NAVAL RESEARCH REVIEWS

OCTOBER 1969

Portraits in Science

RECENTLY APPOINTED BY PRESIDENT NIXON TO THE POSITION OF DEPUTY DIRECTOR IN THE OFFICE OF SCIENCE AND TECHNOLOGY, DR. HUBERT HEFFNER IS A RECOGNIZED AUTHORITY IN THE FIELDS OF QUANTUM ELECTRONICS, NOISE THEORY, ELECTRON BEAM FOCUSING, AND PARAMETRIC AMPLIFIERS. ON LEAVE FROM HIS POST AS PROFESSOR OF ELECTRICAL ENGINEERING AT STANFORD, DR. HEFFNER WAS FORMERLY ASSOCIATE PROVOST AND DEAN OF RESEARCH THERE. HE HAS SERVED FOR A LONG TIME WITH THE DEFENSE DEPARTMENT'S ADVISORY GROUP ON ELECTRON DEVICES AND NASA'S SPACE SCIENCE STUDY GROUP. HIS LONG-TERM RELATIONSHIP WITH ONR IS BOTH THROUGH HIS ONR-SPONSORED RESEARCH AND BY VIRTUE OF HIS TOUR OF DUTY IN 1960 IN ONR'S LONDON OFFICE.

Salvaging the ALVIN

LCDR John Donnelly
Office of Naval Research

The Office of Naval Research Deep Submergence Research Vehicle, ALVIN, sank on 16 October 1968 during a launching accident. ALVIN had submerged for dive number 307 to make a visual and photographic inspection from surface to bottom at a taut wire buoy mooring in 5000 feet of water. A short circuit in the camera trigger circuit necessitated surfacing for repairs. During the launch from LULU, on completion of repairs, two of the wire ropes that lift the cradle parted plunging ALVIN into the sea. After a few seconds ALVIN came back to the surface and the three occupants scrambled to safety aboard LULU. ALVIN's pressure hull rapidly filled with water breaking the manila handling lines that still held her. She plunged to the bottom barely 90 seconds after the initial accident.

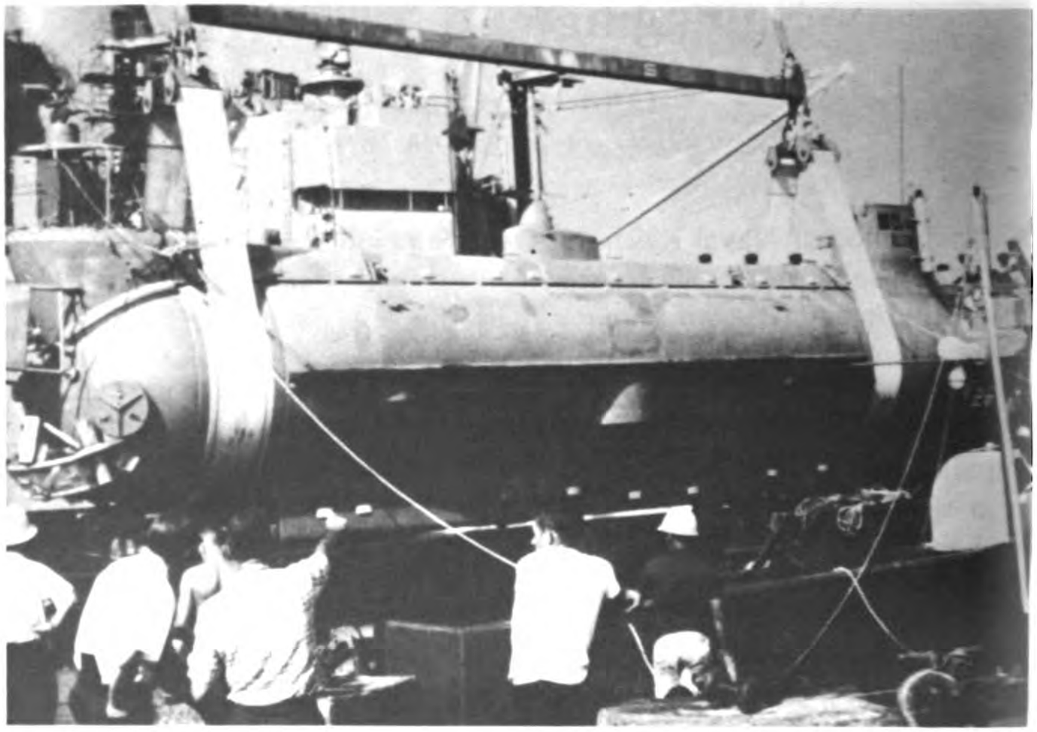
There she lay unseen until June 1969 when she was photographed by the Naval Research Laboratory and Woods Hole Oceanographic Institution team aboard USNS MIZAR. An effort to recover ALVIN was made in October and November 1968. Three sorties were made by LULU with DOWB aboard, R/V CHAIN of Woods Hole and USCGC Sassafras, each time to be beaten back by weather. The effort was ended on 22 November because of the prediction of typical winter poor sea conditions.

USNS MIZAR operated by MSTS for the Naval Research Laboratory conducted a test and training in the ALVIN area. Personnel from Woods Hole were aboard to assist in tracking the camera fish and to help find the proper place to look using a detailed bottom contour chart developed from data taken immediately after the sinking. On 9 June 1969, MIZAR's fish photographed ALVIN during the seventh run. Additional runs were made producing rare photographs of ALVIN and other man-made articles on the bottom.

Based on this photographic evidence showing ALVIN to be upright with a slight list to port, down by the head and only two feet imbedded in the silt, the decision to recover ALVIN was made in early July. The Supervisor of Salvage, Naval Ship Systems Command, was tasked by the Chief of Naval Research to plan and execute the job of raising ALVIN and delivering her ashore.

Aluminaut was selected for the submersible to make the attachment to ALVIN. MIZAR was selected for the tracking and lift ship.

From the MIZAR an acoustic transponder was implanted on the bottom near ALVIN; and four photographic runs were made, but ALVIN was not in any of the 9600 pictures. On 5 August, MIZAR



The Aluminaut was the submersible used to salvage ALVIN

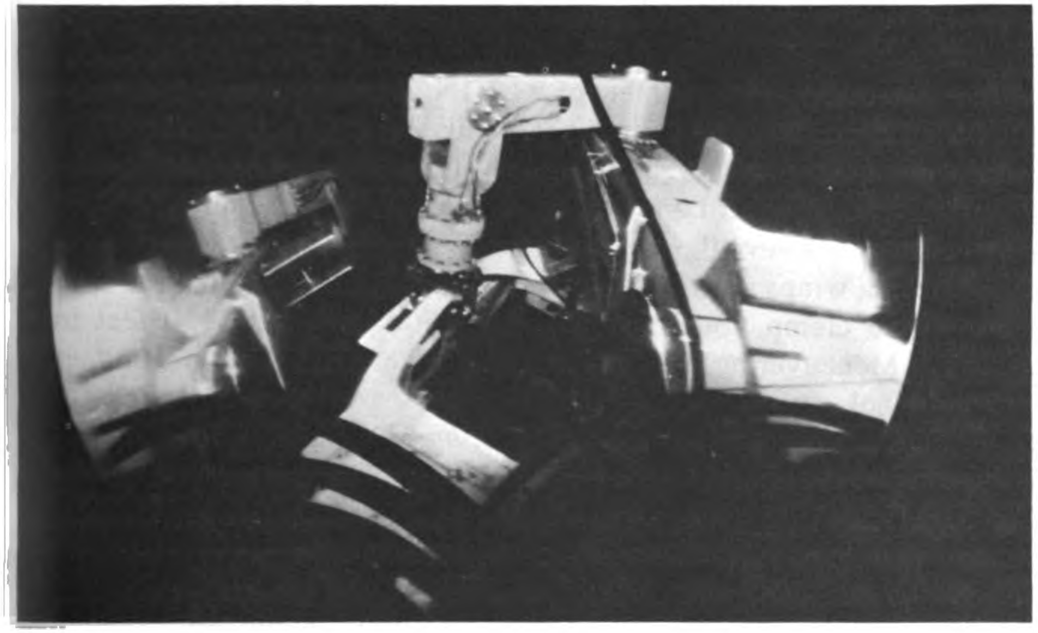
arrived in Boston Naval Shipyard for installation of a special winch and rigging for handling the nylon lift line through her center well.

Meanwhile, Aluminaut arrived in Boston Naval Shipyard aboard her tender, Stacey Tide, for final preparations of fitting the ALVIN lifting equipment, and for a crane hoist of Aluminaut into the water.

The primary lifting plan called for MIZAR to locate ALVIN and direct Aluminaut to ALVIN using the computer aided tracking system installed by NRL. Aluminaut was to submerge to ALVIN carrying a reel containing 7000 feet of 4-1/2-inch double braided nylon line and a toggle bar to fit inside ALVIN's hatch. This assumed the hatch was open, which had yet to be established. After placing the toggle, Aluminaut would surface paying out line. If Aluminaut became entangled in the line, a sharp down angle would dump the reel out of its rack, or the line could be cut with a guillotine held by one of the manipulators. On the surface, the line would be taken aboard MIZAR, reeved through the rigging and ALVIN lifted to shallow depth.

MIZAR departed Boston in the forenoon of 12 August, arriving over ALVIN early the next morning to resume photo runs. On the 15th ALVIN was sighted on the film as it came out of the developer. The photos still did not give the critical evidence that the personnel sphere hatch was open.

Aluminaut departed Boston in tow of Stacey Tide stopping off in Provincetown for practice in mounting the reel at sea and check out



Seen here from the porthole of the Aluminaut is her manipulator gripping the sail of ALVIN

at shallow depth of the handling of the toggle and line payout from the reel. She arrived at the site joining MIZAR and R/V CRAWFORD, from Woods Hole, in the evening of 16 August.

The sea was not calm, with waves about six to eight feet high, and causing extreme difficulty in mounting the reel. At noon 17 August, attempts to mount the reel were abandoned. The decision was made to use an alternate plan that had previously been developed in the fall of 1968. MIZAR would lower the line to the bottom, buoy and cast free the bitter end on the surface. Then Aluminaut would dive, take the toggle at the bottom of the line to ALVIN and make the insertion. The lift would then be the same as in the primary method.

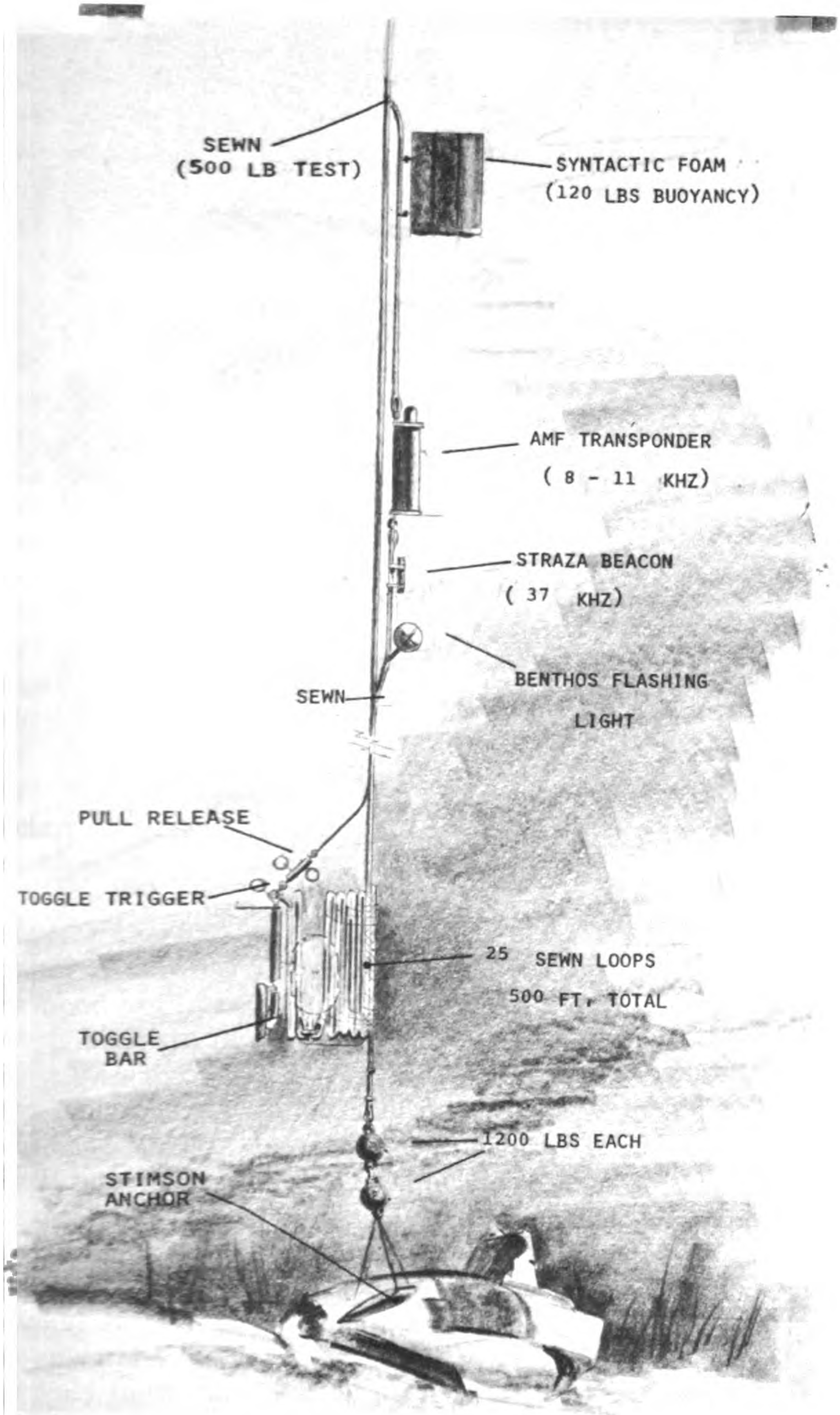
The bottom of the lift line had to be prepared for lowering by MIZAR and handling at the bottom by Aluminaut. First, the line had to be weighted to carry it to the bottom. Two 1200-pound headache balls and a Stimson anchor had been loaded aboard in Boston just for this purpose. Second, the toggle and 500 feet of line had to be bundled so that Aluminaut could pull it free so she could maneuver at the bottom without dragging the anchor and weights about. Third, a transponder was required on the line so that it could be tracked as MIZAR maneuvered to put the package dubbed the "clump" near ALVIN. All of the attachments to the line had to be made in such a way that they could be removed as they came aboard in order for the lift line to pass freely through the blocks and winch.

After the reel of line was transferred from Stacey Tide to MIZAR, the design of the clump was laid out on paper as a guide to assemble.

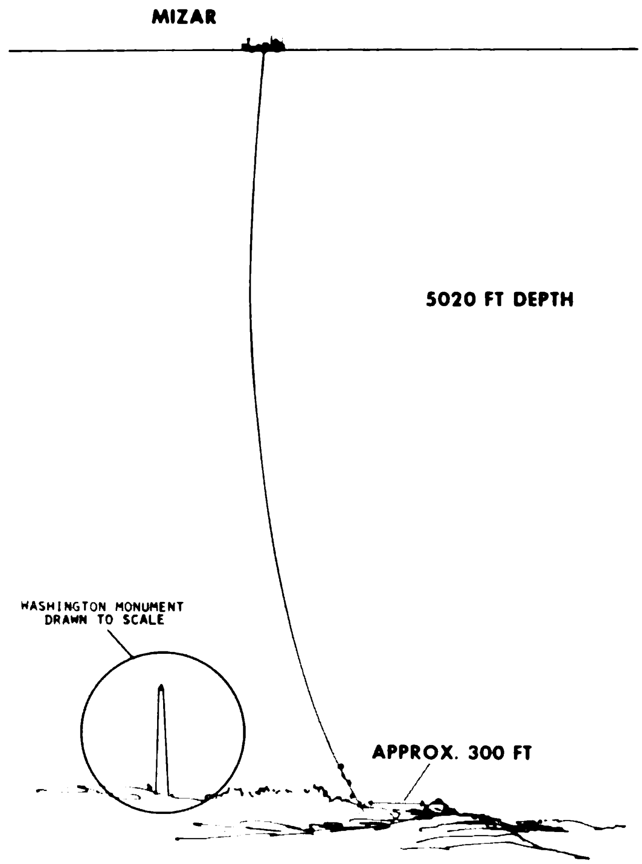
The job of assembling the clump took most of the night. On the morning of the 18th, the clump was started over the side to begin the difficult task of placing it within 500 feet of ALVIN. Just as the clump cleared the side, the light thread holding loops of line bundled together, began to part and a 500-foot long bight of line was dumped into the ocean. This was hauled back aboard and the task of bundling and sewing was started again. At 11:10 AM the clump was put over the side and swimmers cut the extra wraps used to give the strength for handling in air. MIZAR lowered the clump, touching bottom at 5:00 PM some 800 feet from ALVIN. Maneuvering by MIZAR to put the clump within 300 feet of ALVIN took another two hours. The upper end was attached to an 8.4-ton salvage pontoon and cast free. Aluminaut submerged at 8:05 PM reaching the bottom at 9:16 PM. She had ALVIN in sight in another 38 minutes. Clouds of silt were stirred up by contact with the bottom and cleared slowly, severely reducing visibility. Aluminaut's vertical lift motor and straza sonar were out of commission. To examine ALVIN, Aluminaut had to use her manipulators to crawl about on the bottom and climb up on ALVIN. At 12:22 AM on the 19th a shout went up aboard MIZAR as Aluminaut reported the hatch wide open and clear. Next, Aluminaut had to locate the clump with the toggle. Aluminaut arrived at the clump at 3:00 AM and was back to ALVIN with the toggle attached to the end of the line by 5:01 AM. Efforts to insert the toggle proved fruitless. The manipulators had been repeatedly overloaded by crawling about on ALVIN and the bottom; in addition seven men had been closed up aboard Aluminaut for almost 17 hours. Aluminaut started the long trip to the surface with carbon dioxide building up to a dangerous level and the crew exhausted.

Once on the surface at 6:00 AM attempts to charge batteries and make repairs to the sonar and lift motor were hampered by the six- to eight-foot waves and a 20-knot wind. Aluminaut, in tow of Stacey Tide, headed for sheltered water near Nantucket for a place to charge batteries without shipping water through her open hatch. A radiotelephone conference produced the decision for the small force to make for Woods Hole where the Oceanographic Institution's facilities could be used in helping to repair Aluminaut's equipment, and a calm harbor was available for charging batteries.

MIZAR arrived late in the afternoon of 20 August with Stacey Tide and Aluminaut following early in the morning of the 21st. On Friday morning the 22nd as the crew conducted a checkout, Aluminaut's manipulators would not function. It appeared to be due to a burned out motor for the hydraulic drive. This required either docking or lifting the 73-ton submersible. Aluminaut headed for Boston where the Naval Shipyard crane could lift her out. There was some suspicion that the toggle now lying on ALVIN had tripped or was damaged in such a way as to prevent Aluminaut from inserting it into the hatch. Another toggle



The salvage equipment at the end of the lift line is called the clump

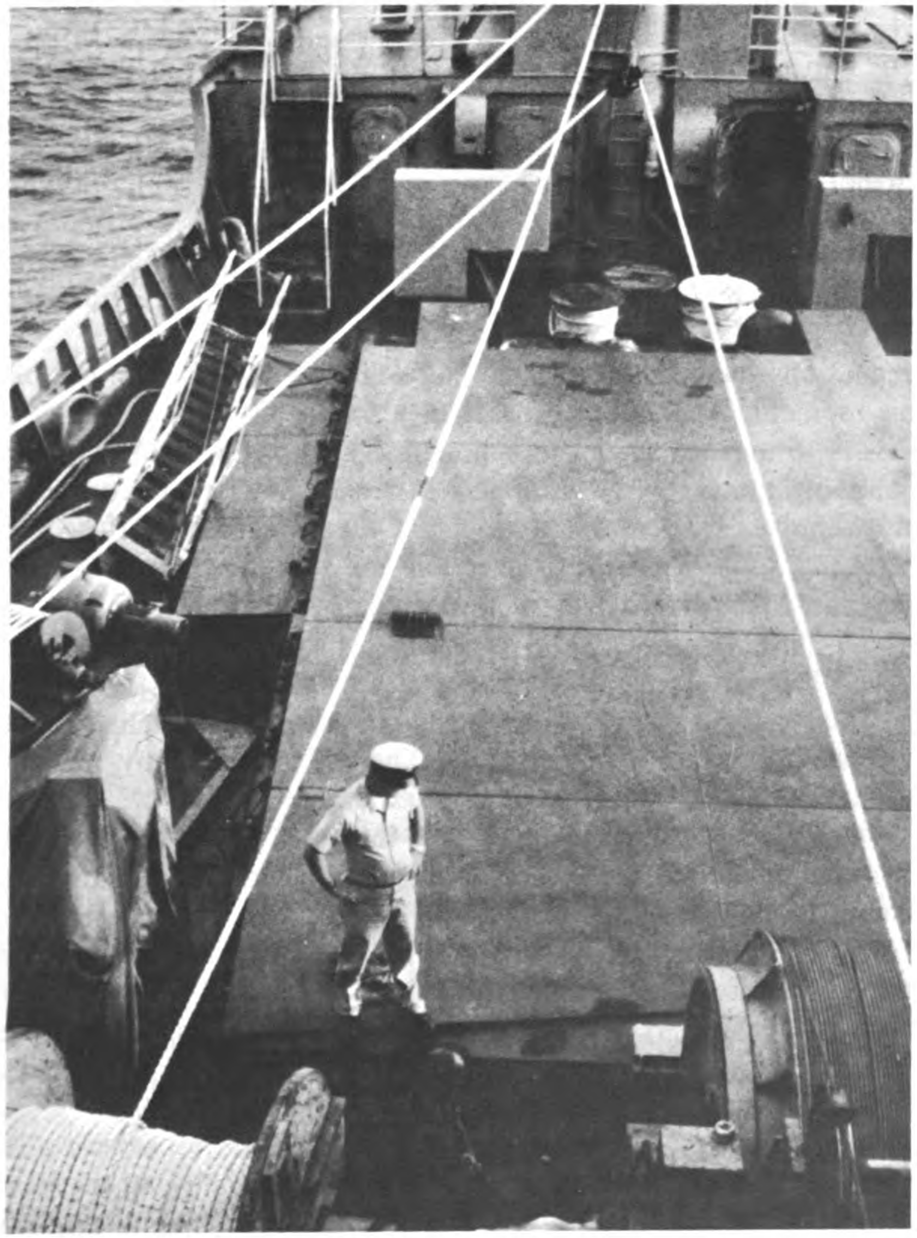


Scaled drawing of the salvage site

was built in two days. As with the first one, syntactic foam was added to reduce its weight in water to about 15 pounds so that it could be handled by Aluminaut.

Aluminaut departed Boston at 10:00 AM, 25 August, having made repairs to a splice in the power cable that fed the manipulators rather than the motor. They had also fitted the new toggle to her light boom so that pulling three pins would drop the toggle in a vertical attitude.

The salvage force again gathered on the scene in the morning of 27 August. Happily the buoy was still in position and the transponders on the bottom indicated that the clump had not moved. The toggle was rigged, shot ballast was loaded, and other diving preparations were made aboard Aluminaut. She submerged, but current carried her some three miles from ALVIN's position while preparing to dive. Once on the bottom at 5000 feet, Aluminaut was directed to ALVIN by MIZAR. There were hours of agonizing silence interrupted half hourly only by a coded message "all's well" from Aluminaut as she worked trying to insert the new toggle. She tried the first toggle and then went back to the second one. On several tries the toggle seemed to float out of the hatch just when she was ready to trip the trigger. Finally, using the manipulators, most of the port side of ALVIN's sail was torn away to give clear access to the pressure sphere hatch. By "flying" over ALVIN and



The lift line on the deck of MIZAR

stabbing with both manipulators, the toggle was put into the hatch and tripped. Then the nylon pendant on the new toggle had to be attached to a ring in the lift line with a snap hook. With this completed, Aluminaut headed for the surface.

The lift line was brought aboard MIZAR at 8:30 AM and inhaul commenced. Seas were very calm with waves and swells less than one foot. At 11:07 AM, 28 August, lift line tension had gradually built up to 9000 pounds and leveled off as ALVIN lifted off the bottom for the first time in ten and one-half months. About 12,000 pounds tension had been expected, and there was immediate concern that perhaps only the personnel sphere was on the hook. Lifting went very smoothly though slowly since the winch ran at a constant 35 feet per minute. With about 600 feet to go, hoisting was stopped to remove the transponder string from the lift line. The transponder was lashed to a stanchion in the well, and the soft eye spliced into the main lift line was cut, with a report like a gunshot. Next the headache balls were lashed in the well and cut free of the lift line. The next stop occurred with ALVIN at a depth of 50 feet and hanging below MIZAR's centerwell. Divers made their first inspection and reported that "it's all here." This was passed by radio to CRAWFORD and Stacey Tide.

Precautions were taken to make sure that ALVIN would not be lost at this moment. ALVIN's lifting bridle was lowered on a wire pendant for divers to make a secure attachment. The stern propeller, manipulator, and lift motors were strapped to the hull to prevent their loss. Because the sea was calm, the Salvage Officer decided to try to surface ALVIN alongside MIZAR. The nylon line was disconnected from the toggle, passed outboard and reconnected to the lifting bridle. As the load was shifted to the overside lift, the wire rope was disconnected, and ALVIN was brought to about 30 feet alongside MIZAR's starboard. Here, the sàlvage pontoon that had held the lift line since 18 August was connected to the bridle. The 8.4 tons of buoyancy of this pontoon was more than twice enough to support ALVIN. An attempt to blow ALVIN's ballast resulted only in a cloud of bubbles. It turned out that her fiberglass ballast tanks had split on impact with the sea in October. It was feared ALVIN would break up from bumping into the side of MIZAR. ALVIN was lowered to 40 feet, and a net was pursed around the entire submersible and other preparations for submerged towing were made. At a speed of two knots, there was some time for rest for the weary crew that had worked through from early morning lifting ALVIN and readying her for tow.

A shallow protected area was needed for the final lift where a barge with a suitable crane could be made ready. Menemsha Bight on the west shore of Martha's Vineyard was chosen. Each day while towing, ALVIN was inspected by divers to assure that she was riding well. On the second day one of the three pontoons deflated so another was added.

MIZAR arrived in Menemsha Bight at 4:30 PM, 31 August. At 8:00 AM on Labor Day, 1 September, the crane started lifting ALVIN to the surface. As the hatch broke the surface, a hose was put in to pump the sphere. Some 30 boats had gathered to witness the return of ALVIN. The sphere pumped dry, ALVIN was lifted clear of the water, still wrapped in the net, and swung around to be placed on the barge. The barge and CRAWFORD headed for Woods Hole, MIZAR headed for Washington, D.C.

On the way to Woods Hole, the ALVIN crew started the long job of disassembling and preserving compartments. First, a flush with fresh water, then with preservative, and then the taking apart. By the time the barge reached Woods Hole, most of the instruments had been removed from the personnel sphere. ALVIN was landed on the dock at Woods Hole at 2:35 PM on 1 September.

When the electric motors on the ALVIN were cleaned, it was found that only a few repairs were necessary. The repairs to the manipulator will be minor. As of this writing the inspection of the ALVIN continues and will result in a detailed report on the damage.

New Research Vessel

The nation's newest oceanographic research vessel, the 245-foot, 2075-ton *Melville*, departed Defoe Shipbuilding Company, Bay City, Michigan on her long voyage to San Diego where she will be used by Scripps Institution of Oceanography.

The *Melville* sailed through the St. Lawrence Seaway and arrived at Woods Hole, Massachusetts, on September 10. There she paid a two-day courtesy call on Woods Hole Oceanographic Institution (WHOI). Defoe is building for WHOI a sister ship of the *Melville*, the *Knorr*, scheduled for delivery later this year.

Following her stay at Woods Hole, the *Melville* proceeded to the Bahama Islands area for two weeks of intensive sea tests and trials. She is due in San Diego at Scripps' in late October.

The Bahamas' trials will provide extensive testing for the ship's machinery, especially her winches and other deep-sea gear.

The vessel will also get a thorough test of her maneuverability with a new type of propulsion that enables the ship to proceed forward, backward, or sideways, or remain stationary over a fixed point in 35-knot winds and heavy seas.

This propulsion system uses vertically mounted, multi-bladed, cycloidal propellers, one at the bow and one at the stern. Although this system was designed in this country, its use is relatively new here. It has been used in Europe for more than 30 years.

The Bahamas' trials, which will include acoustic tests, are related to the prototype nature of the ship and are intended to compare actual operating data with those obtained under controlled conditions as determined from model studies performed during preliminary design of the ship.

When all outstanding deficiencies resulting from the official acceptance trials were completed by the Defoe firm, the Navy accepted delivery of the *Melville* and turned her over to the Regents of the University of California for operation by Scripps.

The *Melville*, built at an estimated cost of $7 million, including equipment, has a maximum capacity of 62 scientists, technicians, and crew members.

The *Meville* and the *Knorr* were built under the Fiscal 1966 Navy shipbuilding program, under which the Office of the Oceanographer of the Navy and ONR sponsor oceanographic vessels used by university and oceanographic institutions. These agencies have provided six oceanographic vessels for use by universities and laboratories since 1960.

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Automatic Collection of Environmental Data

CDR W. R. Wilson
Office of Naval Research

Collecting environmental data from remote ocean areas has been a long standing problem for the U.S. Navy. By the old system, limited observational data was collected from various operational vessels, widely scattered fixed station weather ships, and a limited number of reconnaissance aircraft. In order that timely environmental data might be obtained on a routine basis from remote areas the Navy Oceanographic/Meteorological/Automatic Device (NOMAD) was developed under U.S. Navy sponsorship.

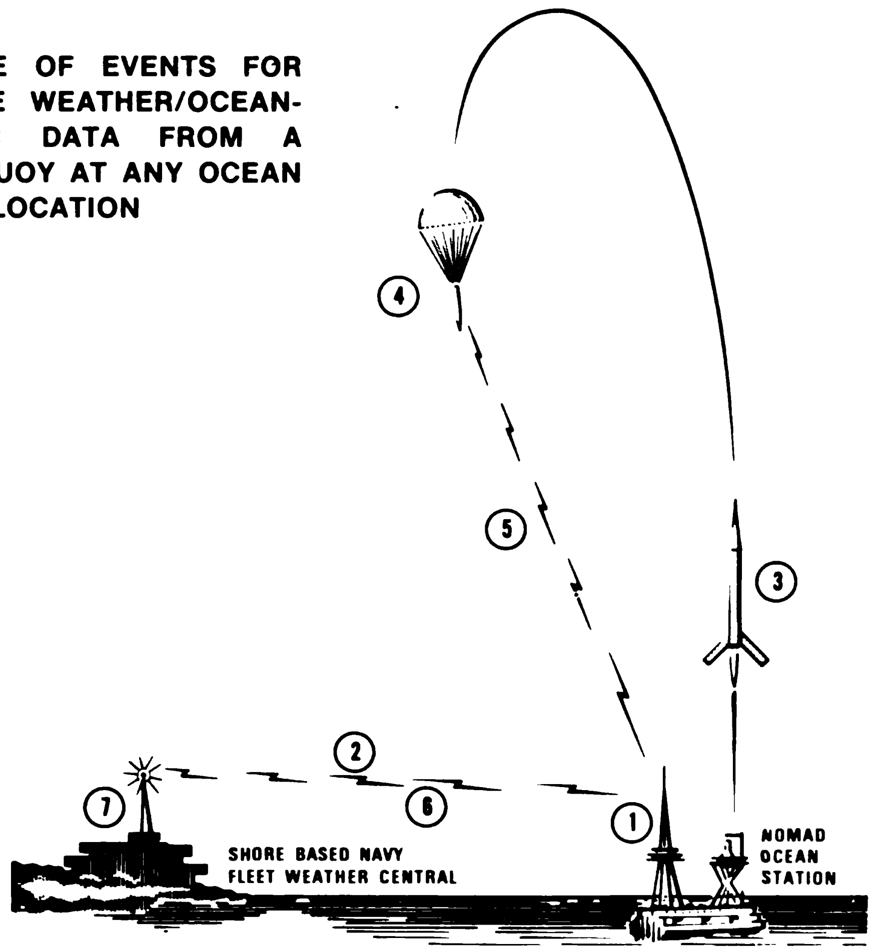
Following World War II, there was a need to reduce Navy operating costs while maintaining, and improving, the established capability for operational Fleet weather forecasting. A limited number of weather ships, assigned to specific locations, were the only means for acquiring regular weather reports from many remote ocean areas. Although the ships and their personnel performed well in assignments which often involved adverse conditions, weather ships proved to be not sufficiently effective.

Unmanned automatic weather-buoys were studied carefully as a means for supplementing weather data gathering at lower cost. The concept had merit and resulted in the development of today's NOMAD automatic ocean-buoys which collect surface weather and oceanographic information on a regular basis and transmit the information by radio to shore stations. One NOMAD buoy has been operating reliably in the Gulf of Mexico for approximately eight years.

To expand the capability of the NOMAD data gathering system, the Office of Naval Research has developed a compatible sub-system which provides reliable sounding of the troposphere. Various devices were considered with the result that the WEBROCK (Weather Buoy Rocket) system was selected for combination with NOMAD. The new buoy is called NOWEB a combination of the names NOMAD and WEBROCK.

The WEBROCK system obtains tropospheric data from ocean buoys by taking upper air soundings using meteorological rockets. The rockets, which can reach a height of 22,000 feet, obtain vertical profiles of temperature, pressure, and relative humidity during the parachute descent. Data is telemetered to an onboard receiver, stored, and retransmitted with surface and subsurface data to a shore station (Figure 1).

SEQUENCE OF EVENTS FOR COMPLETE WEATHER/OCEANOGRAPHIC DATA FROM A NOMAD BUOY AT ANY OCEAN STATION LOCATION



STEP 1. Onboard sensors measure typical parameters such as:

- Surface Wind Direction
- Surface Wind Speed
- Ambient Air Temperature
- Ocean Water Temperature
- Barometric Pressure
- Storm Winds

STEP 2. Above values are automatically converted to International Morse Code and transmitted to shore based Navy Fleet Weather Central.

STEP 3. Small rocket is automatically launched per program previously established.

STEP 4. At apogee rocketsonde starts parachute descent to ocean surface.

STEP 5. Rocketsonde measures selected atmospheric variables (pressure, temperature, humidity) and simultaneously transmits the data to an automatic onboard receiver.

STEP 6. Upper air information is processed by logic system, converted to International Morse Code, then transmitted automatically to Navy Fleet Weather Central to supplement the surface data.

STEP 7. Fleet forecasters have complete surface and vertical sounding data from the specific ocean station location to prepare forecasts.

Figure 1 – Diagram showing how a NOMAD buoy performs with the NOWEB rocket sounding capability

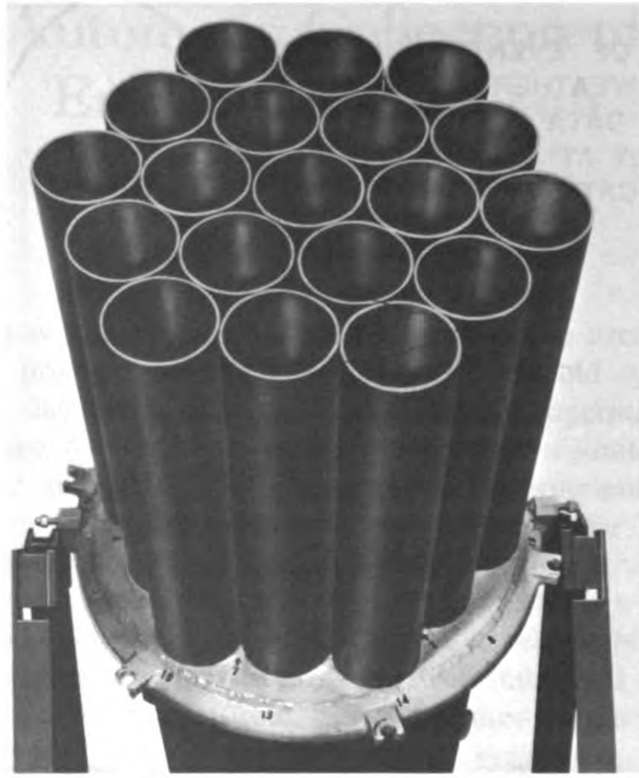


Figure 2 — Closed breech 19-tube rocket launcher

The WEBROCK program was developed under the constraint that an upper-air capability be incorporated with minimum modification to the existing system. Therefore, NOMAD equipment and data gathering techniques were left unchanged.

The two major parts of the new system are: a 19-tube rocket launcher (Figure 2) for the 2.75-inch Fold-Finn Air Rocket (FFAR), and the subsystem electronic package (Figure 3). Since an available buoy instrument well could accommodate a standard cluster of nineteen fixed-position-launch tubes, the number and configuration of the rocket launcher was established.

The subsystem electronic package was configured, as a rack mounting, to fit into a second available instrument well on the NOMAD. This assembly included a special firing switch which would assure launching only when the tubes were oriented within 10 degrees of vertical. An automatic scanning receiver, which would "hunt" from 400 to 406 MHz for a nominal 403 MHz rocketsonde transmission, and a solid state logic circuit which will command the entire sequence of events automatically comprised the remainder of the subsystem. The "logic" was designed to accommodate a sequential launch of up to 180 rockets to facilitate system growth from the prototype version to a fully operational system with expandable capabilities. Both the rocketsondes and

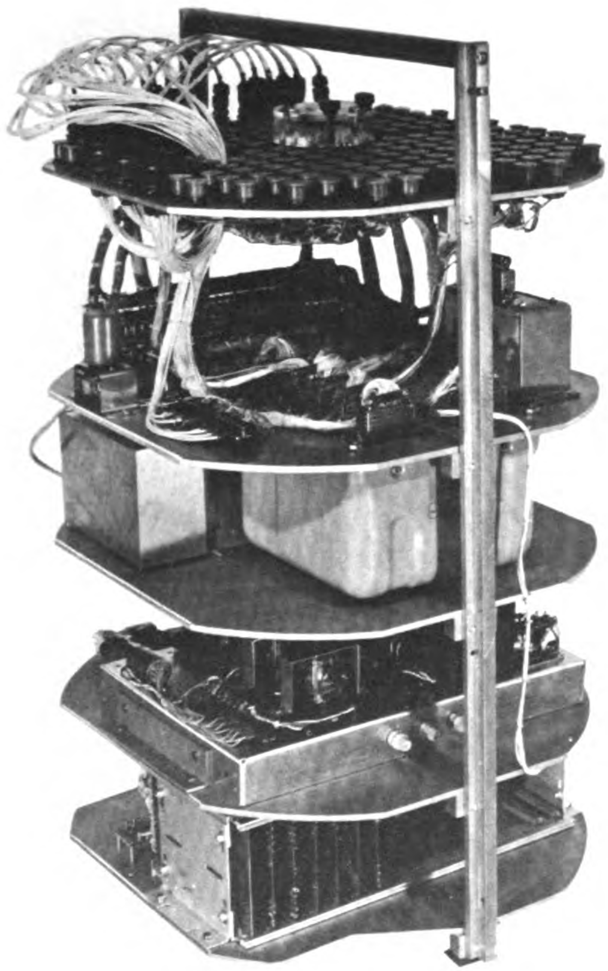


Figure 3 — Electronic equipment rack

2.75-inch FFAR motors were provided to the contractor as Government-Furnished Equipment.

After development and testing, the subsystem was installed in NOMAD and further ground simulation tests were conducted. When ready for operational tests, the NOMAD buoy, modified to incorporate the NOWEB upper air data subsystem, was transported to Lake Superior on Michigan's Upper Peninsula. It was then taken aboard USCGC WOODRUSH which anchored the NOMAD into a selected position in Keweenaw Rocket Research Range (Figure 4). This summer the system successfully completed its second series of tests and is now ready for full-scale ocean evaluation.

Investigations are in progress to develop a method of wind data acquisition. Expanding the 19-tube rocket system to include 180 rockets is also being studied.

Although the work to date has been related only to the NOMAD buoy system, it is apparent that the NOWEB upper-air data subsystem

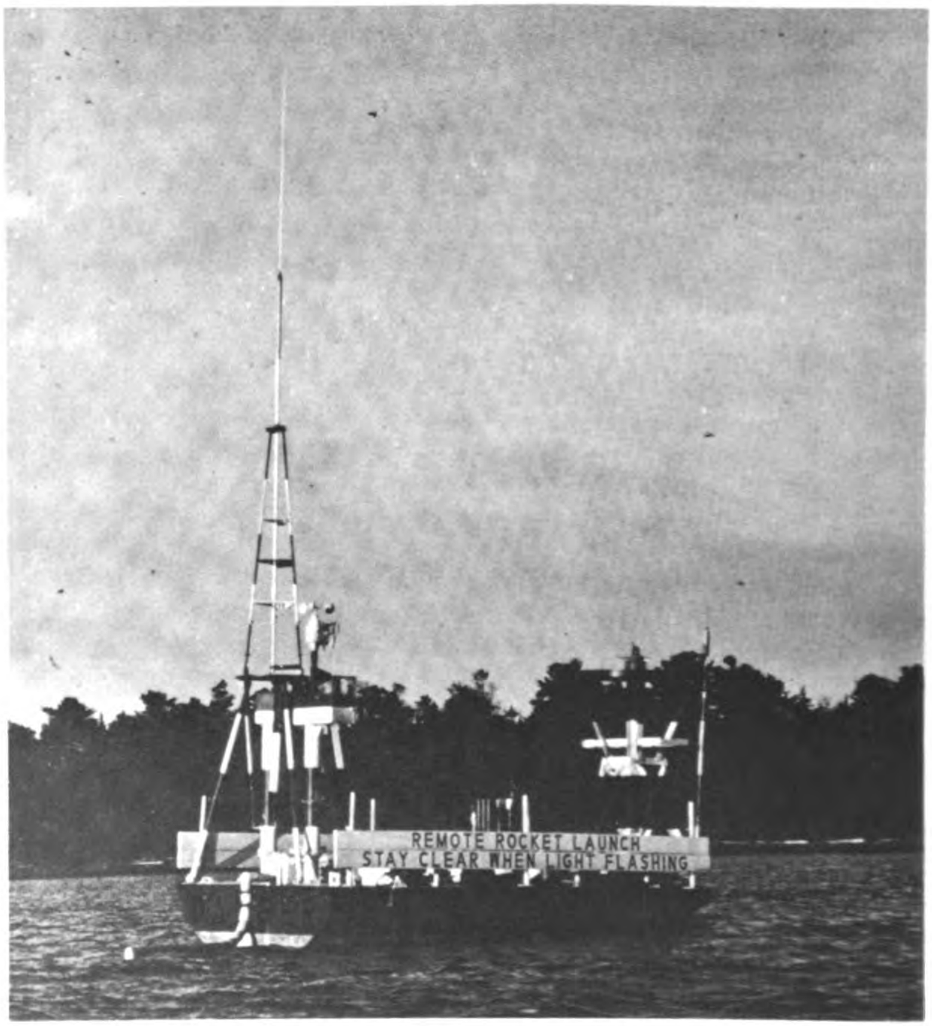


Figure 4 – Rocket equipped NOMAD in Lake Superior for 1968 tests

can be made available, as is or with modifications, as an important extension in the capability of the Monster Buoy and other buoy systems. Another ramification of the NOWEB concept is the consideration of installing this capability on selected ships. Since minimum space is required, certain Navy, Coast Guard or Merchant ships might be employed as platforms for upper-atmospheric data acquisition. Because the system is automatic, the capability could be maintained without the requirement of having a qualified meteorological staff on board. Additionally, NOMAD buoys with atmospheric sounding capabilities will be an important contribution to the Global Atmospheric Research Program and to any subsequent worldwide operational meteorological data acquisition system which would combine all relevant data from such sources as land stations, ocean buoys, balloons, aircraft, ships and satellites.

Requirements for Modern Ship Production

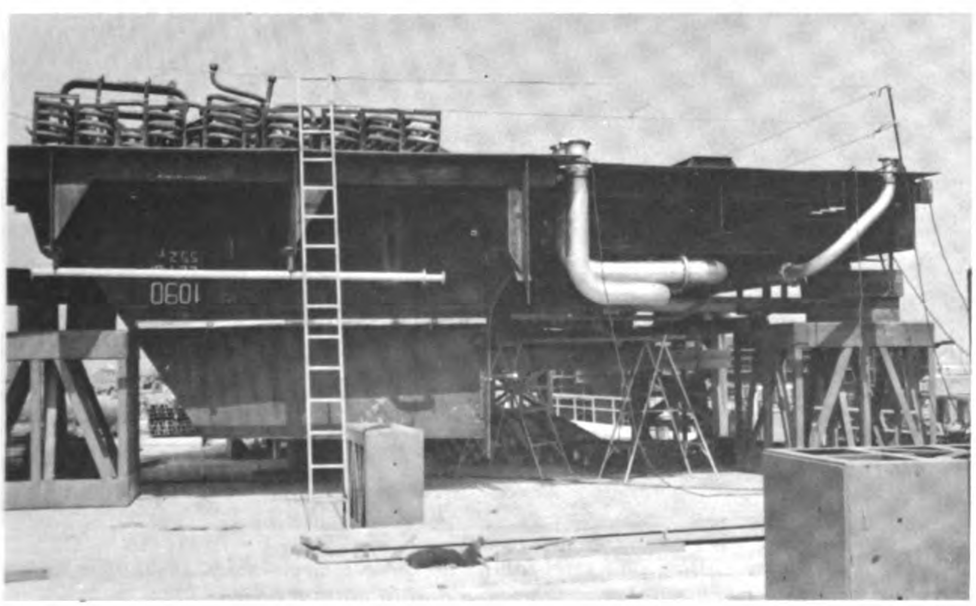
E. Frankel
Massachusetts Institute of Technology

Increased productivity in the U.S. shipbuilding industry has proceeded at a slower rate than most other industries. Improvements are needed in the industry so that the shipyards can effectively meet the present day needs of the Navy. The Office of Naval Research sponsored a study of U.S. shipbuilding capacities and recommended changes to improve productivity, man-hour requirements, and coordination of the flow of people, raw materials, work pieces, and information.

Outfitting is of particular importance in the development of effective shipyard processes. Automated steel fabrication and assembly processes constitute only a small portion of the total shipbuilding effort. On the other hand, outfitting of the assembled hull after completion or erection requires a large amount of labor activity in extremely small spaces, which results in low labor productivity. This process could be improved by diverting outfitting to a number of different areas in the shipyard and incorporating it with certain stages of the actual hull erection process, examples of which are shown in Figures 1 and 2.

Of importance to the effective use of a ship production facility is the general shipyard layout, with particular reference to the ship erection line, subassembly transfer method, and launching techniques. Shipbuilding is a very complex production process with great deviations from

Figure 1 — Preoutfitting of tanker hull preassembly



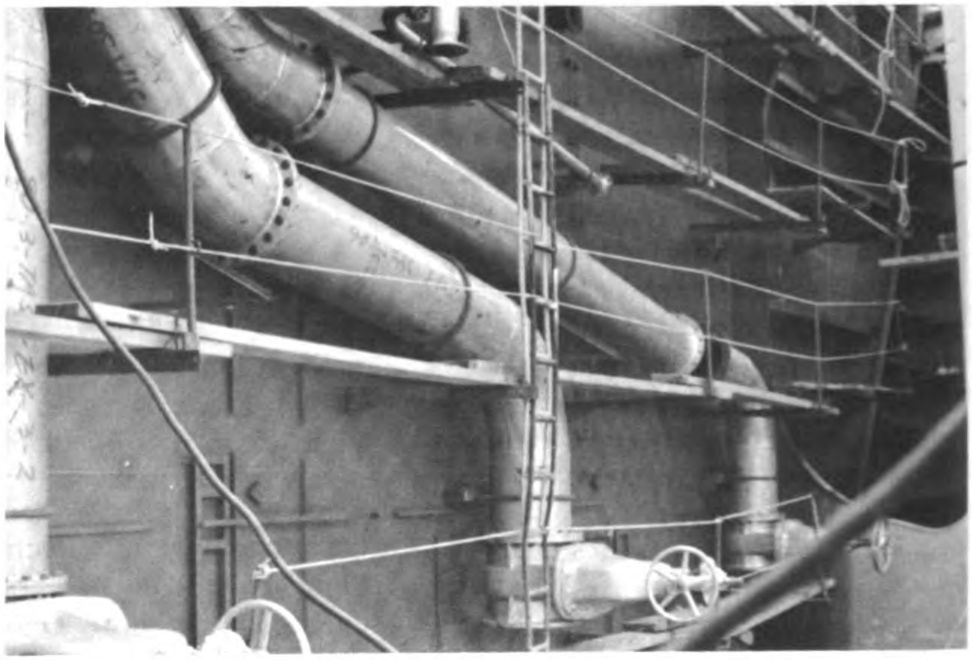


Figure 2 — Preoutfitted bulkhead lifted into position

the expected completion times for the various individual production states. As a result, it is important that sufficient storage and supply areas be provided at various points along the way of the assembly process to handle pieces waiting for the next stage of construction.

A well-designed steel fabrication shop is shown in Figure 3. While some in-line production techniques have been incorporated into the

Figure 3 — Flame cutting and steel fabrication. Note large aisles and buffer areas and small number of workmen during normal operations.

steel fabrication processes of many U.S. shipyards in recent years, very little advantage has been taken of in-line production techniques in other shops, in particular, the steel and ship erection processes. Interesting details of modern welding techniques are shown in Figures 4 and 5. Numerical control for the various production processes and the availability of accurate measurement and alignment techniques would allow more phases of the ship erection process to be completed while in the production line. An ever-present and important factor in the layout of a new ship production facility or the redesign of an existing facility is sufficient buffer storage areas to assure continuous process flow and material control.

Another important aspect of shipyard design and ship production planning is proper documentation such as the availability of a data bank as well as an efficient information and data control system. These are required for the planning and scheduling of the ship production process and are of particular importance in series construction of ships. Planning and scheduling of the production and material flow and the allocation of human and other shipyard resources requires the use of recently developed network analysis techniques. The adaptation of computerized PERT and decision networks, as well as the use of flow graph techniques has been found effective. These computerized methods for information and process modeling, planning, scheduling, and control can usually be incorporated with other new techniques such as linear, dynamic, or parametric programming. The extent and complexity of processes and material flow in a ship production facility often makes the network

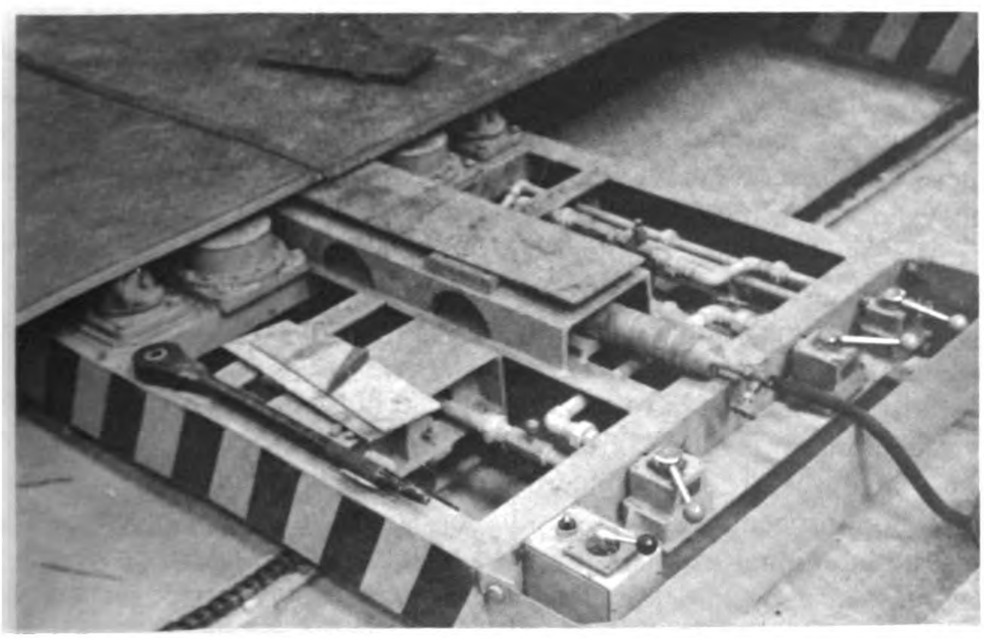


Figure 4 — Copper backing and hydraulic alignment for one-sided welding operation

Figure 5 — Multiple gravity welders operated by single workman in continuous operation

approach cumbersome. By subprogramming buffer storage areas as nodal points, such networks can often be greatly reduced or divided into smaller networks of tractable size.

The results of several network analyses of ship production processes indicate the advisability of providing central material storage for all material except processed steel. Received and processed material could be accumulated in one central area and formed into integrated kits on steel pallets designed to centralize all the material required for erecting the subsystem in one specific area. Such a procedure not only assures proper material flow control, but also more precise planning. These kits include everything required for the assembly of a particular subsystem, even such items as specialized hand tools.

Lifting and transfer problems in the shipyard impose new problems as a result of the potential size of the prefabricated units to be handled. Detailed study is needed for the design and planning of effective material handling equipment.

Statistical methods have been developed for the analysis of accumulative tolerances resulting from fabrication and erection inaccuracies. These analyses are also concerned with the development of necessary correction procedures. The results of some initial analyses indicate that the additional expense involved in introducing a higher degree of accuracy in the shop fabrication and subassembly processes is well warranted.

Another area of interest is information transfer, which involves the development of a procedure which will permit better control of the individual worker's functions. As a result, the use of numbered isometric sketches showing detailed erection or fabrication sequences to be used by the workers is found effective. It is believed that such sequence diagrams and isometrices can eventually be generated by the ship working plan computer design programs (CASDOS) currently being developed.

Other problem areas in which operations research techniques are used are ship production engineering, market analysis, and development of shipyard criteria for the optimum use of funds and materials. Some of these problems are concerned with inventory and procurement policies as well as with the physical layout for material storage and maintenance. Some operations analysis techniques are also useful in designing cost centers and cost control procedures. These centers and procedures form part of an integrated management information system—a basic prerequisite for an effective shipyard management and control structure.

Our efforts for improving ship production techniques must be aimed at curing the inherent ills of our ship construction approach and not isolated symptoms such as steel marking, cutting, or storage. This requires extensive analysis, planning, and coordinated management and control of material flow, fabrication processes, manpower allocation, resource allocation, and inspection.

A prerequisite for progress is better coordination and collaboration among the various interests in ship construction and the dissemination of the large amount of data and information available in the various shipyards. We hope that the shipbuilding industry of this country will join in facilitating this effort by permitting the exchange of experience and information for the good of all members of the industry.

National Research Council Program Expanded

The National Research Council-Bureau of Medicine and Surgery Postdoctoral Research Associateship Program, involving four U.S. Naval medical research activities in 1969, is being expanded to include a fifth activity for the 1970 program. The Submarine Medical Research Laboratory in New London, Connecticut, will join the Naval Medical Research Institute, Bethesda, Maryland; Naval Aerospace Medical Institute, Pensacola, Florida; Naval Medical Neuropsychiatric Research Unit, San Diego, California; and the Aerospace Medical Research Department, Johnsville, Pennsylvania. The credentials of the research advisers and the scientific merits of the research programs of each laboratory are approved by the National Research Council. During the 1969 program, eight candidates accepted appointments under this program.

Candidates applying for these associateships must have received the equivalent of an M.D. or Ph.D. For a candidate to receive an associateship, the potential adviser must approve the candidate's qualifications; after this, the NRC screens the records of the remaining candidates and selects those worthy of appointment. Candidates may receive more information regarding this program by writing to the Associateship Office, National Research Council, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

Working with Sea Floor Sediments

R. J. Smith
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Naval Postgraduate School

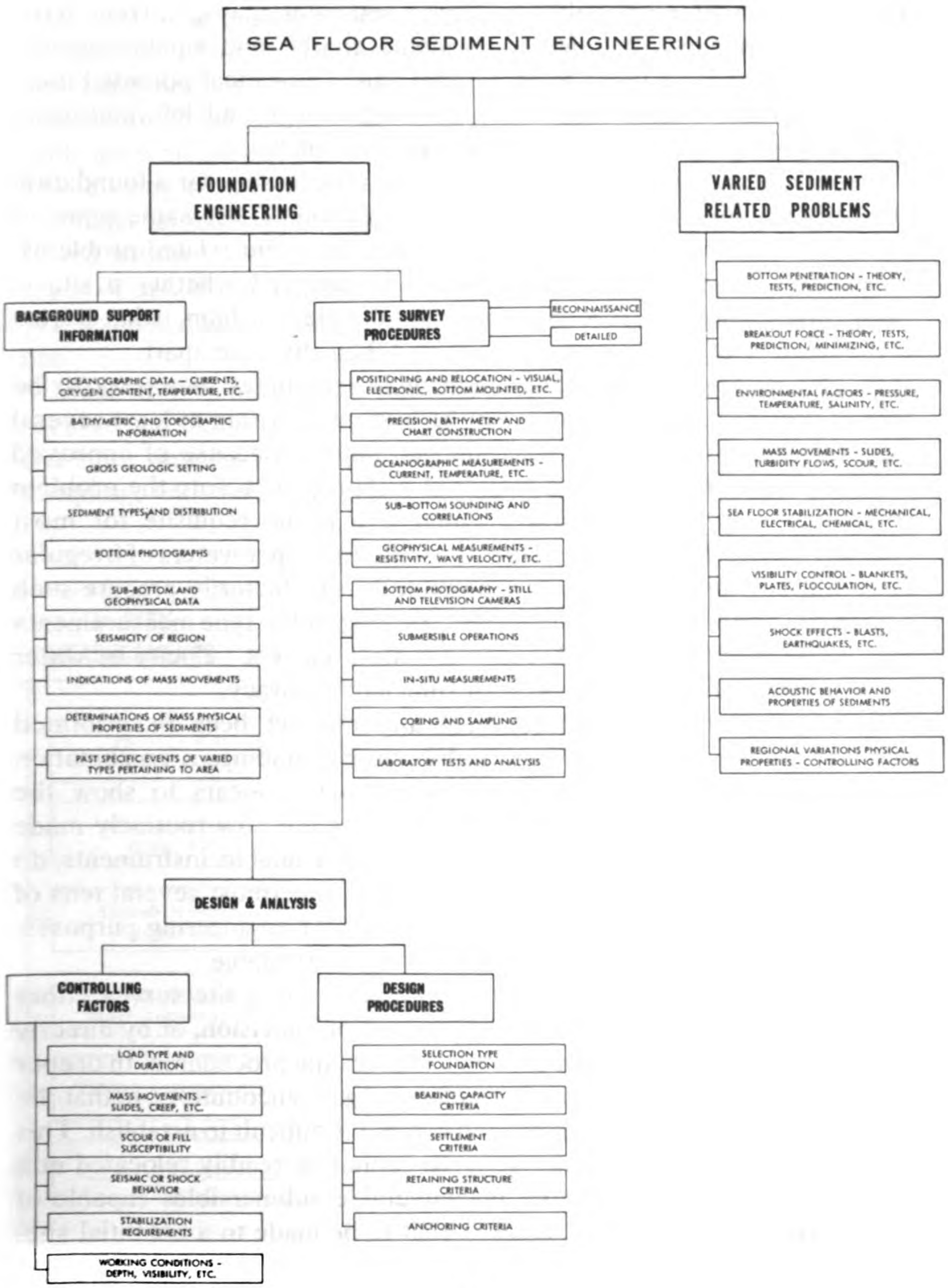
For more than a hundred years the sediments of the deep sea floor have been subjected to study by marine geologists, geophysicists, mineralogists, sedimentologists, and oceanographers. The purpose of these studies has been to scientifically gather information about the oceans; more specifically to learn the histories of the various oceanic basins and something as to the types of materials that fill them. In spite of the effort that has gone into this, an understanding of the processes involved is far from complete. The Office of Naval Research and the Naval Postgraduate School are supporting work in this field.

The last several years have seen ocean engineers place some emphasis on putting the seas to practical use; and as a consequence there is an interest regarding the physical characteristics of the bottom sediments. Because petroleum production is going to greater depths as is mining, engineering questions having to do with undersea pipelines, cables, and other similar support structures often arise. Most activity is largely confined to the shallower water of shelf areas at the continental margin.

Various types of anchorages and surveillance equipment foundations are being placed on the bottom, deep-diving submersibles and submarines now operate close to or on the sea floor, and search and recovery efforts are carried out as part of "deep submergence" programs. Questions often arise as to what will occur when a large object or vessel is placed on the bottom—will it rest on a hard surface or will it sink in, and if so how far? Are some areas of the sea floor overly susceptible to movement in the form of landsliding, turbidity currents, or perhaps scour? Can the objects be readily freed from surrounding bottom muds when the time comes for retrieval? During the early stages of search and recovery operations the possibility always exists that the object sought might be so deeply buried in soft sediments that it is totally hidden.

The answers to such questions rely on a combination of instrument techniques and engineering procedures. The field of soil mechanics and foundation engineering as developed for use on land is being modified for the deep sea floor. These fields are not very old, having largely developed since the 1920's under the capable guidance of the mechanicist-geologist Karl Terzaghi; and a backlog of useful experience is being accumulated. Some aspects of these disciplines are quite soundly based, while others are empirical and their appropriateness to the deep sea remains to be proven.

The realm of sea floor sediment engineering, as shown on the accompanying chart, can be divided into the two broad and interwoven categories: *foundation engineering* and *varied sediment related problems*. Foundation engineering is the simpler of the two because if a proposed site proves unsatisfactory another location can be sought. This advantage does not hold true in all cases, as for example, a stranded vessel. Here



the bottom must be dealt with as it exists regardless of possibly difficult conditions.

Prior to starting a detailed foundation investigation, it is advantageous to first bring together the available background support information. This can be of many different types and is to be found either within the literature or in the various data storehouses. Such accumulated information is naturally more abundant for proposed sites closer to shore, and it is sometimes possible to locate sediment maps, current data, sub-bottom surveys, detailed topographic charts, and similar records made for areas very close to that under study. For most potential locations in deeper waters further from shore, background information in sufficient detail to be of value is usually not available.

For preparing a site survey the data that is necessary for a foundation design is supplied from laboratories and the field. These same types of surveys must be carried out for other varied sediment related problems. Essentially the same basic information is gathered whether a site is being investigated in reconnaissance or detailed fashion, what varies is the number of measurements made and their distance apart.

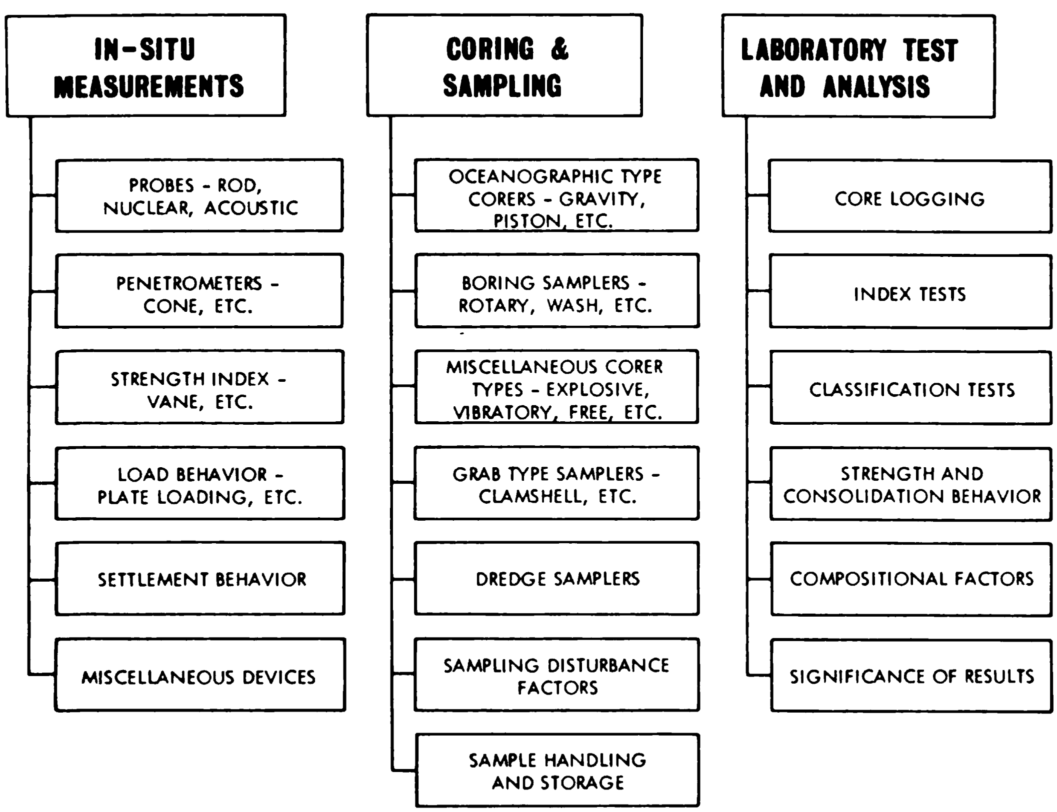
In placing an undersea foundation, it is sometimes necessary to be able to precisely relocate points on the bottom to within at least several feet; this cannot be done well in deeper waters. Because of improved instruments, it may be only a matter of a short time before the problem is solved. A precise topographic map is a prime requisite for most engineering projects either on land or at sea. In deeper waters of irregular bottom topography it is not now possible to satisfactorily prepare such a base. On the other hand, the normal oceanographic-type measurements that are sometimes required, such as bottom current velocity or water temperature, can now be made with sufficient accuracy.

Geophysical techniques have generally not yet been incorporated into the site survey procedures. Sub-bottom sounding, a combination of acoustic profiling and reflection seismology, appears to show the greatest potential use. Very deep penetrations are now routinely made for petroleum exploration purposes, but the available instruments do not give a fine enough calculation, within the uppermost several tens of feet of the sediment column, to be adequate for engineering purposes. The technology to accomplish this seems to be available.

An ability to visually observe the bottom during a site survey either by examination of photographs, or by means of television, or by directly viewing it from a submersible greatly enhances the procedures. In deeper waters, however, the positioning problem is again encountered in that the precise location of a still or television camera is difficult to establish. This means that points of particular concern cannot be readily relocated at a later time. The advent of more maneuverable submersibles capable of going to deeper depths does allow a visit to be made to a potential site. Similar to the above, however, the methods available for fixing the subsurface positions of submersibles is not yet precise, and the locations of observed features are not accurately known.

The most important of the various site survey procedures are those involving the in-situ measurements, coring and sampling, and laboratory tests and analysis. As a consequence these portions of the overall chart are shown in expanded detail. Probes, penetrometers, vanes, and plate loading devices are extensively used on land and do have the conspicuous advantage that the soils are dealt with under full-scale and in-place conditions. The possibility of making similar tests on the sea floor appears inviting, particularly as a means of cancelling out the unknown hydrostatic pressure effects on sediment behavior. Conducting such tests on the sea floor by remote means does pose many problems. The making of the precise readings that are necessary for in-situ tests is almost an impossible task, and then the data obtained must either be stored within a pressure chamber or else relayed to the surface. Various types of in-situ equipment are currently being developed, but none have yet reached such a stage of reliability as to be considered for standard use.

Most of the information necessary to design a foundation must be secured through a program of sampling and laboratory testing of cores. On land, samples for testing purposes are obtained by drilling and then sampling, and then by drilling and sampling again, until the necessary



depth is reached. At sea, however, it is not possible to re-enter the same core hole a second time as the sampling tool is swinging on the end of a wire. This means that only one continuous sample can be obtained at each point. The resulting cores are usually too short to permit a proper engineering evaluation. Also the materials have been subjected to an unknown degree of disturbance during the sampling process. The devising of means to secure undisturbed samples of sufficient length represents one of the most pressing problems in the field of sea floor sediment engineering.

The samples undergo a laboratory analysis procedure that involves core logging, index tests such as density and water content, classification tests for grain size distribution, shear strength measurement, consolidation (settlement) behavior, and mineralogic composition. To varying degrees, portions of each of the above analysis steps are open to question as to appropriateness for sea floor sediment. Some tests are appreciably in error. This situation at least partially results from the fact that some of the marine sediment types that are found on the bottom are unlike anything that is encountered in land soil mechanics. Only by continued analyses of many different kinds of marine sediments will the correct procedures eventually be worked out.

The laboratory test results enable the design and analysis of a foundation to be made for the sediment involved, subject to certain controls. Some of the factors to be considered are the type and shape of the load, the length of time it rests on the bottom, the possibilities of mass movements occurring at the site, potential scour and fill brought on by excessive bottom currents, the likelihood of pronounced earthquake movements, and perhaps in some instances the requirement that the sediment be locally stablized with an additive or by compaction. The working conditions that may be anticipated for a potential site also act as an all-important control primarily with relation to the depth at which a structure is to be placed. The procedures presently being used to design a foundation for the sea floor parallel those that are applied on land, with a knowledge that these may lead to some yet undetermined errors. The type of foundation to be used must be selected, the ability of the sediments to support the load without a bearing or shear failure ascertained, and an estimate of possible excessive settlements made. Perhaps sediment retaining structures will eventaully be designed for deep sea situations, though none have to date, and it can be expected that construction of a retaining wall in deep water will offer numerous difficulties. Buoyant structures have an anchoring or 'hold-down' requirement, and these presently generally follow surface anchorage design procedures.

The various sediment related problems represent an area of almost a complete lack of understanding. How deeply a downward moving object (as a submarine) might penetrate into a particular type of sediment cannot be determined with any degree of reliability. Some experimentation has been done to determine the force that would be required to pull a bottom-setting object free of the suction influence of surrounding fine muds, but an acceptable solution is far from established. Some work has been done on the influence of the high hydrostatic pressures on the physical behavior of sediment, but again the results are inconclusive. A question often arises as to whether the data secured from a nearby analyzed core is truly applicable to the precise point where a load is to be placed.

Only a few of the numerous areas of uncertainty in this field of sea floor sediment engineering have been noted here. An effort is being made by the Naval Facilities Engineering Command and its associated groups to answer some of the questions.

Self-Contained Respirator

Valley Forge, Pa.....The General Electric Company announced today the awarding of a research contract by the Office of Naval Research to develop a self-contained medical respirator. The suitcase-size respirator will assist in, or actually provide the breathing function of a patient at forward area hospitals, hospital ships and in medical evacuation missions.

The portable G.E. respirator, expected to weigh about 40 pounds, will be able to operate without benefit of external electric power or an external source of oxygen for approximately eight hours. A unique closed-cycle regenerative system will be used to achieve this long autonomous operation, which will permit continued use of the respirator from initial medical aid through delivery of the patient to rear area fixed facility hospitals.

In the closed-cycle system the exhaled breath is chemically processed for removal of carbon dioxide, and appropriate oxygen concentrations are automatically added and recirculated to the patient. Once in a rear area hospital, the respirator can be switched to open-cycle operation and used indefinitely, drawing on the power and oxygen supplies of the facility.

The impetus behind the development of the respirator was the requirement for such a device in Vietnam. Navy physicians reported there was an urgent need to make available to military field forces a small, lightweight and highly effective respirator duplicating the performance of in-hospital units.

The respirator, the first of its type, is described by Company officials as one of the most flexible medical therapeutic devices ever introduced. Features include a highly accurate oxygen sensing and control system which allows the physician to monitor accurately the oxygen concentration being fed to the patient. Another special feature is continuous electronic monitoring of the amount of gas the patient receives in each breath.

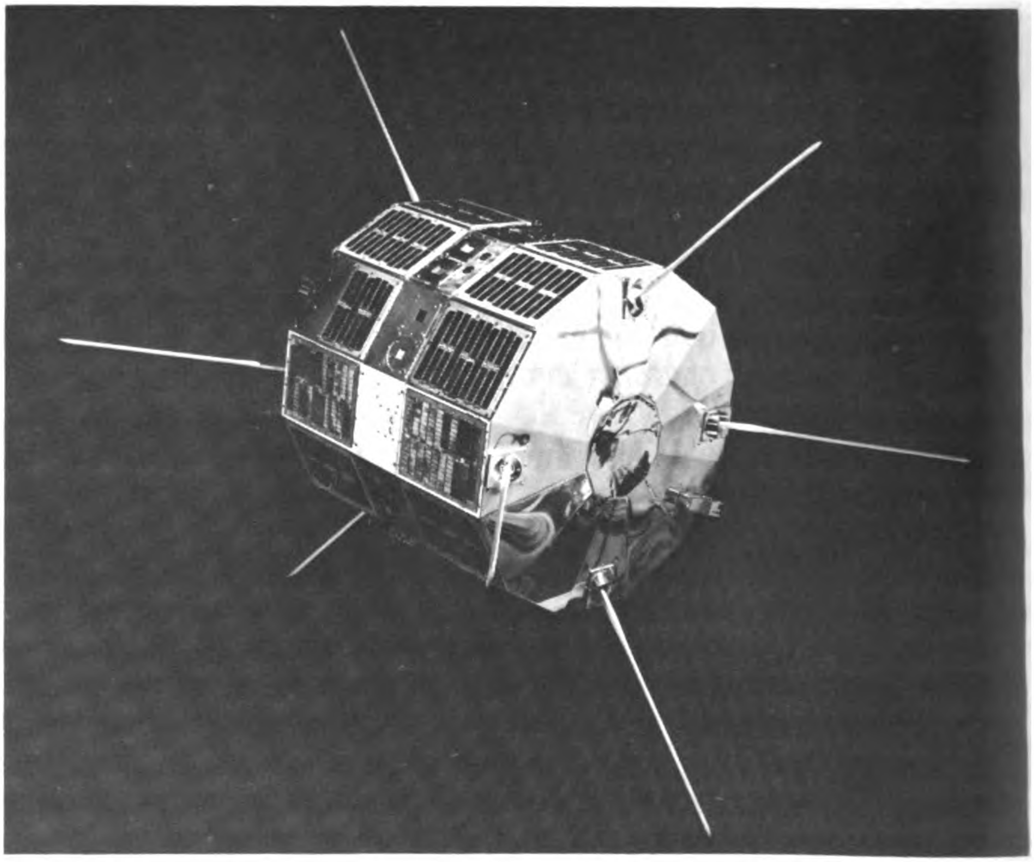
The respirator is also designed with a pressure override device so that the patient can overtake the machine when his respiration is sufficiently adequate to maintain his own pulmonary function. The machine then works to assist, rather than to control the patient's breathing.

The technology to be used in the development of the respirator is the result of spinoff from the life-support space activities of the Company's Missile and Space Division.

Following delivery of the prototype units, the Navy's Bureau of Medicine and Surgery will conduct laboratory and field evaluations of the respirator.

Research Notes

SOLRAD Satellite



Short-term solar flare activity forecasts derived from information furnished by the Naval Research Laboratory's SOLRAD-9 (Solar Radiation) satellite during America's historic moon landing, played a significant role in safeguarding the spacemen and their communication systems in Apollo XI.

Laboratory scientists said that solar radiation, which fluctuates, can be in the form of intense proton streams that would be harmful to spacemen out of their vehicle or could play havoc with ground communication systems.

SOLRAD-9, the 9th in a series of solar radiation detection satellites, senses solar x-ray emission, records them, and upon command telemeters the data to a receiving station at the Lab's Blossom Point, Maryland site. SOLRAD satellites are sponsored by the Naval Air Systems Command and are put into orbit by the National Aeronautics and Space Administration.

Special operations for the Apollo VIII moon mission by the SOLRAD satellite data system began at the request of NASA officials in December 1968 when spacemen first circled the moon and returned to earth. During this period the satellite stored a continuous record of solar x-ray activity. It was queried also for radiation data as often as six times during a day when it was in view of the Blossom Point receiving station. The stored data was processed in about a half an hour's time at the Naval Research Laboratory and then transmitted by facsimile to the Environmental Science Services Administration's Space

Disturbance Forecast Center at Boulder, Colorado where it was used to assist in the evaluation of the space environment. SOLRAD Project support was also given during the flight of Apollo X in May 1969. Scientists ascertained that the radiation levels that existed during the Apollo VIII and X missions were not hazardous.

As a safety measure, the SOLRAD Project support was used again at a request of NASA officials during the Apollo XI mission to provide solar activity data to the Space Disturbance Forecast Center. The record low level of solar x-ray activity measured during the mission proved that the astronauts were operating in optimum radiation environment and at no time were in any danger from the solar radiation.

The data resulting from the Naval Research Laboratory's SOLRAD Satellite system was considered by mission officials to be timely and accurate. Timeliness was significant because very intense solar radiation could result in the cancellation of certain phases of the lunar mission.

The first of a series of nine SOLRAD satellites was conceived and developed by the Naval Research Laboratory and launched in 1960. In the years prior to the 2-month successful results of SOLRAD I, scientists used rockets to life x-ray sensors above the earth's atmosphere. These were the first detectors to experimentally confirm that the sun emits x-rays.

SOLRAD 9, which was launched 5 March 1968, weighs 195 pounds and is in the shape of a twelve-sided drum. It is about 30 inches high and 30 inches across. After a year and a half of continuous operations the satellite is still transmitting measurements of the time history of solar x-ray emissions.

NRL Developes New Laser Beam Detector

A new laser beam detecting device developed by a Naval Research Laboratory scientist, is expected to advance laser beam technology by its use to observe the shape, size, and mode structure of laser beams in the infrared region.

Mr. Philip Allen, an electronic engineer research with the Laboratory's Radar Division, recently developed and successfully tested the instrument that allows scientists to observe infrared laser beam images through the use of encapsulated liquid crystals as a sensing-indicating medium. Real-time viewing from the use of the device permits rapid and adjustments of infrared lasers and visual alignment of associated optical systems.

As a result of the new development Naval Research scientists expect to build more sophisticated imaging detectors for high-powered lasers that will eventually result in the improved application of CO_2 lasers for communications, radar, and other systems.

Mr. Allen stated that prior to his new invention, researchers had a difficult task of observing the long-wavelength beams of CO_2 lasers and often had to resort to obtaining "images" burned in paper or wood. He stated that quantitative measurements of the beam power from a CO_2 infrared laser are routinely made with the use of a calibrated thermopile but this method does not reveal certain detailed information about the beam needed for research.

Mr. Allen credits the success of his new device to the use of encapsulated liquid crystals (ELC) in which thermally sensitive material is sealed in very tiny protective capsules some 20-30 microns in diameter. The capsules hold their sensitivity while liquid crystal screens used in other devices often lose sensitivity when exposed to the atmosphere and ultraviolet light. The colorful images produced by the use of the new detector can be viewed in high illumination, allowing the images to be photographed by conventional methods for further scientific investigation. Mr. Allen said the detectors are inexpensive, relatively simple to fabricate and can be made as large as required.

On the Naval Research Reserve

NRRC 1-1, Naval Technology Seminar

The Naval War College hosted the Ninth Annual First Naval District Research Reserve Seminar at Newport, Rhode Island. The seminar on advanced naval technology was conducted by NRRC 1-1 of Boston for the Office of Naval Research. The Seminar was designed to give the attendees an understanding of the force and command structure, operations, platforms and systems of the several surface and airborne forces of the Navy. The six days of briefings included such topics as Naval Air, Service Forces, Amphibious Forces, the Cruiser-Destroyer Force, Weapons Systems and Ordnance, and the Marine Corps. Two days were devoted to research reserve matters and progress reports.

NRRC 5-10, Bethesda, Maryland, went to the Naval Air Station, Norfolk, Virginia, recently for an indoctrination tour of several naval installations. The schedule included visits to the Naval Air Rework Facility, the Fleet Anti-Air-Warfare Training Center, the Naval Weapons Station, and HMCS Assinboine, a Canadian destroyer escort type vessel. NRRC 5-10 is made up of Reserve Officers who work as scientists, engineers, or administrators in research and development programs in civilian life. Meetings are held on the second and fourth Tuesday evenings of each month at the Naval Medical Research Institute on the grounds of the Naval Medical Center, Bethesda, Maryland.

NRRC 13-5, Corvallis, Oregon, recently sponsored the Seventeenth Annual West Coast Research Reserve Seminar along with the Pasadena Branch of the Office of Naval Research. The seminar was "Oceanography and Marine Resources." Lecturers were primarily from the staff of the Department of Oceanography at Oregon State University with support from other departments, various institutions and Federal agencies.

The program was divided into sessions on physical oceanography, chemical oceanography, biological oceanography, marine economics and law, and marine fisheries and food technology. There was a field trip to the Science Center at Newport which included a cruise on the research vessel YAQUINA.

Selected Contract Research Reports

The contract research reports listed below have been extracted from U.S. Government Research & Development Reports 69, No. 7 of 10 April and No. 9 of 10 May 1969. Government agencies and their contractors who are registered with the Defense Documentation Center of the Defense Supply Agency may obtain copies from the Center at Cameron Station, Alexandria, Virginia 22314. Abstracts of the reports are found in USGRDR 69, Nos. 7 and 9.

For non-DDC users, most reports may be purchased from the Clearinghouse for Federal Scientific and Technical Information, Department of Commerce, Springfield, Virginia 21151.

AERONAUTICS

Rotor Induced Flow Fields in Ground Effect in the Vicinity of a Vertical Step; W. Va. U.; Migliore; AD-683 792

ASTRONOMY AND ASTROPHYSICS

Interplanetary Sector Structure in the Rising Portion of the Sunspot Cycle; Calif. U.; Wilcox and Colburn; AD-683 789

Coronal Structure at the Solar Eclipse of September 22, 1968: Prediction and Observation; Calif. U.; Schatten; AD-683 790

The Age of the Galaxy from the Decay of Uranium; Princeton U.; Dicke; AD-683 801

Cosmology; Princeton; Peebles; AD-683 802

Origin of the Globular Star Clusters; Princeton U.; Peebles and Dicke; AD-681 521

Discovery of an Intense OH Emission Source; CalTech; Eliasson and Bartlett; AD-681 708

Observations of Sunspot Fine Structure from the Stratosphere and Theoretical Interpretations; Princeton; Danielson; AD-682 099

Primeval Fireball Intensity at Lambda=3.3mm; Princeton; Boynton *et al;* AD-682 100

ATMOSPHERIC SCIENCES

Low-Frequency Interchange Instabilities of the Ring Current Belt; Calif. U.; Liu; AD-681 724

A High-Rotation General Circulation Model Experiment with Cyclic Time Changes; Colorado St. U.; Elsberry; AD-681 744

An Analog Computer Solution of the Wave Interaction Equation; Pa. St. U.; Horwitz; AD-681 774

Summary Report. Atmospheric Propagation Background Studies Up to September 1, 1968; Columbia U.; Tolstoy *et al;* AD-683 312

Large Amplitude Pc 1 Events at College; Alaska U.; Heacock; AD-683 430

Ionospheric Observation of VLF Electrostatic Noise Related to Harmonics of the Proton Gyrofrequency; Iowa U.; Mosier and Gurnett; AD-683 666

Humidity Augmentation as the Initial Impulse in a Numerical Cloud Model; Rand Corp.; Murray; AD-683 258

BEHAVIORAL AND SOCIAL SCIENCES

A World Political Data and Analysis Program; Yale U.; Foltz *et al;* AD-683 791

Components of an Operational Theory of International Alliance Formation; Yale; Russett; AD-683 839

On the Complexity of Grammars; Iowa U.; Fleck; AD-683 296

Web Grammars; Md. U.; Pfaltz and Rosenfeld; AD-683 684

The Effect of Multiple Responses and Certainty Estimates on the Integration of Visual Information; Denver U.; Halpern and Ulehla; AD-683 363

A Program for the Study of Role Theory; Mo. U.; Biddle; AD-683 682

Effects of Prior Agreement by Others on Task Confidence and Conformity; St. U. of N.Y.; Julian *et al;* AD-683 904

A Production Management Operating System Simulation; Carnegie-Mellon U.; Kriebel; AD-681 717

Organizational Archetypes of a Multi-National Company; Carnegie-Mellon U.; Rutenberg; AD-681 722

Automatic Generation of Efficient Lexical Processors Using State Techniques; M.I.T.; Ross *et al;* AD-681 576

A Career Development Program for ADP Personnel at NACSOSSACT; U. of S. Calif.; Rigney *et al;* AD-681 772

Chemical Variation in Brain Loci During Shock Avoidance; York U. (Canada); Gaito *et al;* AD-681 522

Chinese and American Perceptions of Nations in Conflict. A Laboratory Test of Bronfenbrenner's Mirror Image Hypothesis Under Conditions of Simulated Limited War; Purdue U.; Streufert and Ishibashi; AD-681 698

COMROQ: A Fortran IV Program to Construct Multiple Rank Order Questionnaires; Educational Testing Service; Friendly; AD-681 716

Leadership in Negotiations and the Complexity of Conceptual Structure; Purdue; Streufert *et al;* AD-682 097

The Perception of Experimentally-Induced Success; Purdue; Higbee and Streufert; AD-682 098

Relationship Between Hypnotic Susceptibility and Fear of Failure Motivation; Bucknell U.; Teevan and Manganello; AD-682 207

Some Applications of Procedures for Allocating Testing Time; Educational Testing Service; Novick and Thayer; AD-682 223

A Program for Estimating a Bivariate Distribution of Test Scores from the Marginals; Educational Testing Service; Stocking *et al;* AD-682 238

Prior Task Agreement and Liking from Others as Determinants of Conformity; St. U. of N.Y.; Willitts; AD-682 231

BIOLOGICAL AND MEDICAL SCIENCES

FCC License Applications for Biotelemetry; American Inst. of Biological Sciences; AD-681 814

Ectoparasite and Host Collections from Nepal; American U.; Lewis; AD-682 241

Effects of Intense Noncavitating Ultrasound on Selected Enzymes; Ill. U.; MacLeod and Dunn; AD-683 216

Linear, ISO and Anteiso Fatty Acids in Recent Sediments of the North Atlantic; Woods Hole; Cooper and Blumer; AD-683 870

Chromosomal Alterations in Marine Fish Cells in Vitro; Miami U.; Regan *et al;* AD-683 845

Aerosol Behavior in High-Pressure Environments; Bolt Beranek and Newman, Inc.; Gussman; AD-683 794

Aldohexuronic Acid Catabolism by a Soil Aeromonas; Ga. U.; Farmer, III and Eagon; AD-683 185

A Digital Computer Program for Constructing Ventilation-Perfusion Lines; St. U. of N.Y.; Olszowka and Farhi; AD-683 838

Brain Mechanisms in the Behavior of the Squirrel Monkey; Tulane U.; Pinneo; AD-683 907

CHEMISTRY

Preparation of Boron-Substituted Carboranes by Boron Insertion Reactions; Olin Mathieson Chemical Corp.; Roscoe *et al;* AD-683 668

Polymer Chemistry of Boron Cluster Compounds; Olin Mathieson Chemical Corp.; Schroeder; AD-683 669

Poly (Bis(Phosphinato)Fluorolanes); Dow Chemical Co.; Schmidt and Flagg; AD-683 788

Sound Absorption in Electrolyte Solutions Due to Chemical Relaxation; Scripps; Eigen and Tamm; AD-683 325

The Molecular Structure of Perfluorodiazirine; Cornell U.; Hencher and Bauer; AD-683 372

The Structures of C6, B3N3, and C3N3 Ring Compounds; Cornell; Bauer *et al;* AD-683 373

Observation of Molecular Motion in Solid H2 Below 4.2K; Duke U.; Amstutz *et al;* AD-683 624

Stimulated Raman Emission and Absorption Spectroscopy. Intensity and Gain Measurements of the Stimulated Raman Emission in Liquid O2 and N2; Toronto U.; Stoicheff *et al;* AD-683 698

Environmental Effects on Phosphorescence. Matrix Site Effects for Triphenylene; Calif. U.; Offen and Hein; AD-683 699

Sublimation of a Monatomic Element; Cal-Tech; Kerber and Hsieh; AD-683 710

Inelastic Collisions Between Excited Alkali Atoms and Molecules: Sensitized Fluorescence in Mixtures of Sodium with CH4, CD4, C2H2, C2H4, and C2H6; Windsor U. (Ontario); Stupavsky and Krause; AD-683 796

Non-Equilibrium Effects in Chemical Kinetics; Purdue U.; Ross; AD-683 806

Molecular Orbitals for Large Molecules. Parameterization from SCF Matrices of Related Molecules; Harvard U.; Boyd and Lipscomb; AD-683 811

SCF Matrix Elements for Phosphorus Oxide Anion; Harvard U.; Boyd and Lipscomb; AD-683 919

Fluorescence Lifetime Measurements by Time Correlated Single Photon Counting; Minn. U.; Ware; AD-683 667

Fluorescence Quenching Via Intramolecular Proton Transfer; Minn. U.; Ware *et al;* AD-683 797

Autoxidation of Poly(Alkylene Glycols) in Solution; Stevens Inst. of Tech.; Reich and Stivala; AD-681 858

Electronic Transitions in Phenyl-Boronic Acids. Substituent and Solvent Effects; Akron U.; Ramsey; AD-681 721

A New Function for Dipole Orientation and Rubber Elasticity; Princeton; Soos and Tobolsky; AD-682 206

Surface Tension Techniques for Molten Salts; Rensselaer Polytechnic Inst.; Janz *et al;* AD-682 216

Kinetic Studies of the Oxygen-Peroxide Couple on Pyrolytic Graphite; Case Western Reserve U.; Morcos and Yeager; AD-682 217

The Vibrational Spectra of Dicyanodiazomethane ((CN)2CNN) and the Dicyanomethylene Free Radical (:C(CN)2); Mich. St. U.; Smith and Leroi; AD-682 230

Radiative and Radiationless Processes in Aromatic Molecules: Pyrene; TRW Systems; Kropp *et al;* AD-682 245

Radiationless Deactivation and Anomalous Fluorescence of Singlet 1, 12 Benzperylene; TRW Systems; Dawson and Kropp; AD-682 246

EARTH SCIENCES AND OCEANOGRAPHY

A Special Report on Marine Instrumentation; American Inst. of Biological Sciences; Busser *et al;* AD-681 821

Temperature Relations of Central Oregon Marine Intertidal Invertebrates; Oregon St. U.; Gonor; AD-682 221

Shallow Currents Along the Northeastern Coast of South America; Woods Hole; Metcalf; AD-682 085

Statistical Models in Sedimentology; Northwestern U.; Krumbein; AD-681 525

The Marine Terraces of the Northeast Coast of Tanganyika; Ill. U.; Alexander; AD-681 684

Geologic History of the Intersection of the Pioneer Fracture Zone with the Delgada Deep-Sea Fan, Northeast Pacific; Scripps; Winterer *et al;* AD-682 086

Oceanographic Applications of Digital Filters; Woods Hole; McCullough; AD-681 694

Organic Reef Alignments on the Continental Margin South of Cape Hatteras. Woods Hole; Zarudzki and Uchupi; AD-682 084

Spectral Variation of the T Phase; Hawaii Inst. of Geophysics; Duennebier; AD-681 737

Swarming of Hyperid Amphipods; Scottish Marine Biological Association; Gray and McHardy; AD-683 812

The Significance of the Tintinnids as a Link in the Food Chain; Scottish Marine Biological Association; Zeitzschel; AD-683 813

The Distribution of Tintinnids in the North Atlantic; Scottish Marine Biological Association; Zeitzschel; AD-683 816

The Continuous Plankton Recorder Survey of the North Atlantic; Scottish Marine Biological Association; Glover; AD-683 818

Arctic Basin Faunal Precis—Animals Taken Mainly from Arctic Drifting Stations and Their Significance for Biogeography and Water-Mass Recognition; U. of S. Calif.; Mohr and Geiger; AD-683 821

Horizontal Temperature Variations in the Upper Water of the Open Ocean; Scripps; Williams; AD-683 187

Measurements of Vertical Motion and the Partition of Energy in the New England Slope Water; Woods Hole; Voorhis; AD-683 871

Seismic Reflection Study of the Shallow Structure of the Hawaiian Arch; Scripps; Normark and Shor, Jr.; AD-683 188

Regional Changes in Shoreline; Academy of Natural Sciences; Richards; AD-683 356

Magnetic Fabric of Sediments from the La Jolla Submarine Canyon and Fan, California; Scripps; Rees *et al;* AD-683 389

Magnetic Stratigraphy and Faunal Patterns in Arctic Ocean Sediments; Wisconsin U.; Steuerwald *et al;* AD-683 843

ELECTRONICS AND ELECTRICAL ENGINEERING

Associative Processing for General Purpose Computers Through the Use of Modified Memories; Stanford; Stone; AD-683 384

The Flow Graph Schemata Model of Parallel Computation; M.I.T.; Slutz; AD-683 393

Lambda-Calculus Models of Programming Languages; M.I.T.; Morris; AD-683 394

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Third Asilomar Conference Circuits and Systems to be held at Pacific Grove, California, December 10-12, 1969. Additional information may be obtained from Mr. Sydney R. Parker, Naval Postgraduate School, Monterey, California 93940. Sponsor(s): Naval Postgraduate Schood, University of Santa Clara, Stanford University, and IEEE Groups on Circuit Theory and Automatic Control.

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