Computers," and "Future Trends in Computer Applications and Usage".

The practical and applied nature of the seminar was evident in the nine unique programming laboratory sessions and the two special evening sessions of program runs on digital computers which were interspersed with the discussion sessions and the other seminar activities. During the laboratory periods, each officer completed the "FORTRAN - Self-teaching Manual" and was presented with a specific problem. The officer then sought a solution to his problem through the use of a program which he had prepared himself using FORTRAN computer language. With the aid and assistance of LTJG William J. Oberle, USNR, and other officers of NRRC 3-14, each officer had the opportunity to use a computer at the facilities of the IBM Corporation, Poughkeepsie, New York, to test out his "program" and to give significant meaning to his seminar experience.

An opportunity for seminar participants to tour field installations to view and inspect computer applications was afforded by field trips to the U.S. Army Signal Corps Development Center, Fort Monmouth, New Jersey; IBM Corporation facility at Poughkeepsie; and 465L SAC Control System, Paramus, New Jersey.

At the closing session of the seminar, Miss Eleanor F. Kehoe (CDR, USNR) Education Specialist, ONR, presented an overview of the Naval Reserve Research Program and its functions and activities. She related the accomplishments of the seminar to the aims and objectives of ONR and presented general information of interest to the conferees relative to thier status as Reserve officers.

A Challenge to the Scientific Community — Continued from page 4

motivation? I do not know. But I do know this. There is nothing so deadening to an organization as to have an opinionated, out-of-date technical man in a position of authority.

In conclusion, the scientific community must face up to three new facts: (1) the inevitability and urgency of its new public-service functions; (2) the need for a new and respected career pattern to fulfill these functions and (3) the need to develop methods to maintain the highest technical competence under these conditions.

The government, on its part, must also do many things in order to honestly face the demands of the scientific revolution. One of them is to correct the inadequate salaries, particularly on the executive levels (a problem, incidentally, which the clever legal profession has solved). For example, the Supreme Court Justices receive $35 thousand a year. Another is offering technical people suitable environment under the control of professional scientists and engineers. But frankly, I believe that the limitation today is more in the attitudes and limited horizons of the scientists and engineers themselves than it is the government. When their house is in order they can demand and will eventually receive the responsibilities which only they can adequately carry.

A Use of Simulation — Continued from page 16

necessarily respond to their social environment as human beings even though the environment may be artificially simplified. In the war game, however, there is more role-playing, in which the actors need to imagine many features of the military situation and respond to each other's moves in terms of these self-

* U.S. GOVERNMENT PRINTING OFFICE : 1963 O—713-412

imposed role conceptions. Usually there is time compression, so that, for example, a month's warfare may be enacted within a day. The mechanical and civil engineer often builds his simulation by reducing his phenomena in scale. The operations research analyst represents the flow of traffic in symbolic form, so that he may use digits in a computer as simulation of a distribution of vehicles. In making such an analogue, there often is simplification, as when traffic is allowed only to turn left or right, even though vehicles in reality can make U-turns. All these devices have been used in developing the inter-nation simulation. We have attempted to represent social units—nations, in this case—in their inter-relations with each other. We have simplified and reduced the number of variables involved. We have used both analogies and replication in contriving the parts. *Our simulation is an operating representation in reduced and/or simplified form of relations among social units by means of symbolic and/or replicate component parts.*

Reducing Tensions in a Test Tube World — Continued from page 20

steady for periods 9, 10 and 11. In period 12 it showed signs of going down even further, and in period 13, with the reciprocal move of UTRO part of "world history," it dropped to its lowest level—even lower than it had been at the beginning of the game.

In talking to the participants afterwards, all of them felt that the experiment had been one of the most stimulating and challenging experiments of their lives, and they thanked the experimenters for the opportunity to participate as subjects in the study. As the sailors climbed onto the bus to return to the Naval Training Center on the day that the world "ended," the psychologists could still hear them discussing the relations between ERGA and UTRO, the merits of arms control and disarmament, the pros and cons of OMNE's "march toward peace."

Further Research

To portray the human drama of this experiment, the technical details on data collection, statistical analysis, and methodological controls have been omitted. Also, the complex of arguments over the role of simulation in social science research and the "external validity" of such studies have not been discussed.

With continued research efforts by behavioral scientists in sociology, political science, anthropology and psychology; with continued repetition of studies such as the one reported here, and with the attendant accumulation of empirical data from diverse approaches to this area, the problems of international relations and world strategies will eventually become the legitimate subject matter of the social sciences and be brought under the same rigorous experimental controls as have other aspects of man's social existence. For the present, however, simulation studies like the one described here shall serve the highly useful purpose of generating hypotheses about the important variables in the real world situations which are being simulated. Also, they hold the promise of adding small increments to our ability to predict and control man's behavior scientifically, in all areas of human activity—personal and national, as well as international.

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NAVAL RESEARCH REVIEWS publishes highlights of research conducted by Navy laboratories and contractors and describes important Naval experimental facilities. Manuscripts submitted for publication, correspondence concerning prospective articles, and changes of address, should be directed to Code 740, Office of Naval Research, Washington, D.C., 20390. The magazine is listed for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Subscription price: $1.50 per year in the U.S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. The issuance of this periodical approved in accordance with Dept. of the Navy publications and printing regulations.

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NAVEXOS P-510

A boat from the USNS ELTANIN attempts a landing on an antarctic island to make geological observations during a recent expedition. The ship is seen behind, over a rough sea. Above the photograph is a portion of the original manuscript written by a Russian oceanographer describing his research on the voyage (see page 6).