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RESEARCH REVIEWS

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COVER PHOTO: When tests in the Pacific in March 1954 resulted in the dusting of four inhabited Marshall Islands with fallout, this seven-year-old girl got her share. In her case the most noticeable result was that a patch of her hair began to fall out—see photo page 4—but it all grew back again as you see her on the cover.

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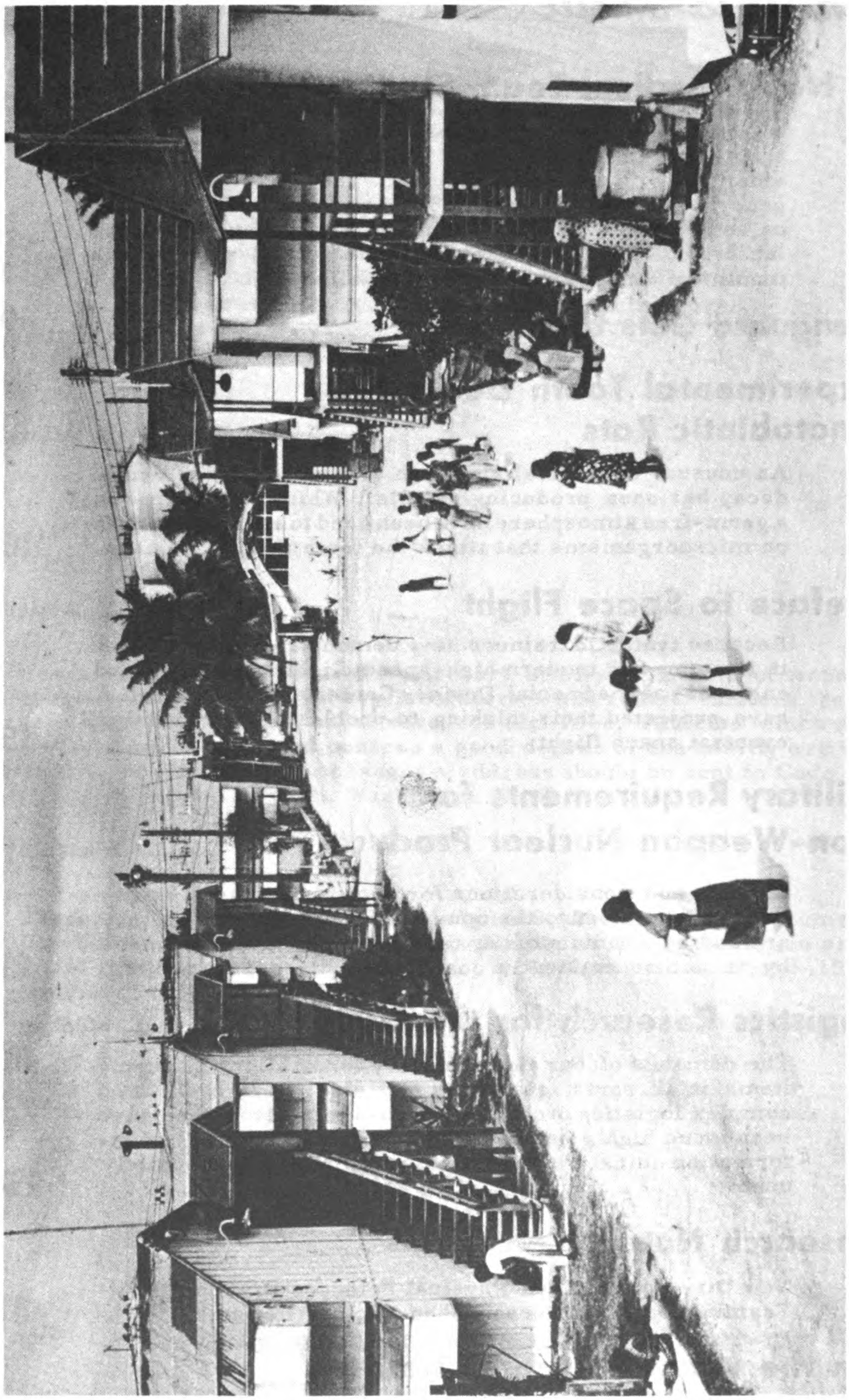
In This Issue



Natives from the Marshall Islands relocated at Kwajalein after incident of 1 March 1954

A Navy Medical Team Studies Fallout Effects

From the time the Naval Medical Research Institute was established in 1945, there has been a research program on radiation. In recent years considerable attention has been given to gamma and beta radiation growing out of work in the field-testing of atomic bombs and nuclear devices. The Hematology Department of the Institute became active in a program which investigated medical aspects of radiation as it affected the biological systems. In common with much medical investigation, considerable work was done with animals which had been irradiated under controlled conditions.

As this specialized research progressed at the Institute, a team of well-informed Navy medical men, all in the Hematology Department and accustomed to working together, became widely known in Navy medical circles as a unique group with unusual qualifications. This was indeed fortunate, for on 1 March 1954 there were some unforseen results from the field test of a nuclear device in the Pacific islands. The Japanese fishermen who were dusted by the fallout became famous overnight; not so well known is the fact that at the same time another group of people was also dusted. Their danger touched off a Navy medical operation that made history because of its prompt and adequate response to a peace-time emergency.

The following story is the result of an interview with CDR Robert A. Conard (MC) USN of the Naval Medical Research Institute, Bethesda, Md., who was a member of the medical team assigned to care for the exposed people of the Marshall Islands.

Word came through naval channels to the Institute that approximately 300 people had been dusted in the Marshalls, and that they were being evacuated to Kwajalein where there is a Navy hospital facility. Within 36 hours, the team from the Hematology Department of NMRI had assembled 2 tons of equipment, and was on its way to Kwajalein. NMRI Navy doctors and enlisted men were joined on the west coast by several medical people from the Naval Radiological Defense Laboratory in San Francisco and from the Atomic Energy Commission.

The 239 exposed natives from four Marshall Islands had already arrived at Kwajalein. There were also 28 American service men from a weather station on an island not otherwise inhabited. The natives were all set up in special quarters (Frontispiece) where they were living in family groups. The Americans were checked into the Naval hospital as ambulatory patients and were allowed as much freedom as their medical schedules would permit.

From the beginning, intensive medical histories were kept on all the people who had been dusted. Not only did the medical staff record such routine information as temperature, appetite, etc., but they embarked on a whole series of specialized tests (Figures 1, 2 and 3) which are indicative of a patient's condition after a dose of radiation that is apt to undermine his health. Also it was important to find out as soon as

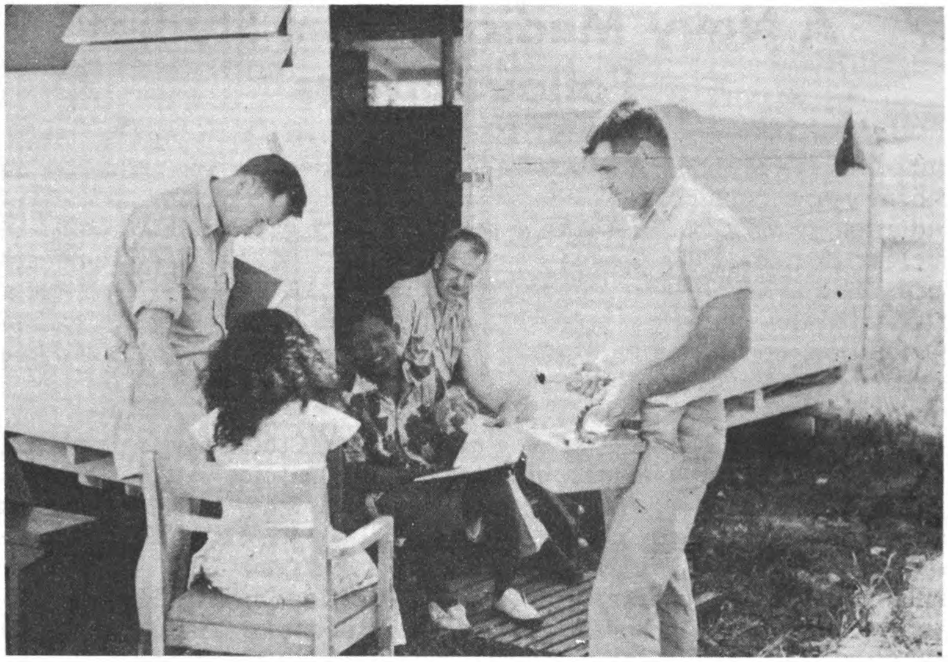


Figure 1 - A native couple on Kwajalein being checked by a Navy medical team for possible after effects from the fallout to which they were exposed on another island

Figure 2 - Navy medical technicians put in long hours making analyses in the laboratory

Figure 3 - Laboratory work was vital to the medical check ups that continued for months

possible the extent of the radiation each person had received. This information was later put together to reflect in a table (Figure 4) the average amount the people on each of the four islands had received.

A group of 64 natives on the island of Rongelap was the worst affected—they picked up an average of 175 roentgen units each (400 such units is believed to be a dose that will kill 50 percent of any group exposed). The largest island group (Utirik) escaped with the lightest dose—only an average of 14 roentgen units per person. The 28 Americans also

GROUP	RONGELAP I	AILINGINAE II	RONGERIK III	UTIRIK IV
POPULATION	64 MARSHALLESE	18 MARSHALLESE	28 AMERICANS	157 MARSHALLESE
AMT. FALLOUT OBSERVED	HEAVY (SNOW-LIKE)	MODERATE (MIST-LIKE)	MODERATE (MIST-LIKE)	NONE
ESTIMATED TIME OF FALLOUT AFTER EVENT	4 HRS.	4 HRS.	7 HRS.	22 HRS.
BEST ESTIMATE OF GAMMA DOSE	175 r	69 r	78 r	14 r
EXTENT OF SKIN LESIONS	EXTENSIVE	MODERATE	SLIGHT	NONE

Figure 4 - Characteristics of fallout - Marshall Islands

Figure 5 - Some of the hair of this 7-year-old girl fell out. But it grew back within six months--see Cover Picture

had a dose considerably less than lethal, and while they were carefully checked for months, only slight ill effects (mostly skin irritations) were detected as the direct result of their exposure to fallout.

There happened to be a group of 18 natives away from their home island of Rongelap on a fishing trip; they were on Ailinginae when the fallout occurred. As a consequence, they escaped with but an average of 69 roentgen units of exposure. In the case of the large group of 157 from Utirik, the dusting had been so light that none of the natives were conscious of anything unusual in the atmosphere. Natives from the other islands, and the Americans, described the fallout as being whitish in color. On Rongelap, where the dusting was heavy, the fallout was said to be like snow. The word "mist" was used to describe the fallout on Ailinginae and on the island where the American servicemen were stationed.

The doctors in charge of the care and treatment of these natives scouted around and set up independent "control" groups of natives from other Marshall Islands that had not been exposed. This afforded a base for comparisons, and followed accepted practice of the medical profession when engaged in a study of the health of a group such as the evacuated natives of the four Marshall Islands.

The amount of powder the natives collected on their person varied, and in some cases they went swimming or otherwise washed off the dust. The habit of these people in dressing their hair with a heavy coconut oil increased contamination of the head and added to their troubles later on (Figure 5). Also it was unfortunate that their water supply came from open cisterns (Figure 6) and the dust fell in the drinking water. Some of the food (Figure 7) also picked up dust which was eaten. The woven mat houses (Figure 6) of the natives were readily penetrated by the dust, and thus practically everyone down to the tiniest babies were irradiated.

Most of the American servicemen washed the dust off, and otherwise were careful as they were more aware of the harmful effects of the fallout. As a result they received only minor lesions and in six months they were all back to duty or had left the service to follow civilian pursuits. The age group of the natives ran from young babies to the oldest woman in the Marshall Islands—a hardy old crone said to be more than 100 years old.

Figure 6 - Drinking water was contaminated because the natives used open cisterns

Figure 7 - Typical food of the Marshallese. In some cases the food had radioactive dust on it when eaten

EFFECTS OF FALLOUT ON NATIVES

In the meantime, thorough tests were made on the radioactive dust that had fallen on the four islands. The pulverized coral particles emitted both beta and gamma radiation. The proportion of beta was much higher, but the gamma radiation had been sufficient on the 64 natives of Rongelap to bring out, during the first ten days, some of the known symptoms of radiation. During the first two days, about three-quarters of the people became nauseated, and a few vomited and had diarrhea. Many complained of itching and burning of the skin. However the symptoms had subsided by the time they arrived in Kwajalein.

The skin sores and loss of hair (brought on by beta radiation from the dust) developed beginning about 2 weeks after the accident and affected the children more than the grown-ups. Many cases developed painful skin ulcers particularly in the group of 64 from Rongelap who had suffered the most exposure (175 roentgen units). Those parts of the body covered by clothing had little or no skin lesions. Sores showed a tendency to develop in normally sweaty places—such as under the arms. There were quite a few cases of sore places on the top of feet and between the toes (Figure 8) but none on the soles of the feet although the natives had walked around in the dust and probably had more contact on the soles of their feet than anywhere else. It was the doctors' guess that this was because the skin on the soles of the feet was too thick and tough for penetration of much beta radiation.

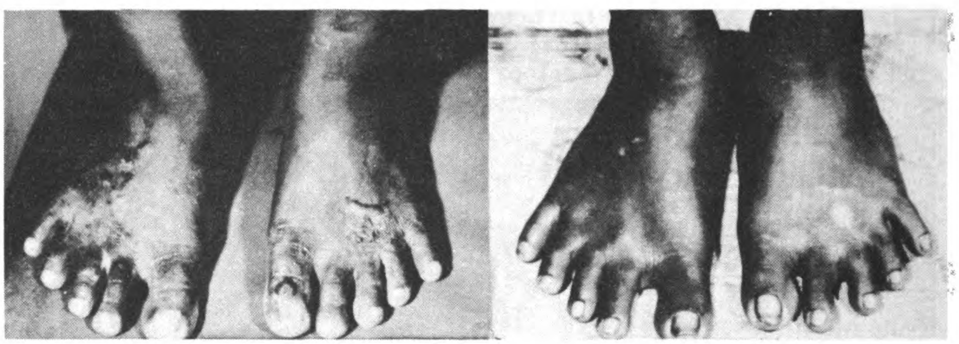


Figure 8 - The feet of some of the natives developed blisters and sores. Picture at right shows lesions healed at six months

The skin lesions were the most obvious ill effect, and in some cases the lesions were painful. A number of the deeper lesions healed without a return of normal pigmentation; instead there are white splotches (Figure 9). These are being carefully checked to see if there might be a tendency for the soreness to reoccur. So far, such a tendency has not been detected.

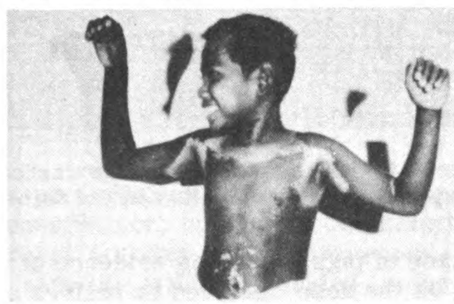
The doctors were confronted with a problem when the blood count on white corpuscles later dropped, and there was a depression in the blood platelets. The outbreak of an epidemic of colds along with the severe skin lesions made the evaluation of prophylactic therapy critical. During this time of crisis, a decision had to be made as to the use of antibiotics as a general treatment on the afflicted people. Because the state of health of most of those affected could not be correlated with the degree of depression of the blood cells in individual cases, antibiotics were not used except in a few cases where the native had some ailment not connected with the fallout. Children continued to have measles, and tonsilitis was in evidence about the same as in the "control" population. The one chronic diabetic, a mature man, continued with his health about the same. The elderly woman thrived and is still alive. In fact, no one has died in the 18 months since the accident occurred.

A small amount of fallout was absorbed internally with food and water, but the amount has been calculated to be too small to be harmful.

Four women who were pregnant at the time of the accident all had their babies normally, and with no evidence of trouble for the baby in the future. Several of the women have become pregnant again, and their medical check-ups are satisfactory.

After three months, and when the natives were doing well, they were moved from the hospital grounds at Kwajalein to a location (Inside Back Cover) on the island of Majuro in the southern Marshalls. Housing was available there, and the natives were returned to more or less normal living, with the exception that food and other supplies are provided. A number of relatives from the island groups have come to Majuro to live with their affluent kin.

While the doctors looking after the natives have reported that at the end of one year there are no continuing ill effects from the fallout, the checks on their condition will be continued for many months, or perhaps years to come. Eventually the people will all be returned, if they so desire, to their native islands but in the meantime the Atomic Energy Commission and the Navy are both thoroughly checking the habitats to make sure there will be no hazards from anything—vegetation, water, or dwellings—that might contain lingering radiation.



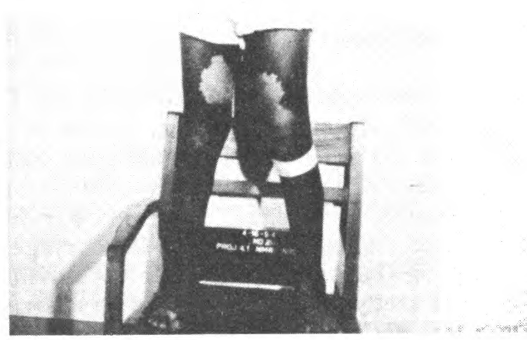


Figure 9 - In the healing process, some of the natives temporarily lost pigmentation in the skin, but the healing in most cases was rapid and the skin repigmented

On later trips to the Islands, chickens and pigs (Figure 10) which had been subject to the radioactive hazard were taken to check, and in

Figure 10 - On a later trip to the dusted islands, animals were rounded up and brought into Kwajalein to be checked for fallout effects

the case of pigs there was evidence of internal irradiation ten times as great as the dose received by natives of Rongelap. Thus these animals picked up far more than the dose received by the Marshallese. As in the case of the famous pig in the Bikini tests, they seemed to be doing all right. When these animals die they are thoroughly examined for radiation effects.

Two of the Navy doctors on the team that went to Kwajalein, Dr. Eugene P. Cronkite and Dr. Victor P. Bond, are now civilians with the AEC on the staff of the Brookhaven National Laboratory. CDR. Robert A. Conard of the original group is still in the Navy, and recently attended the "Atoms for Peace" conference in Geneva and the International Conferences on Radiobiology in Cambridge, England where he presented a paper on the only experience the medical profession has had in a controlled study of fallout effects on a sizable group of people. Dr. Conard and Dr. N. R. Schulman, also of the original group, are both at the Naval Medical Research Institute, Bethesda, Md.

In particular, Dr. Conard can tell of some of the useful things learned. Even thin layers of clothing afford some protection. Other measures are to wash off the dust as quickly as possible; it might be a good idea to shave off the hair on the head, and to remove hair from under the armpits under certain circumstances. Sweaty places on the human body tend to become irritated—preventative effort should be made to keep dust off these sensitive spots. Any action taken to keep from breathing the dust is recommended—avoid drinking water or other liquids that have been contaminated by dust. The 64 natives from Rongelap were heavily dusted with white powder over a period of four hours. The clothing they wore, and the housing of their villages provided much less protection than we would have. Yet, after 18 months, all 64 of these natives are still alive, and none suffer from any lasting after-effects as the result of their experience with radioactive dust.

VANGUARD GETS UNDERWAY

VANGUARD is the project name assigned to the scientific satellite announced in July of this year by the White House, the National Academy of Sciences and the National Science Foundation. The artificial satellite of the earth placed on orbit by rocket techniques will provide new and unprecedented opportunities for scientific measurements of the upper atmosphere. The satellite will greatly increase the time available for scientific observation, because it will have a life measured in weeks, or even months, depending on the still unmeasured atmospheric density at very great heights and the particular orbit chosen. The satellite, travelling as it does around the earth will permit world wide scientific observation of physical phenomena. The program for such a vehicle was stimulated by a resolution passed by the Special Committee for the International Geophysical Year at its Rome meeting in October, 1954.

The Defense Department's participation in the satellite project, announced by Secretary of Defense Wilson, will be accomplished as a joint Army-Navy-Air Force program under Navy management. The small earth-circling unmanned satellite will be included in the final stage of a three-stage rocket launching vehicle. The system will be launched some time during the IGY (July 1, 1957 to December 31, 1958) from a site to be selected on a scientific and functional basis. The Defense Department will look to the National Academy of Sciences for the scientific program for the satellite. The Academy is responsible for such program development in connection with some twelve fields of geophysical study for the IGY.

RADM Furth, the Chief of Naval Research has been assigned responsibility for the Navy's participation in the project VANGUARD. The Naval Research Laboratory will conduct the technical program for the production and launching of the satellite. Dr. John P. Hagen is the project director for the technical program.

The Glenn L. Martin Company has been awarded the prime contract for a major part of the project, the three-stage rocket launching vehicle. General Electric Company will supply the rocket motor which will be used in the first stage of the launching vehicle, and other important portions of the launching vehicle will be supplied by various industrial sources.

Experimental Tooth Decay in Gnotobiotic Rats

Frank J. Orland
Director, Zoller Memorial Dental Clinic
The University of Chicago

As long ago as the time of Aristotle, men have been wondering about the cause of tooth decay. More than 2200 years ago, in ancient Greece, Aristotelian writings asked these simple questions:

> "Why do figs, which are soft and sweet, injure the teeth? Is it because of their stickiness, that they cling to the gums and because they are soft, that they penetrate the tooth spaces and being warm, quickly cause decay? Also, perhaps because of the hardness of the seeds, the teeth, upon chewing them, are soon caused to ache."

Today, in this land, even at the tender age of 2 years, 50 percent of our children have dental decay in one or more teeth. This disease is very common by the fourth year of life and is extremely prevalent thereafter, as long as the natural teeth are present in the mouth. At the age of 16, the average individual has seven teeth (involving 14 different tooth surfaces) already attacked by decay.

At this tremendous attack rate, there just are not enough dentists available in the United States, neither in civilian nor in military life, to keep up with the new dental cavities. The only feasible alternative is an extensive and intensive program of prevention. Yet to prevent tooth decay, a more complete understanding of this disease is absolutely necessary.

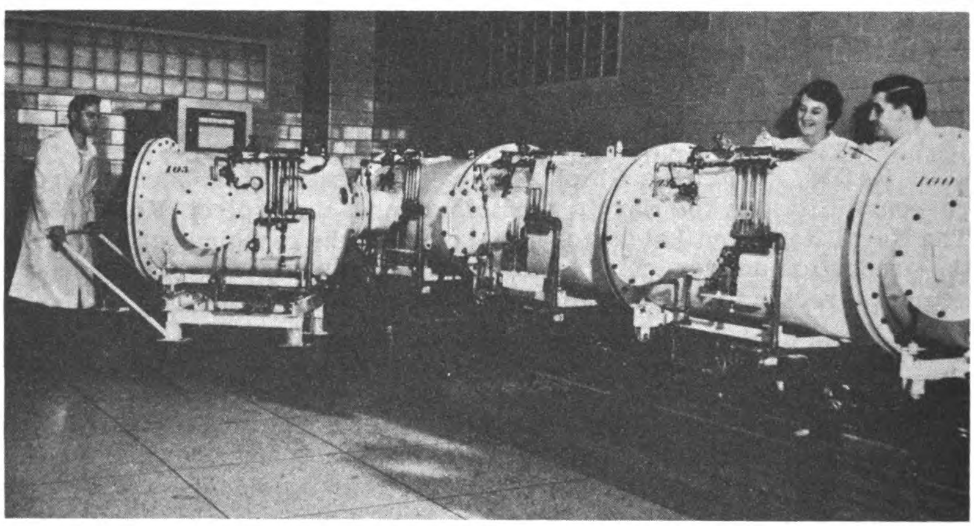


Figure 1 - Batteries of receptacles at Notre Dame University. These provide a germ-free environment for small mammals

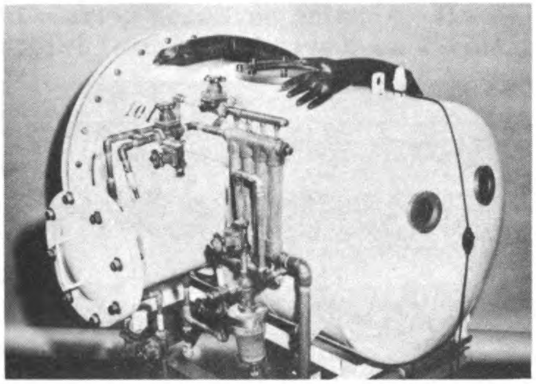


Figure 2 - Design of germ-free unit prevents contamination

Currently, based on fragmentary evidence, it is surmised that dental decay (or caries, from the Latin) is caused by bacterial action on fermentable carbohydrates such as sugar. This fermentative process results in a weak acid capable of dissolving tooth structure. Whether the acid will actually disintegrate the outer covering of teeth depends on length of time of contact. Even though this outer shell of every tooth, known as the enamel, is the hardest substance the body is capable of producing, great damage can be inflicted on its inorganic salt content within fifteen minutes after sugars from the food find their way into the natural crevices of the teeth. Whether the bacterial acid remains in contact with the tooth very long depends on many factors. It depends on the kind of dental plaque adhering to the tooth surface. This plaque is a mucinous, gelatin-like film which sticks firmly to enamel surfaces and acts as a shield for bacteria and their acid by-products—so they can't be washed away by saliva. Decay may occur in a variety of locations on the tooth, although the most vulnerable areas are the natural crevices and fissures as well as the smooth surfaces in contact with adjoining teeth.

Since action on the teeth by the microscopic creatures living around the teeth is judged to be of prime importance, a major effort was undertaken to study this pathological phenomenon in animals at the University of Chicago years ago. Mouth microorganisms were found to be ubiquitous, that is, they lived and grew everywhere around the teeth wherever food debris and saliva were present. Nor could these microbes be eliminated entirely, even with the most powerful and wide-spectrum antibiotics. The only practical manner in which bacteria could be eliminated from the mouths of small animals used in experimental dental caries studies was to obtain animals actually born free of all microbes. This could be accomplished only by the use of the Reyniers Germfree System (Figures 1 and 2), (See Research Reviews, Jan. 1948).

Professor James A. Reyniers and his associates developed mechanical equipment functioning as a microbic barrier which enabled small laboratory animals to be born by cesarean section into and exist thereafter in an enclosed environment entirely free of all living microorganisms. Into such a germfree environment single known strains of microbes could be inoculated for special study. In this instance the animal is called "gnotobiotic" - "gnoto", from the Greek, refers to the "known" while "bio" refers to life.

The research laboratories at the Zoller Clinic of the University of Chicago had conducted much basic work during the late 1930's and early 1940's in experimental caries occurring in the molar teeth of small mammals, while 100 miles away the Laboratories of Bacteriology at the University of Notre Dame (Lobund) were perfecting their methods

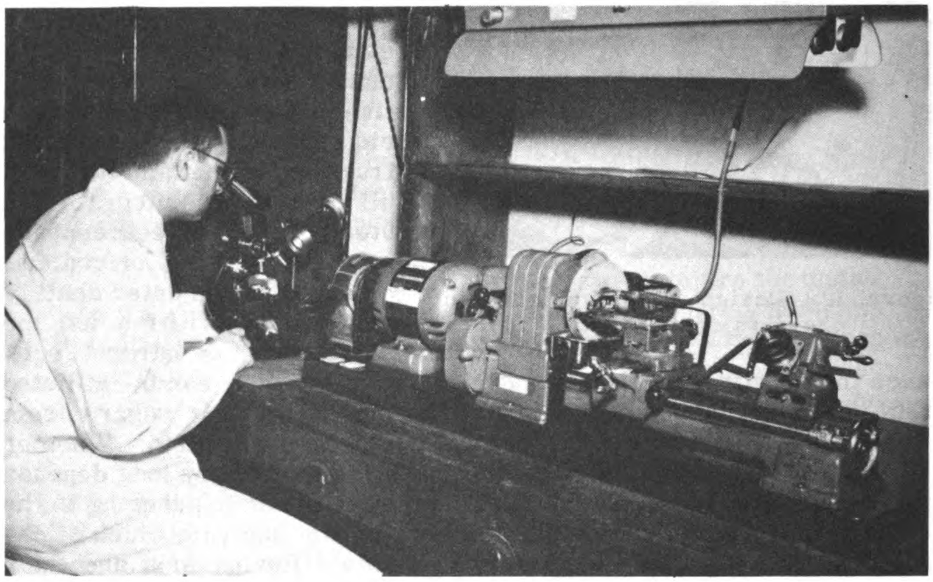


Figure 3 - Dr. Frank Orland examines section of white rat's tooth through microscope

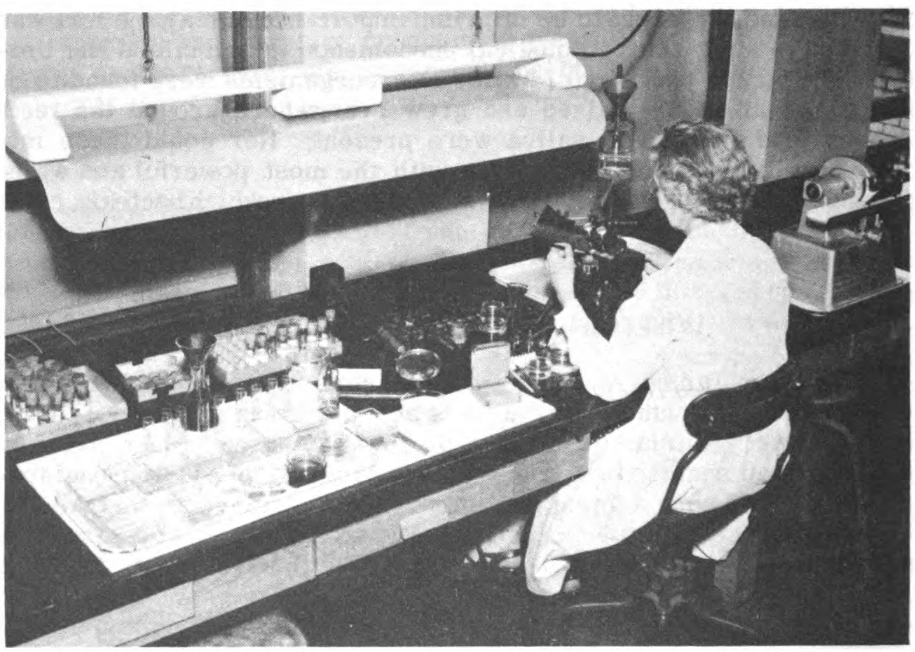


Figure 4 - The molar teeth of a germ-free white rat are sectioned with a special piece of laboratory apparatus. Later decalcified sections are stained to aid in close examination

of rearing germfree animals. It was only logical therefore that a research team should have been fashioned from among members of both institutions to collaborate in an intensive and extensive study of the basic mechanism of tooth decay. Members of this research team consist of James Reyniers, Philip Trexler, Robert Ervin, Morris Wagner, Helmut Gordon from the Lobund Institute; and Wendell Harrison, Roy Blayney, Frank Orland from the Zoller Memorial Dental Clinic.

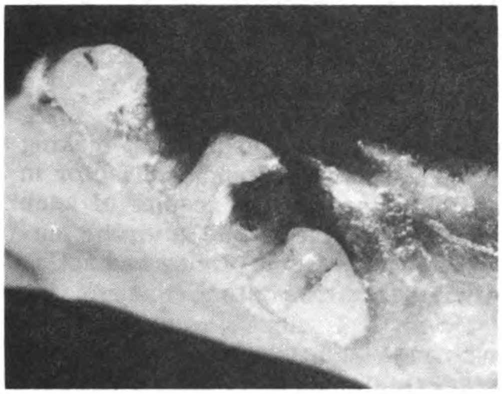


Figure 5 - Upon the introduction of microorganisms causing dental caries, the teeth of a white mouse, no longer germ-free, did decay

In the first phase of the project, now completed and published, (Journal of Dental Research, Vol. 33, p. 147-174, April 1954), it was possible to demonstrate that white rats when reared under controlled germfree conditions did not develop dental caries - not even on a microscopic level. In contradistinction, the conventional control rats, harboring the usual mixed microbial populations, developed carious cavities when maintained for an average of 150 days on the same kind of diet and sugar water that the germfree animals subsisted upon.

On the basis of these findings, though they were not unexpected, it is believed that this base-line study provided adequate experimental evidence to show that dental decay is not possible in the absence of microorganisms. Conversely, these findings suggested in a negative manner that microorganisms are necessary for dental caries to occur.

The second phase of the germfree animal dental caries project is still underway at the present time although a number of individual experiments have been completed to date. This second phase is concerned with inoculating otherwise germfree rats with a single known microorganism. The actions of the inoculated microorganism (or microorganisms) on the rats' molar teeth can be measured (Figures 3 and 4) by gross and microscopic means as indicated in the accompanying illustrations.

The question of whether a single microorganism could actually produce typical carious lesions in the molar teeth of the gnotobiotic animal was a problematical one for a long time and has not yet been completely clarified at this writing. Nevertheless, it was observed that under gnotobiotic conditions, rats inoculated with enterococci (a lactic acid-producing, spherical-celled bacterium) did develop caries-like cavities (Figure 5). Some of the early experimental animals in this phase also harbored a second microorganism which, however, appeared to be very inert in its activity. Nevertheless, the preliminary evidence suggested that these enterococci, found normally in the rat's mouth and often in the mouth of man, could initiate and develop carious lesions not very different from those observed in the conventional control animals having a mixed bacterial flora. As a preliminary report, this evidence was published (Journal of the American Dental Association, Vol. 50, p. 259-272, March 1955) and was awarded First Place in the Prize Essay Competition of the Chicago Dental Society for 1955. Further studies with enterococci and other single bacteria are contemplated.

Later a third phase of the project will be concerned with making changes in the diet. This could be an exceedingly important factor in altering or even entirely preventing tooth decay. The results of such dietary changes would be highly significant in the unique microbic environment of only one or possibly two known bacteria, living and acting on the molar surfaces of these otherwise germfree rats.

A final fourth phase of this long-range basic project would be concerned with adding various inhibitory agents or substances to a stabilized ecological environment consisting of a constant, caries-producing diet and a caries-producing combination of microorganisms.

It becomes apparent that the last two phases of the project might lead to practical applications useful in preventing dental decay in man on a rational rather than on an empirical level as has been the case in the past.

New Low-Temperature Lubricant for Machine Guns

Several years ago there was urgent need for a low-temperature lubricant to be used in 20-mm M-3 aircraft machine guns then mounted on airplanes in combat at high altitudes over Korea. Such a lubricant was developed within 90 days at the Naval Research Laboratory. Then in recent months a new lubrication problem came along with the introduction of the Mk-12 20-mm aircraft machine gun. The lubricant that worked satisfactorily with the other type of machine gun developed a fault with the more recent type. It produced excessive swelling of rubber components in the pneumatic feeder. Also lubricant retention and rust inhibition was less than desired.

Again NRL was assigned the problem of developing a satisfactory lubricant, and the result has been a semifluid grease which is called GLT-700-60. It has performed successfully on range tests at normal temperatures, and in firing tests down to as low as -65° during cold-sweat-cold cycling. Equally satisfactory performance has been obtained in flight tests at altitudes up to 40,000 ft, and at speeds approaching Mach 1.0 (speed of sound at given locality).

The newly developed lubricant is compatible with the oil-resistant rubber used (MIL-P-5516), and it does not evaporate completely from the weapon during the normal service period between lubrications. Also GLT-700-60 has excellent resistance to the anchorage of ice on moving parts of the gun. It is believed that this material will be useful in a wide range of applications involving low-temperature and icing conditions.

Preface to Space Flight

Synthetic Training

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As flight in aircraft has become more complex through the years, we have come to depend more and more on the advantages to be gained from synthetic training. It has been amply demonstrated that flight crews become more proficient, gain confidence, and work together better as the result of a good, rigid training course with devices such as the flight simulator (Figure 1 - Navy P2V-5 Operational Flight Trainer). All except a few of the skills required of a flight crew can be acquired by constant practice with controls, instruments, and equipment built into the trainers. There is no reason why the same technique of synthetic training could not be projected into the situation now unfolding in the realm of space flight. The problems are fairly clearcut and we know how to design devices that deal with many similar conditions—if not as extreme—as those encountered in space flight.

There are some obvious relationships between synthetic training for air flight of today and the most likely training that could be projected for space flight in the future. Any synthetic device developed for space-flight training would have principal elements corresponding to the well known flight simulators: (1) the cockpit section, (2) the instructor's station, and (3) the computing equipment. The operation of the device would bring into play normal and emergency conditions that would demand speedy and accurate reactions from the crewmen in operating controls, reading instruments, and otherwise meeting conditions of space flight. The idea of a "mission" for an aircraft which has been so successfully built into present-day synthetic devices could be extended into the design of a simulator intended to train for space flight. There would be a mission set up for the particular flight planned for a crew via a synthetic training device, and as progress was made in a course of training the mission would be altered or made more difficult.

REQUIREMENTS FOR A SIMULATOR

In assessing the requirements for a simulator that would be effective in training crews for space flight, four present fundamentals of a simulator should be considered: (1) internal environment, (2) performance and flight characteristics, (3) system's operation, and (4) instructor's station.

Quarters for the crew are perhaps as important as any other consideration in duplicating an environment which would be encountered during space flight. Designers would have to approach this problem with imagination as there would be demands for comfort and for physical well-being that would far exceed any now built into crew compartments. Mature thought should also be given to the type and location of instruments, what kind of controls should be used for guiding the ship and how strong they should be, and what should be done about lighting and air-conditioning. Other problems relating to internal environment in a space

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ship would be the same as those already dealt with in airplanes—pressure, attitude, acceleration, and radiation—but the demands for meeting extremes would far exceed any encountered in air flight today.

In order for a simulator to be effective, it should faithfully duplicate the performance of the craft in flight, and the characteristics it displays in successful or unsuccessful flight. For this information to be transmitted from the device to instruments at the crew station and at the instructor's station, complex computing and control equipment would be required. The inputs from various controls would need to be transmitted to the computing equipment where the motion equations and a number of miscellaneous systems equations would be solved. Computed answers could then activate instruments to indicate flight during actual operation of the synthetic device.

The simulator would have built into it certain features which would faithfully reproduce conditions such as exceedingly fast ascent. This would complicate the computing problem, as would other effects peculiar to space flight. To name a few, there are the rate of change of mass, the effect of the variation of gravity, and the possible path a craft might take and how it might be recorded on spherical space coordinates.

In common with the trend in aircraft instrumentation, designers of the simulator for space flight should be concerned with integrating the various systems that would be built into the craft. It would not be enough that the systems be simulated in such a way that normal flight would be represented. There would be emergency operations of these systems that would also have to be simulated which would be too hazardous in actual flight. The emergency systems should be integrated with those controlling normal flight in a way that would be both simple and fool-proof. As an indication of the systems involved, a checklist would look something like this: fuel system, power plant system, flight control, guidance system, atmosphere (internal) system, electrical system,

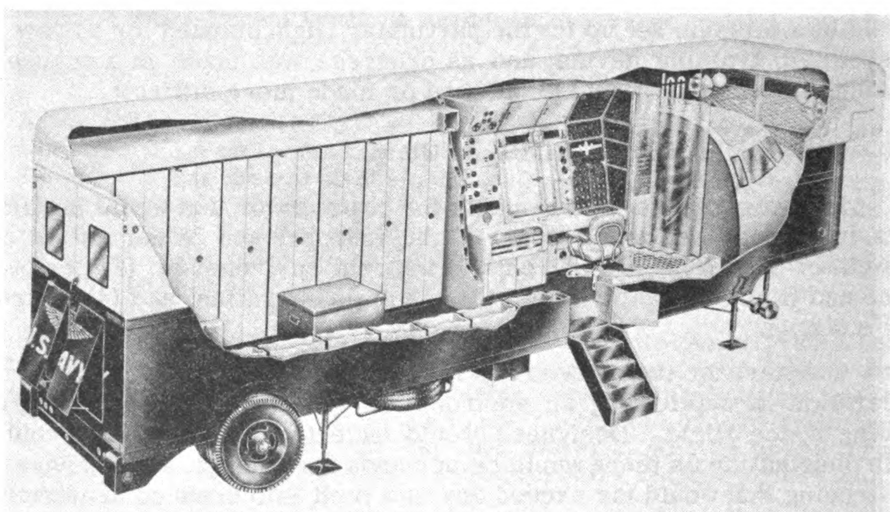


Figure 1 - The design of a synthetic trainer for space flight carries out the idea of "a mission." Instruments, internal environment, and projected operation are all keyed to the accomplishment of a mission

navigation system, temperature control system, radar detection system, emergency escape system, and so on through a host of other related systems. Navigation, which would of course be extremely important in space flight, would be simulated by means of a celestial navigation training attachment (Figure 2) based on present day celestial navigation trainers.

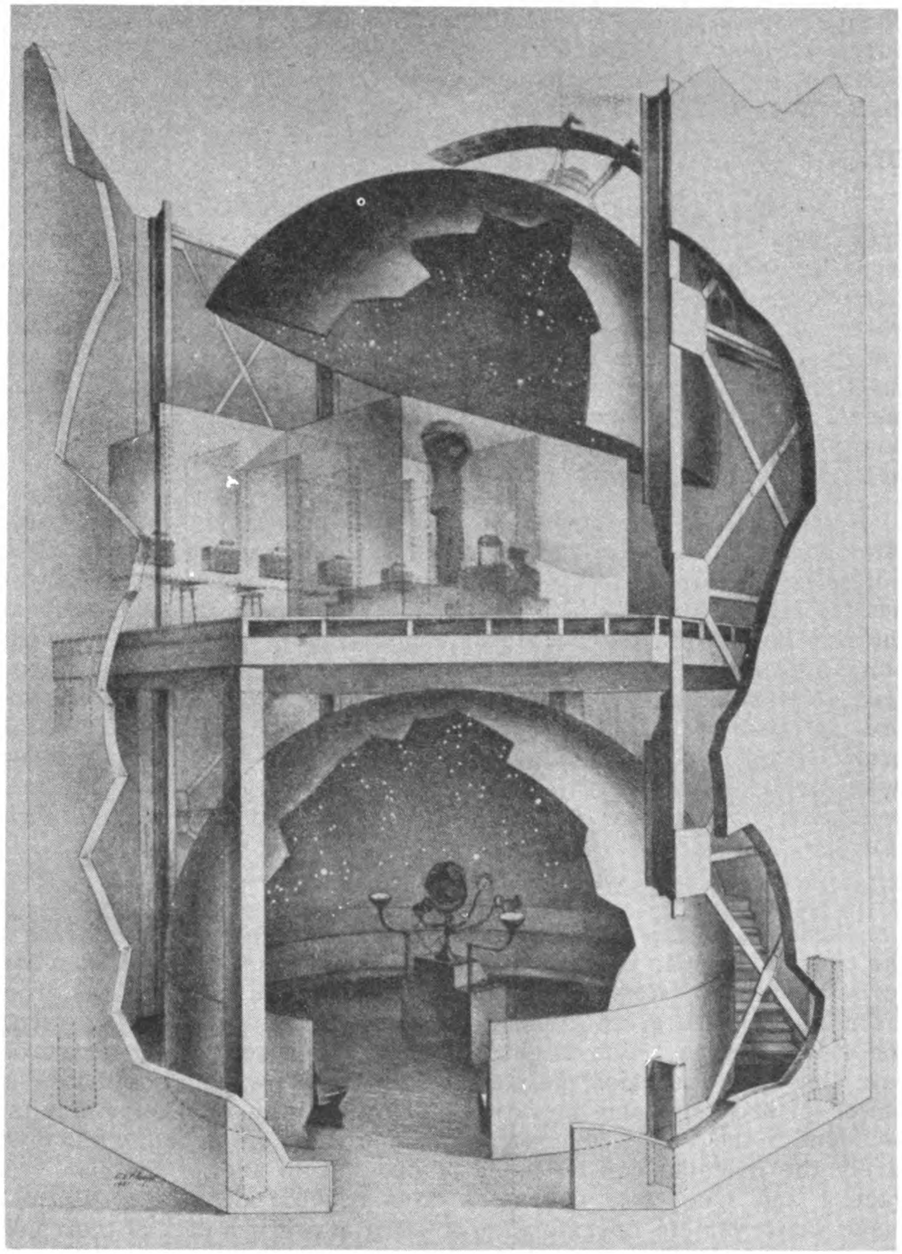


Figure 2 - Design for Celestial Navigation Trainer planned for space flight training

All flight simulators would have an area called an instructor's station. It would contain an array of control mechanisms and appropriate computing equipment which might be very complicated (Figure 3). As the instructor manipulates his controls during the course of a simulated flight, he would be quite likely to introduce specific malfunctions. He would have controls that would make all sorts of troublesome things happen, and it would be up to the crew to deal with the situation he would impose. Among the disturbing but not necessarily fatal conditions he could generate would be uncomfortable temperatures, dangerous pressures, excessive radiation. In some cases these would not need to be real, but indicated unmistakably, so the condition could be pushed to a disastrous situation without peril to the crew.

DESIGN EVALUATION

There is another group of people who would be interested in the operations of a space-ship simulator. These are the designers and engineers who ultimately would have to face the realities of building a craft to meet so many new and rigorous tests. It is common practice nowadays to gather as much preliminary data as possible from simulators—the aircraft and missile manufacturers are among the more insistant in this direction. To illustrate with a specific example, engineers from this group are using analog computers in conjunction with power-operated control systems where the human operator is included to close the servo loop.

Many a problem asked by an engineer may be set up on the simulator for the purpose of gathering data and information which will help him in developing a design. Particularly in the case of emergency situations where the reactions of the crew must be fast and accurate, information can be gathered at the instructor's station or through a computing center. There are no lengths to which the more acute of these highly professional aircraft and missile designers will not go in order to gather from synthetic devices any evidence of weakness in a proposed design. Parallel practice is to be expected from space-ship designers. If a defect should be built into a space ship it would be expensive to alter, or worse, it might go on a mission and end in destruction or disaster.

TRAINING FUNCTIONS

The space ship simulator could be expected to provide training for the crew in specific tasks and also in a broader aspect which has come to be known as "mission" training. Some of the conventional ground training would be given in the good, old-fashioned way—the classroom method. Subjects which might be taught effectively in the classroom are: theory of operation, maintenance procedure, navigation theory, and power-plant theory and operation. The true value of a simulator is to be found in the man-machine relationship, and how speedily and effectively the machine can be made to become an arm of the man. Auto racers and speed-boat operators often develop an uncanny ability to make their vehicle operate almost as if it were a part of their body. The same can be said of aircraft pilots, and in many cases the man-machine relationships have been developed early in their career by many hours of work with a synthetic trainer. We are now at a time when similar advantages could be gained for crew of future space-flight ships.

Figure 3 - The electronic equipment of a space flight trainer would be built along lines of modern equipment currently serving as components to synthetic trainers in use by the Armed Forces

When it comes time for a crew to start putting in hours on a synthetic trainer, attention would be directed first to task training. One skill after another would be worked out with the instructor gradually increasing the difficulties each man would have to overcome, and the group would have to overcome as a team. In the case of simulated space flight the instructor could have a field day in making things miserable for the crew in the operations group. Not only could he give them system and instrument failures and other standard "tricks" of training in air flight, he could give them pressure problems, complex situations in navigation, and sudden plunges into a highly radiated area. The task training given to a crew learning about space flight would gradually merge into mission training; instructors working out the schedule would integrate both types of training.

The approach to mission training requires a well defined and accurate synthetic device and some definite ideas on "mission." It would be a job for some of the training staff to write up some of these missions in script form, and to check-off performance or results as they were set down or "presupposed" in the script.

This brings us back again to the instructor's station, aptly termed the nerve center of the simulator. The design of a space flight instructor's station would exceed in completeness and complexity any existing station which serves in present-day air flight simulation. In space flight, the instructor's station might well have the alternate name of "evaluation center". At this center as elsewhere in simulated space flight, experts would be needed to carry out and supervise the training and auxiliary services.

From the vantage point of the instructor's station, every move of the crew, and their reactions to flight conditions, would be recorded. There would be a pattern of lights on a board to indicate the position of each man in the ship, and his action as he operated controls and otherwise participated in the work of the crew in taking the ship synthetically through space. If mistakes were made, there would be an immediate indication at the evaluation center. Other indicators would show whether the crew members had used a proper sequence in operations. There would be a closed-loop television to bring under constant observation the action and conduct of each man as he did his job and reacted to conditions imposed upon him.

ULTIMATE VALUE OF SYNTHETIC TRAINING

The staff operating the simulators and the crews scheduled for training would face long hours as the problem of space flight would be met only on a one-to-one time basis. Because so much time would have to be spent in conditions of simulated environment, emergency conditions would become enormously complicated. This would put demands on a crew that would not be encountered in ordinary flight, and for that reason, the personnel should possess unusually high capabilities—they would need to be well trained. Also it would be essential that the individual members be well adjusted and compatible one to the other and as a team.

Repetition of synthetic space flight would be a "must"—there would be no other way to gain the required proficiency for so hazardous an undertaking. Those who participate in space flight some time in the future will need a supreme confidence that could be gained only by repeated experience with conditions approximating as nearly as possible the most challenging of earth-man's frontier—that of space beyond the earth's atmosphere. It will have to be an intrepid and well-trained crew in the ship, and on the ground when one day earth-man bursts from the shackles that bind him to his planet and whizzes out into space on a mission yet to be decided.

Military Requirements for Non-Weapon Nuclear Products

John B. Macauley
Deputy Assistant Secretary of Defense
(Research and Development)

In the past few years, there has been increasing public interest both in this country and abroad in the non-weapons uses of nuclear products. The requirements of the Department of Defense are governed by the situation facing the country. Threats to our security must be countered in ways that will take full advantage of our technological and industrial strength.

To carry out its military program, the Defense Department has a tremendous establishment. The replacement value of its capital assets is some 38 times that of the country's largest corporation. The annual expenditure in recent years by the Department has been more than $200 for each man, woman, and child in the country. Many of the problems of management are the same as those encountered by a large business organization but the criteria involved in discussions may be different. Products sought are often the same as those in demand among the civilian segment of our economy. Then there are many items needed by the Department that are essentially military.

The Navy is understandably proud of the NAUTILUS and the SEAWOLF. The launching of these submarines was a tribute to combined Atomic Energy Commission and Navy enterprise and to the atomic industry generally.

Great technological progress was made in an incredibly short time. The nuclear plants of the two submarines were purposely made competitive, partly to determine which is the better power plant and partly to exploit the rapid advancing technology of nuclear propulsion.

Pioneering in the nuclear propulsion field for naval submarines has generated new technical knowledge which will have extensive peaceful applications. The technological basis has been established for propulsion of other ships as well as for fixed power plants. There have also been collateral benefits. New metals had to be produced, and processes devised for refining and using them.

By way of illustration, only a few years ago zirconium was used only in minute quantities to absorb gases in vacuum tubes. It cost several thousands of dollars a pound. As the result of the naval reactor development, zirconium technology has advanced to where its commercial application for other purposes has become apparent and the cost dropped considerably. Similarly there was developed a whole area of knowledge concerning liquid metals where no knowledge previously existed.

The future of nuclear propulsion for combat vessels is assured. Last year Congress authorized the building of two more nuclear submarines, and this year Congress approved plans to build four more.

Thus this fiscal year the Navy will have a total of eight nuclear submarines in being or under construction.

The Secretary of the Navy described the importance of nuclear propulsion by saying that "We have crossed the threshold of a period of change which promises to alter the face of the Navy even more than did the changes of sail to steam and of wood to steel combined."

Of course, the Navy plans nuclear powered ships of other types for the future. Currently, the Navy is sponsoring seven different nuclear reactor projects with the objective of developing a family of reactors which will be applicable to surface ships as well as to submarines. Under this program authorization has been obtained and the Atomic Energy Commission will soon begin the construction of a prototype large ship reactor at the National Reactor Testing Station in Idaho.

In the propulsion field, both the Air Force and the Navy are attracted by the potential advantages of nuclear-powered aircraft. The Atomic Energy Commission is continuing to push forward the frontiers of reactor technology in an effort to develop a successful nuclear-powered aircraft reactor. The Air Force and industry participate in the aircraft nuclear propulsion program and the Navy is giving special attention to nuclear-powered seaplanes.

Although a large user of electric power at its posts, camps, navy shipyards, and air bases, the Defense Department does not have requirements for the large central station power plants such as predominate in the electric power industry in this country today. Generally speaking, the Department purchases electric power from the public utility in the same manner as most industries. There are, however, many areas of the world, in the Arctic and desert wastes and in underdeveloped countries, in which we have fixed military installations which do not have access to the convenient power lines of an indigenous public utility system. From these areas there arises a requirement for power generation plants.

These are not large plants in the industry sense; the usual installation consists of a number of standard diesel electric units. However, the fuel supply presents a large problem. Fuel transportation involves costs which provide the incentive on purely economic grounds for the development of packaged reactor power plants.

The Army package power reactor planned for Fort Belvoir is a prototype for furnishing heat and power at remote bases of the three services. It is designed for 1800 kilowatts of electricity and is expected to commence operation in late 1957.

For the future, study projects are underway to prepare designs of advanced reactor systems to meet additional needs in the whole range of sizes of military interest. We are probably only in the early dawn of an era of packaged nuclear power plants for the generation of electricity for military use.

The diverse and cosmopolitan nature of our interest means that the Defense Department has similar requirements to those of the civilian economy for many other nuclear products. We, too, have the industrial type and the medical type requirements for radioactive isotopes. We are installing research-type reactors as tools for other research and development work in two of our laboratories—the Naval Research Laboratory here in Washington, and the Army Ordnance Laboratory at Watertown, Massachusetts.

We also have wide interest in kindred areas and their products, particularly those pertaining to safety and radiation protection. Here again our basic requirements are similar to civil needs.

One very interesting field with both civilian and military implications is that of food preservation. The Army and the Atomic Energy Commission have a joint program in which the Army supplies the food technology and the AEC the radiation technology with the ultimate objective of achieving complete food sterilization. It has been demonstrated, for example, that the shelf life of pre-packaged meat products can be increased from 3 to about 21 days using mild gamma-ray pasteurization dosages. Potatoes, exposed to a mild dose of gamma radiation and then held at a storage temperature of 50° F show no evidence of spoilage or sprouting for periods up to two years.

The potential logistic advantages of a system of food distribution based on the storage and handling characteristics of irradiated food justify support of this research for military purposes. Here again, just as in the case of a ship reactor power plant, the major ultimate benefits to mankind might well be in its civilian application but the initial work in the field is justified by the special needs of the military services.

I have mentioned some detailed requirements of the Defense Department for nuclear products and some of the work underway to meet the requirements. In all aspects of the work, progress results from the combined efforts of many groups; the AEC and the Defense Department, the nuclear physicists and other scientists, and the engineers and technology of U.S. industry. In the ultimate sense, then, the Defense requirements should be stated in terms of a healthy and vigorous nuclear products industry. They should be stated in terms of continued basic research and in terms of an adequate supply of trained scientists and engineers. These are basic requirements for the Defense needs as they are for the general welfare. Meeting these requirements represents the great challenge to all of us.

It is significant that the Atomic Energy Act of 1954 liberalized the ground rules and provided a basis for the increased dissemination of information. The Department of Defense supports the declassification and dissemination of information for peaceful uses of atomic energy; Defense information relating to atomic energy must be continually surveyed with the objective of declassification so as to assist in progress.

The Atomic Energy Act of 1954 properly protects nuclear weapons. It clearly specifies that information relating primarily to the military applications of atomic weapons cannot be published unless, in the joint judgment of the Department of Defense and the Atomic Energy Commission, such publication will not adversely affect the common defense and security. Further, the law requires the Department of Defense and the Atomic Energy Commission to determine jointly just what information pertains to the military utilization of atomic weapons. You can well understand that implementation of the Act presents a challenge to us.

Very little needs to be said about basic research in discussing an industry which has been so immediately and so intimately the result of basic research. The entire basis of both the weapons and the non-weapon aspects was in research form less than a score of years ago. Since that time thousands of other problems of the industry have been solved by reference to basic physical knowledge.

In our commendable haste to utilize the atom extensively for peaceful purposes, let us not forget to maintain the life-blood of new ideas from basic research. The new Act, like the old one, recognizes this point by directing the Commission to conduct research in support of the atomic energy program. The Commission has liberally sponsored basic research. It is incumbent on the rest of us, outside of the Commission, to follow along this course.

Fundamental to all is the adequate supply of trained scientists and engineers into our economy. You are aware that the Soviets are currently graduating more than we are. Although they are still behind us in total, they will not be long in catching up if the present rates are continued.

Now numbers alone are not everything. Quality and proper utilization of trained personnel cause uncertainties if we compare numbers as such. But there is no doubt that the Soviets have established a modern industrial empire based on a well advanced technology. The military weapons we know about are ample demonstration of their scientific and engineering capability.

Happily enough, there is an awakening here. There is an increasing awareness of the situation and studies have begun to pin-point some of the trouble spots. From the primary and secondary school level right through to the proper utilization and effective incentives for the trained man or woman these problems represent a great challenge to us all, both within the government and outside. I am certain that we can meet it.

Team of Biochemists Join Navy Research Project

The staff of the Navy Medical Research Unit #3 in Cairo, Egypt will soon be supplemented by a man and wife team of scientists who will engage in research on the Biochemistry of certain exotic diseases in North Africa over a period of two years. Dr. Martin E. and Maude Martin Hanke are the investigators who are to serve under an Office of Naval Research contract with the University of Chicago which supports the work of the Unit in Egypt.

Logistics Research for the Navy

VADM Ralph E. McShane, USN (Ret.)
Consultant, The George Washington University
Logistics Research Project

During World War II many of the people engaged in logistics endeavors were dissatisfied with the working of the systems and methods then current. They concluded that it would be profitable to study the subject and attempt to apply scientific methods to the solution of logistics problems. It was considered that such a process could best be carried out as a separate research endeavor rather than as an administrative action and that such research should be undertaken as a project by a university instead of as an intra-Navy activity. Consequently, at the recommendation of the CNO (and particularly Admiral R. B. Carney who was at the time Deputy CNO for Logistics) the Secretary of the Navy in 1948 directed the Office of Naval Research to establish such a project. One of the steps taken by ONR was to make a contract with The George Washington University to establish a research group. Thus, the Logistics Research Project was born.

The original head of the Project was Dr. C. B. Tompkins who had been a principal advocate of the basic idea. He assembled a very small group of associates from the fields of mathematics, statistics and economics together with two retired naval officers who had long and varied experience in logistics matters. This nucleus of continuous workers was supplemented by a few consultants with pertinent special competencies and interests. While the specific constitution of the Project's personnel has changed in the interim, its character remains the same today.

It was recognized originally that research in many logistic problems would depend on the analysis of large quantities of numerical data and that logistics practice would sooner or later be improved if similarly large quantities of data could be handled quickly. The employment and further development of high-speed computing machines was, therefore, of primary interest to the Logistics Research Project. An initial task of the Project was to collaborate with the Office of Naval Research in the design of a computer specially adapted to handling the types of calculations encountered in logistics. Such a machine, named The Logistics Computer, was designed and procured. It is now in operation under the supervision of the Project (see Research Reviews, May 1955).

Thus, for some five years a small group has been spading a new field: to acquaint themselves with naval logistics experience and practice, to study the basic problems involved, and to apply modern scientific analysis to these problems with the aim of improving Navy practice.

PURPOSE OF THE LOGISTICS RESEARCH PROJECT

Logistics involves "the calculated risk" to such an extent that the aim of the Project may be stated as an endeavor to improve the calculation and reduce the risk. More formally the purposes may be stated thus:

- To provide a small group of people who are technically and temperamentally qualified to study logistics questions and who, working cooperatively, can apply their technical knowledge to the improvement of logistics practices. If such a group is to be effective it must be free from routine administrative duties,

- To conduct some measure of pure research in the expectation that useful new ideas will be developed,

- To maintain liaison with other centers of contiguous research and select new applicable information,

- To circulate new logistics knowledge to the Navy's practicing logistics activities,

- To provide a central source of certain logistics information which may be consulted on a case basis by Navy activities in the search for current improvement.

New theories and their resulting techniques which have potential naval applications are arising constantly through the efforts of many researchers. One example, now finding its way into various practical fields, is the discipline commonly known as "linear programming". The development of such new ideas, and their introduction and initial application, can best be performed by research groups and such is one of the purposes of the Logistics Research Project.

WHAT THE LOGISTICS RESEARCH PROJECT HAS DONE

The Logistics Research Project has engaged in a large number of tasks. Some of them may be considered to have been "completed"; some are still underway. Among the completed tasks the following, briefly described, will reveal generally the character of the work done.

In order to facilitate the determination of logistics requirements in very broad terms for the initial planning of naval operations a Three Factor Method was developed. This scheme is intended to provide quickly first approximations of supply requirements for each "activity" type under a wide variety of conditions. It is for the use of high-level operational commanders and provides a ready means of determining basic logistic requirements upon which further planning can proceed or to provide a basis for modifying initial plans. The scheme provides for the inclusion of the inescapable "judgment factor" but offers aids to the application of judgment by specifying those characteristics which are not susceptible of sound numerical characterization and provides basic numerical data as an aid to judgment.

The Three Factor Method includes comprehensive tables from which can be picked readily, for example, the daily fuel consumption for a given ship type over a wide range of operating conditions. The preparation of these tables involved an enormous number of arithmetical operations which were performed on The Logistics Computer.

Another problem, which in this case involved the application of modern mathematical techniques in its solution, arose in the process of calculating aircraft inventory requirements, although the solution is applicable to other problems which have the same characteristics.

Briefly stated the basic situtíon is this:

- A given type of aircraft is intended normally to operate for a given period of time, say "X" months,
- At the end of that period it is placed in overhaul for "n" months and then is again available for operation,
- After a certain number of cycles of X + n months the aircraft is retired,
- New aircraft are introduced into the system from time to time,
- The "normal" pattern is interrupted in some instances as a result of accident or other unforeseen failure which may
  - Render the aircraft useless for further employment, or
  - Require overhaul prior to X months of operation.

These contingencies are "probabilities" which cannot be scheduled in the normal fashion but must still be considered.

The situation creates other problems such as: with a given schedule for the introduction of new aircraft, how many aircraft will be operational at various times and how many will be in overhaul? Or, the converse problem may be: with a given planned schedule for operational aircraft, what must be the schedule for the introduction of new planes?

In common with many everyday problems which can be formulated simply, the solution of this one is more complex and difficult than may appear at first glance. The common empirical solution of "cut and try" frequently results in poor solutions or else requires the expenditure of a longer time than usually is available.

Logistics Research Project formulated this problem in mathematical terms, analyzed it by the application of modern mathematical methods and procured a solution which can be translated into methods and associated statistical data for routine application by non-technical personnel. The result is a far more rapid process for reaching specific results and, among other things, permits the comparison of alternate schemes which in the past would have been possible only at the cost of much greater effort.

The LRP has produced a series of Logistics Papers which range in content from pure general theory to analysis of particular current problems. The range of subjects covered is a quite good indication of the breadth of the activity.

CURRENT TASKS

Among a number of tasks which are underway, the following are selected to illustrate generally the current efforts.

The advantage of accurate predictions of material usage, particularly in time of war, is obvious. Despite the existence of huge masses of data on material in one or another form in the Navy's hands, the calculations of future consumption still depend to a large extent on inadequate historical data and involve a great deal of fallible judgment. A number of analyses have been undertaken to improve the situation. One of the most ambitious of these is the Korean Data Collection Program (KDCP) of the Logistics Research Project.

The KDCP initiated the collection of detailed data on the material used by or on account of a representative number of ships of different types engaged in the Korean campaign, selected to provide a balanced sample. The data include not only material used directly by the ships themselves but also that used by tenders, repair ships, naval and private shipyards and other shore activities for the benefit of the sample ships. Whether it be for operation or for maintenance, repair or alteration, if material is "used" it is covered by the data. Such data have now been collected for the period commencing 1 July 1950 and will continue for some time into the future. As a measure of magnitude the data now in hand cover about 3,000,000 individual transactions.

Concurrent operating data for the sample ships have been collected to provide information on some of the major factors upon which usage depends.

The great mass of data available, and the large number of characteristics which define it and indicate the factors which determine its use, would make its analysis impracticable except by machine methods. Therefore, the aggregation of these data and their assembly into forms suitable for further study is a typical task for The Logistics Computer.

Analysis of the data has commended. While some broad conclusions already can be drawn which differ from widely held beliefs, much more work is necessary to provide useful and practical working techniques. It is confidently believed that the end results of this program will be at least the following:

- A "catalogue" of usage data which will be more complete and authoritative than any existing data. Such a compilation should be useful in the near future to many logisticians for a variety of purposes. In a sense, this catalogue will be analogous to a report of a census and should have similar widespread utility,

- The development of procedures for handling such data on high-speed computers and suggestions for the use of such computers in the Naval Establishment,

- Authoritative information on the causes of usage and the development of methods to improve the accuracy of future calculations.

Another current endeavor in which certain Logistics Research Project personnel are engaged part-time might be considered to lie at the other end of the scale from the viewpoint of immediate applicability. This activity is in the field of pure research, largely mathematical. In this process the daily activities of working logistics personnel are translated into abstract terms and the form of such analysis would seem to the "working people" to bear little, if any, relation to their operations. For instance, one such activity concerns studies of a mathematical area in which such phrases as "vector spaces", "linear transformations" and "inner product" are part of the common vocabulary of the researchers. While an activity of this nature may seem to many people far removed from inventory control of "nuts and bolts" it is an essential procedure in a scientific approach. There are many analogies in history of the ultimate utility of such efforts. To cite only one well-worn example, if Newton and Leibnitz, aided by a host of predecessors, hadn't speculated, theorized and abstracted certain phenomena, we couldn't build modern aircraft carriers. The justification of pure research rests on the belief—proven often in the past—that this kind of activity by qualified people produces methods applicable in daily life which are superior to the methods now employed.

It should not be concluded, however, that the Logistics Research Project is staffed by a large group who do nothing but speculate in "ivory towers". The pure research is pursued by people who, when occasion demands, focus their present knowledge on efforts to find better solutions to current problems.

THE LOGISTICS RESEARCH PROJECT'S POTENTIAL UTILITY

In the Navy's constant search for improvement, it is pertinent to ask the question: "Can the Logistics Research Project (and other similar agencies) contribute significantly to the improvement of logistics practices and, if so, how?" One answer is that contributions have already been made; their value must be judged by the recipients.

To be more specific there are two things LRP or any other research group can supply:

- First, people who have types of knowledge which are not commonly found in working logisticians, and

- Second, time to focus attention on a specific problem with minimum diversion from that task.

These facts do not imply that no improvements are made by people who are engaged largely in routine operations—far from it. Perhaps a major effect of research is to speed up the improvement by greater concentration on the task.

The grist of the Logistics Research Project's mill must be a reasonably steady flow of problems. Some of the problems have been and will be formulated internally as a result of the research people becoming more familiar with existing Navy practices and their end purposes. This source of problems may be supplemented with profit by reference to the Logistics Research Project of matters which vex the operating personnel in their regular procedure. If help is not immediately available from its existing personnel and equipment, the Logistics Research Project can constitute a kind of switchboard and transmit the question to some other competent agency.

As a technique, the Logistics Research Project with the Logistics Computer is in a position to "simulate" many problems and test new and alternative ideas more quickly and cheaply than is possible with the full-scale experiments which frequently have been the only available method of trial. This process in itself has the potentiality in many instances of quickly testing new ideas at low cost. It is akin to the use of a model basin in the process of ship design.

Finally, it may be worthwhile to repeat a couple of generalities which, although they may be clichés, are not less true. A basic justification for "research" is the faith that application of the scientific method of analysis to any human endeavor will result in some improvement. It would be an egregious error to expect that science will in any instance eliminate entirely the need for human judgment based on personal experience. However, judgment can be supplemented and aided by the results of research to the end that correct decisions are more likely and predictions are closer to the ultimate results.

Logistics Progress

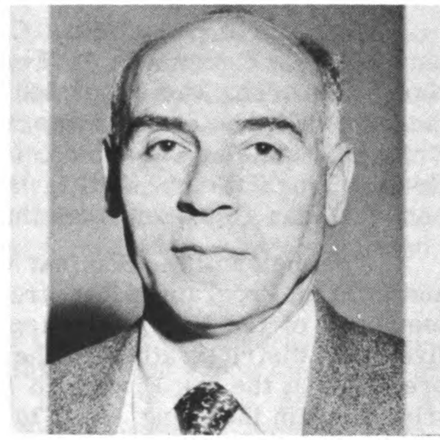
The complexity of the Navy's logistic problems grows in a geometric progression as the complexity of naval material and operations increases. For example, as the number of models of aircraft has multiplied greatly since World War II, the task of planning and controlling the usage and logistics of all aircraft and the half million different parts and supply items has become one of staggering magnitude. In order to achieve the optimum timing and balance of each part and of the whole, new methods and new equipment--new extensions to the human mind--offer the only means. As yet, complete logistic control is still in the future, but with the increasing implementation afforded by electronic methods, the point of final absorption of the major logistics problems of the entire naval establishment is no longer just a dream.

One method of attacking the situation has been an evolution, by continual refinement and innovations, of office methods and equipment, within the organizations which cope with the practical logistics problems daily. By this process, in the field of aircraft, OPNAV, BUAER, and ASO have acquired modern electronic computers to supplement, in part, the calculations, work sheets, ingenious desk devices, and factor tables used to calculate inventory requirements and schedule logistics activity. The same computers are being applied to the need for more timely and thorough knowledge, and hence control, of the vast inventories involved in naval aviation.

Relatively rapid progress along this line has been made since 1945. We now stand on the threshold of a daily application of these advanced techniques and special machinery, without which the Navy could not handle the complex logistic problems which science, engineering, and the world situation has thrust upon it. Those applications, coming from pure science on one hand and from the evolution of daily administrative struggles on the other, will merge into the ultimate systems to furnish the Navy with the right things in the right place at the right time.--Editorial Note.

Research Notes

New Director for ONR Physical Sciences Division



Dr. Shirleigh Silverman, of the Applied Physics Laboratory, Johns Hopkins University, has been loaned to the Office of Naval Research to serve as Director of the Physical Sciences Division. He will assume his new duties on about 1 November 1955.

Dr. Silverman was educated at Johns Hopkins University where he did his Ph.D. work in the field of surface physics under Professor K. F. Herzfeld. After receiving his Ph.D. in 1930 he continued at Johns Hopkins as an instructor for four years, doing research in the fields of physical optics and infrared in association with Professors A. H. Pfund and R. W. Wood.

In 1934 Dr. Silverman joined the Rayon Department of the Du Pont Co., working in the fields of physical optics and high polymer physics, specifically investigating the elastic properties of fibers and their films. While at Du Pont, Dr. Silverman developed some new analytical techniques for micro-analysis.

Dr. Silverman joined the Applied Physics Laboratory in 1943 to work on the proximity fuze project. In 1945 he became associated with the guided missiles program, working on free-flight aerodynamic problems using 5-inch rockets as test vehicles. In 1946 Dr. Silverman was assigned to the original group which formed the Research Center at the Laboratory and together with Drs. E. O. Salant and R. C. Herman, started a group in flame spectroscopy. This group later developed into the Chemical Physics Group which does research on problems in spectroscopy, solid state physics and chemical kinetics.

A well-known expert on infrared spectroscopy and chemical kinetics, Dr. Silverman has published numerous papers in these and related fields. He is a fellow of the American Physical Society, member of the Optical Society, Washington Academy of Sciences, and Philosophical Society.

Training for Navy Personnel in Nuclear Power

In the near future the Navy will have a school for officers and enlisted men in nuclear power. Classes are expected to convene in January 1956 at the U. S. Naval Submarine School, New London, Conn.

Students will first attend a basic nuclear-power course of instruction, and then follow-up with training at an appropriate land prototype reactor. In building up the new program, the Navy will draw on the experience that has been gained at its civilian-operated plants at Idaho Falls, Idaho and at West Milton, N.Y. These installations are to furnish trained personnel to operate the land prototype reactors.

On the Naval Research Reserve

Fourth Annual West Coast Research Reserve Seminar

The Fourth Annual West Coast Research Reserve Seminar, sponsored by the Commandant, Twelfth Naval District, and the Office of Naval Research, was in session during the period 28 August—10 September 1955. The Seminar was conducted by the Office of Naval Research Branch Office, San Francisco of which CAPT J. H. Rodgers, USN, is the Commanding Officer. CDR H. B. Joslin, USNR, Reserve Program Officer, ONR San Francisco, was the Seminar Chairman.

The theme of the Seminar was "Administration of Naval Research and Current Program in Research and Development". Approximately 45 members of the Naval Research Reserve, representing companies in five naval districts, attended the Seminar, which—in addition to lectures presented at the San Francisco Naval Shipyard—featured a broad field-trip program including visits to nine naval commands, two government agencies, and four civilian organizations engaged in research and development. The field trips were set up in a manner to include lectures by eminent speakers in varied scientific and technological fields, as well as tours of the various facilities.

Figure 1 - RADM Frederick I. Entwistle of the Mare Island Navy Yard welcomes Reserve Officers to the Fourth Annual West Coast Research Reserve Seminar

On the opening day, 29 August, RADM Frederick I. Entwistle, Commander, Naval Base, Mare Island, made the welcoming address (Figure 1) and set the tone for what proved to be a most interesting and valuable training experience for the officers attending. CDR H. F. Burr, USNR, Training Officer, Research Reserve, represented the Office of Naval Research. He discussed the role of the Research Reserve in the Navy, and reviewed some current objectives of the program. In the afternoon of this day, the group made a tour of the U. S. Naval Radiological Defense Laboratory, San Francisco.

Starting on the second day with a visit to the U. S. Naval Ordnance Test Station, China Lake, Inyokern, an extensive travel schedule was maintained which enable the group to receive a varied program of instruction, presented at places where the research and development are actually being performed. Extensive use of aircraft was made in providing such a variety of visits during the two-week period.

Field trips included visits to the U. S. Naval Air Missile Test Station, Port Mugu; the U. S. Naval Civil Engineering Research and Evaluation Laboratory, Port Hueneme; the U. S. Naval Post Graduate School, Monterey; the Hopkins Marine Memorial Laboratory at Stanford University; the NACA, Ames Laboratory, Moffett Field; and the University of California Radiation Laboratory. These and other tours kept the trainees moving through Saturday of the first week, leaving Sunday and Monday (Labor Day) for shore leave and recuperation before another active and rewarding week.

On Tuesday of the second week air travel was temporarily abandoned, and the Seminar went to sea. On this day, the group embarked in a DE at San Francisco Naval Shipyard, Treasure Island, and made a day's tour which included visits to U. S. Naval Magazine, Port Chicago, and the Mare Island Naval Shipyard. The rest of the second week featured lectures and tours at the Radiological Defense Laboratory, SFNS; the U. S. Naval Hospital at Oakland; the Department of Agriculture Regional Laboratory, Albany; the U. S. Naval Biological Laboratory at Oakland; and the U. S. Naval Air Station, Alameda. The closing session (Figure 2) on Friday, 9 September, was conducted at the home base, SFNS, and the seminar was concluded by a banquet at the Officers' Club in the evening. The banquet was sponsored by U.S. Naval Reserve Research Company 12-1. The Commanding Officer of this company is LCDR Paul M. Klein, USNR.

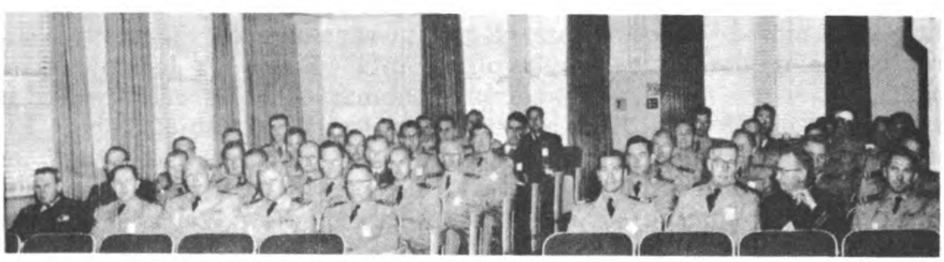


Figure 2 - Reserve Officers in attendance at the recent seminar held under sponsorship of the ONR Branch Office, San Francisco

New Naval Reserve Research Companies Activated

Naval Reserve Research Company 6-16 was officially activated at Melbourne, Florida, on 22 September 1955. The activation meeting was attended by some twenty reserve officers. Ten officers had received orders prior to the activation, and indications point to a like number being ordered to the company in the near future. Most of the officers in the company are affiliated as civilians with the research and development program at the Patrick Air Force Base. CAPT Stanley J. Gustof, USNR, has received orders as Commanding Officer of the company.

CAPT Theodore Blanchard, USNR, Special Assistant to the Chief of Naval Research (Research Reserve), officially activated the company by reading the authority from the Commandant, Sixth Naval District. After the activation ceremony CAPT Blanchard and LCDR J. T. Bedsole, USNR, Reserve Program Officer, Southeastern Area, discussed the aims and objectives of the Research Reserve with the new company.

Naval Reserve Research Company 12-2, Livermore, California, has been officially activated, effective 1 October 1955. The activation meeting is scheduled for the near future. LCDR Louis C. Nofrey will be Commanding Officer.

Three other new companies have been scheduled for activation. NRRC 9-24, Waterloo, Iowa, joins the Research Reserve on 21 October 1955. NRRC 4-10, Toledo, Ohio, follows on 26 October, and NRRC 3-11, Ithaca, New York, is scheduled for activation on 27 October. CDR John O. Chellevold, USNR, will be Commanding Officer of NRRC 9-24, LT Charles A. John, USNR, will be Commanding Officer of NRRC 4-10, and LCDR Arden F. Sherf, USNR, will be Commanding Officer of NRRC 3-11.

Reserve Officer Promoted to Rear Admiral

Commodore Robert V. Kleinschmidt, USNR, 77495/1405, a member of the Staff of Special Assistants of the U. S. Naval Reserve Research Company 1-1, Boston, has received appointment to the rank of Rear Admiral, effective 1 July 1955.

RADM Kleinschmidt first became prominent in the Navy for his development of the vapor compression distilling equipment. He was commissioned in the Naval Reserve as LCDR EV(s) on 27 May 1936 while engaged in this development and in research on thermodynamic problems and total heats of petroleum oils. His work led to special apparatus for use on naval vessels and submarines. He was ordered to active duty on 28 June 1941 and assigned to the Bureau of Ships. His military duty included head of Machinery Development Section of the Bureau of Ships, a member of the Naval Technical Mission in Europe, and BuShips Representative on Joint Committee on New Weapons, Guided Missiles Committee. He was released from active duty with the rank of Captain on 2 December 1945. He was appointed to the rank of Commodore on 2 November 1945 while on terminal leave. He received the Legion of Merit on 12 April 1946.

After release from active duty, RADM Kleinschmidt was a member of BuShips Volunteer Reserve Company 1-1 and is presently in Naval Reserve Research Company 1-1. Professionally, RADM Kleinschmidt has had an outstanding career. He received his Doctor of Science in Mechanical Engineering at Harvard in 1923; was a Professor in Practice of Mechanical Engineering from 1946 to 1953 and a Fulbright Lecturer at Norwegian Technical Institute, Trondheim, 1951 to 1952. He is a recognized authority on thermodynamics, gas cleaning, properties of gases, distillation, and gas turbines.

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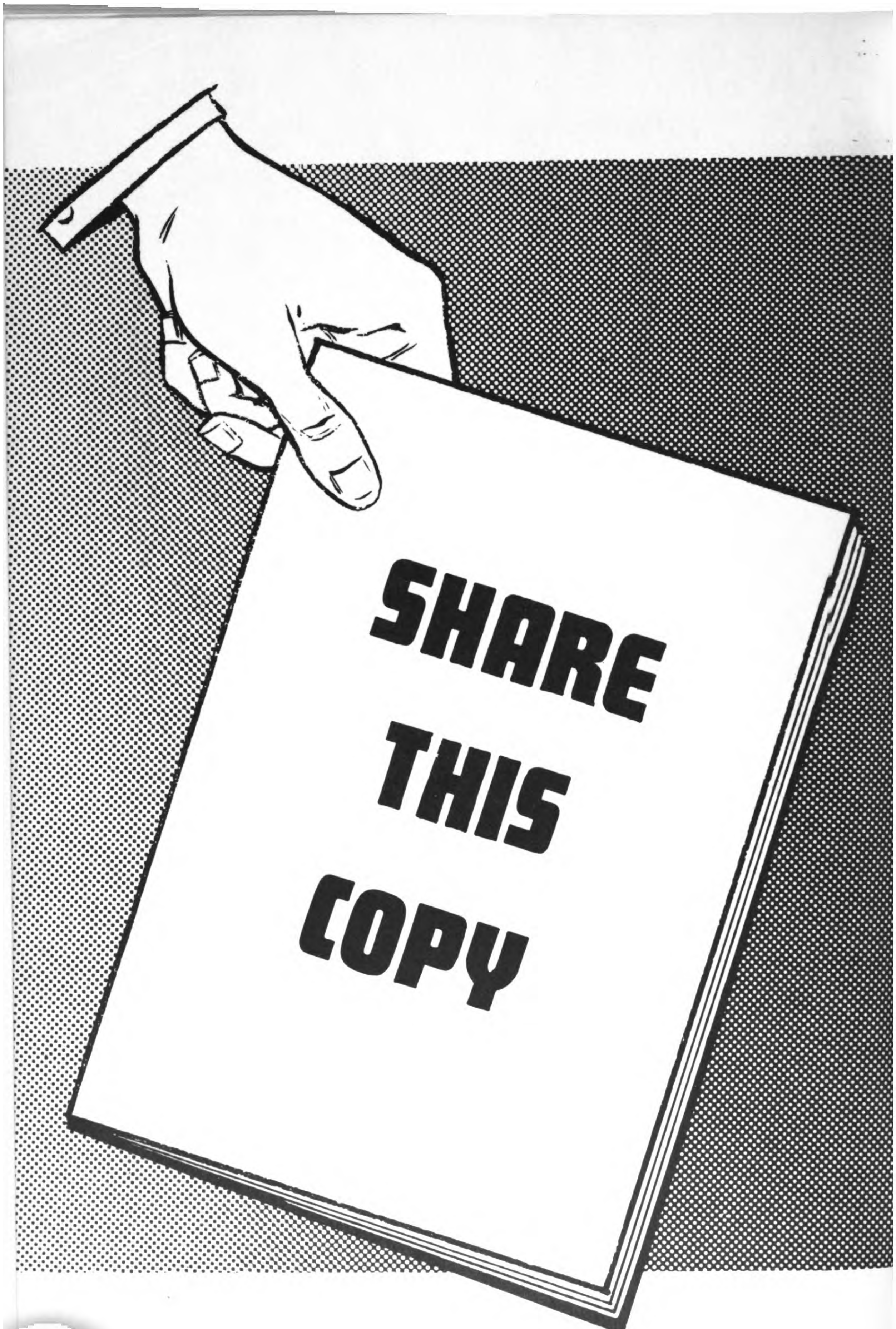
A Navy technician and a Marshallese practical nurse check the physical condition of Island people who were dusted in the incident of 1 March 1954. See story beginning page 1

After the dusted Marshall Island people had been under close medical attention for six months at Kwajalein, they were moved to Majuro (above) where they were comfortably quartered

Pictures shown on pages 2, 3, 5, and above were taken by LT W. L. Chapman of the Navy's medical team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