Postgraduate Education for U. S. Navy Personnel

By CAPTAIN H. A. SPANAGEL, U. S. Navy
Superintendent, U. S. Naval Postgraduate School, Annapolis, Maryland

I deeply appreciate the opportunity to speak to the members of this Society and their distinguished guests to acquaint you with a few aspects of the Naval Educational program as it applies to engineering education.

In recent years we have read many articles and have heard many speakers discuss scientific research and development, technology, nuclear physics, jet propulsion, bacteriological warfare and a number of other scientific subjects relating to national defense but very little has been said in regard to education associated with these matters. It is commonly accepted that the education of individuals to deal adequately with such matters will ensue from previous practices and without giving special consideration to it, that normal peacetime objectives of engineering education will suffice for national security in the future as they have in the past. During a war, all citizens of our Nation are mindful of the military applications of science and technology as evidenced by the flood of suggestions and proposals received by the Armed Services. However, the character of the suggestions and the utility of them are usually commensurate with the technical education of the donor and with his knowledge of military requirements. Too frequently the suggestions are based on commercial or industrial experience, a natural attitude since the engineering education normally gained by the individual is slanted to the needs of industry. Engineering educational requirements for national security are seldom considered or emphasized in designing civilian engineering curricula. Military aspects of engineering occur incidentally, without design, an expected result considering the greater stress which has been placed on the needs of industry during times of peace. Nevertheless the educational requirements for national defense and security also must be recognized and appropriate provisions must be made.

Correlation of Engineering Education and National Defense

The correlation of Engineering Education to National Defense and to preparation for national security is seldom viewed in its proper perspective. Effective engineering education is more essential to national security today than ever before. Furthermore, the growing complexities of science underlying engineering, has brought about a definite trend toward the scientific and basic approaches to engineering education and away from the utilitarian aspects. No longer will training in manipulation alone be totally sufficient. In engineering education greater emphasis must be placed on the fundamentals and components of it on a higher educational level must be included in the curricula as the basis for military preparedness. Likewise research and development must be embodied in the program as they are terms synonymous with higher education in engineering. One cannot readily be achieved without including the others. Effective national security cannot be gained without all of these important factors.

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The future security of this Nation will depend on the effective development of the minds of the young men who are now attending educational institutions and who will be the leaders in the years to come, leaders not only in a military sense, but also leaders in the fields of science and engineering. Preparation of the minds of these young men is deeply, if not more important to the national defense than is the acquisition of materials, the current expansion of the Armed Forces, the building up of stock piles of strategic materials and any other factors which will enhance the defensive strength of this Nation. Without the know-how to utilize to best advantage the many elements of strength, very little insurance will be gained as protection from a possible national calamity. Speaking of the term "leaders," many of us are inclined to accept literally the term "born leaders." Real leaders are seldom if ever born. They are developed by education and experience. This development process is not a short one, it is one that must be anticipated by many years, a term of years several times longer than is required to build the largest aircraft carrier, a battleship or other material construction by man. We must build educationally now for the future; adequate engineering education must be considered as a primary prerequisite for future national security.

World War II served as a concrete example of the benefits of education in this country. The educational level of the men and women actively engaged in that major struggle was higher than in any previous war. The educational background and training of the privates in the Army and the Air Force and the seamen in the Navy gave additional strength to our Armed Forces. They had better understanding of the problems involved. They knew what to do and how to do it. Also in the higher echelons of education, the scientists and technologists contributed more to the successful conclusion of the war than ever before. Their contributions and assistance were indispensable. The influence of science and technology in war was never more pronounced or effective. The essential role of science in warfare was seen with increasing clarity. There is no doubt that the future holds even greater promise of the important role of science and engineering. The development of new weapons for the future will probably determine the total strategy of wars. These thoughts alone warrant the complete and thorough preparation of the minds of young men of today, mental development to the highest levels of learning for students possessing the proper aptitude. The results of this preparation will be more decisive than ever before. We are living in an age of science. We must keep abreast of progress and anticipate the needs of the future by building on a firm educational foundation to ensure the security of our Nation.

**Influence of Government Sponsored Research**

Many of us fully understand the profound influence of engineering education on industrial development in this country. Evidences of this influence are before us constantly. The demands of industry for men and materials have promoted the growth of engineering educational institutions and the quality of education to a major extent. Sponsorship of research and development by industry has benefited colleges and universities academically as well as financially. The Armed Forces likewise have had an influence on the quality of engineering education. In recent years, they have sponsored far reaching projects in research and development. The Navy is no exception in this respect and it is well that it should not be. Actually the Navy is the largest and the most highly technical organization in the world today. Its manifold and varied interests in science and technology surpass all other organizations. In engineering, direct applications meeting the needs of the naval service, involve all fields of engineering and include all of the sci-
ences. Also like industry the Navy must promote engineering education and develop service personnel to meet its particular needs. Naval personnel must have educational backgrounds to fit them for the duties they are required to perform, duties which demand a knowledge of the various forms of engineering as well as knowledge of naval professional subjects.

The technical character of the Naval Organization may be represented by a study of the educational background of its personnel. Among the 14,060 commissioned line and engineering duty only officers, excluding Supply, Medical and Dental Officers and Chaplains, there are 7,049 who hold degrees of Bachelor of Science in Engineering or related fields, 1,553 Masters of Science and 8 Doctors of Philosophy or Doctors of Science. These numbers represent 50 per cent, 12.8 per cent and .05 per cent of the total number considered. If the civilian employees of the Navy Department and the enlisted personnel were included in this study, the numbers would be increased considerably.

Plans for Higher Education

At this point it is appropriate to discuss how these results have been gained, what plans exist for promoting higher education for naval personnel and the role of the U. S. Naval Postgraduate School in the overall educational program.

Understanding of the function of the Naval Postgraduate School in promoting engineering education within the Service, may be gained by a brief review of the School’s historical background and by an explanation of the conditions which prompted its establishment. In 1909 when it was founded as a department of the United States Naval Academy, it was created to provide additional engineering education to fill the needs of the Service at that time. Then, as is the case today, the Naval Academy curriculum included instruction in several fields of engineering but did not permit majoring in any one field. The students gained most of the basic fundamentals in engineering, but time did not permit them to advance much further. The demands for specialization occasioned by the advent of radio, by advances in electrical and marine engineering and by current developments in the field of naval architecture could not be satisfied by modifying the Naval Academy curriculum and something higher than undergraduate work was required. Furthermore, it was generally accepted that specialization should follow a period of seagoing experience. The result was the establishment of the Postgraduate School. During the early years of its existence only part of the postgraduate instruction was carried out at the School; the remainder was gained by residence at a cooperating civilian institution. This same policy remains in effect today. Full advantage is taken of the facilities and capabilities of civilian institutions where our special needs can be satisfied.

Since 1909 the scope of instruction has been expanded in each field of engineering, additional engineering curricula have been established and the enrollment in the Postgraduate School has been increased manifold to keep abreast of the progress within the Service. Initially ten student officers were enrolled in a course in Electrical and Mechanical Engineering. From that start, the School has grown steadily. At the present time we are providing instruction at the Postgraduate School in Annapolis to about 400 students in 24 different engineering courses, each designed to meet a particular objective. The subjects taught under the several courses include: Aeronautical Engineering, Chemistry, Communications, Tacties, Crystallography, Mineralogy, Electrical Engineering, Electronics Engineering, Industrial Engineering, Foreign Languages, Mathematics, Mechanics, Mechanical Engineering, Meteorology, Metallurgy, Marine Engineering, Ordnance and Gunnery, and Physics. In addition, the Postgraduate School is directly responsible for the
administration of graduate work for approximately 500 student officers attending 31 different colleges and universities.

Since the majority of our student officers up to the present time have been graduates of the Naval Academy, the content of the Naval Academy curriculum has greatly influenced the design of postgraduate curricula. As I have stated before, no graduate of the Naval Academy majors in a particular form of engineering; hence, specialization in a field of engineering first requires supplemental instruction paralleling the junior and senior work in engineering in civilian institutions. This our postgraduate students receive, then they are advanced to graduate study embracing the prerequisite subjects for graduate work at cooperating institutions or to complete the prescribed courses at the Postgraduate School. The required undergraduate phases of instruction are completed in less than one year. The advanced work to meet the requirements for a graduate degree require one or two additional years.

**Navy Postgraduate School**

The position occupied by the Postgraduate School in engineering education was recognized by the Congress in 1945. It was previously contended that the quality of education at this School was comparable to that in civilian institutions and that the accomplishments of the students should be recognized by the award of appropriate graduate degrees. This view was supported by a committee of Deans of Engineering which visited the School in June 1945 and made a survey of the academic work. The final result was the enactment of Public Law No. 250, 79th Congress, approved by the President on 7 December 1945 and authorizing the award of appropriate Masters and Doctors Degrees in Engineering and related fields. The rules and regulations approved by the Secretary of the Navy and governing the award of graduate Degrees parallel those for qualification in civilian engineering institutions. To qualify for a Masters degree in engineering or related fields, the candidate is required to complete a prescribed course of advanced study while in residence for at least two years, comprising not less than thirty-two semester hours clearly of graduate level and including not less than four hours of advanced mathematics. In courses carrying graduate credit he must attain an average of B or a quality point-rating of 2.0 and he may be required to pass an oral examination either in defense of his thesis or upon the basic technology of his major field. These requirements which must be met by candidates for graduate degrees are slightly more stringent than in other institutions, a fact substantiated by an advisory committee appointed by the American Council on Education which made a survey of the Postgraduate School activities in May, 1947. The first awards of Master of Science Degrees were made to a group of candidates in Engineering Electronics in June, 1947. Thirty-five additional awards were made this year to graduate students in Aerology, Electrical Engineering, Engineering Electronics and Mechanical Engineering.

The academic year at the Postgraduate School begins the latter part of July and consists of four terms of ten weeks each. An additional week is interposed between the first and second terms, and between the third and fourth terms for special seminars in appropriate subjects.

Applicants for engineering courses are selected on the basis of their undergraduate work with special attention given to results attained in Mathematics, Electricity and Physics and on their professional records and experiences during their commissioned service. We are at present negotiating with the Educational Testing Service and expect to enter into a contract with that organization to design and administer appropriate tests for all applicants to establish the quality and aptitude of the students enrolled. We also have contracted with the University of California at Berkeley
to develop and administer correspondence
courses in Mathematics, Mechanics and
Physics to serve as refresher courses in
these subjects for all selected and ac-
cepted applicants. It is fully expected
that the tests and correspondence
courses I have mentioned will definitely
enhance the quality of students enrolled
and permit more rapid advance to work
on a graduate level. These steps may
even permit a reduction in the length of
each course, a matter of no little interest
to the Navy Department.

Professional Education

In addition to instruction in the fields
of engineering, the Naval Postgraduate
School also serves importantly in the
professional education of naval officers.
Actually, in terms of numbers enrolled,
instruction in strictly naval professional
courses comprises at the present time a
major portion of the School's activities.
As the result of recommendations made
by special boards appointed by the Navy
Department prior to 1927, the Depart-
ment recognized the need for postgradu-
ate instruction in professional subjects
and directed the establishment of a Gen-
eral Line course to supplement previ-
ous undergraduate instruction received
at the Naval Academy and to confirm
seagoing experience gained during the
period since graduation. The course
included instruction in such subjects as
Seamanship, Navigation, Naval Engineer-
ing, Electricity, Military Law, Ordnance
and Gunnery, Radio Engineering,
Communications, Tactics, International
Relations, Military Character or Leaders-
ship, and Organization and Adminis-
tration. The subject matter was covered
in a manner designed to prepare officers
to perform better their duties as Heads
of Departments aboard larger type ships
or their duties as Commanding Officers
of smaller craft.

The number of officers enrolled in the
course during the first few years was
comparatively few, largely due to the
unavailability of personnel at the time.
It was continued however until the out-
break of the emergency in 1941, when
this phase of postgraduate instruction
was suspended for the duration of the
war and until 1945. At that later date
the future needs of the Service, for simi-
lar instruction, were anticipated and a
new class of 134 student officers was en-
rolled in a revival of the General Line
Course. The chief purpose of this pilot
class was to determine the type of in-
struction needed by officers who had
gained extensive war experience and were
prospective members of the post-war
commissioned officer personnel. Naval
Academy graduates were not enrolled in
the course. In this instance the mission
of this School was to care for the present
needs, to indoctrinate and to broaden the
professional knowledge of a large number
of transferred reserve and temporary
officers, who, during the past few years
had served in specialized assignments
and to prepare officers having had several
years of rather narrow responsibilities
during the war for the early assumption
of broader responsibilities aboard ship.
The course furthermore, was to provide
an equal opportunity for all students at-
tending and give a common unifying
professional educational experience to
each and every one. The duration of
the course was to be one year and at the
completion, it was expected that the stu-
dents would reach an educational level
in professional subjects comparable to
the professional education gained by
Naval Academy graduates, that they
would thereafter be able to compete suc-
cessfully with their contemporaries in
rank.

Pilot Group

The men in this pilot group came from
all types of war service and contained
men with all kinds of general educational
backgrounds. The subject matter in-
cluded modern treatment of the subjects
originally included in the course and such
additional subjects as: Foundation of
National Power, Naval Intelligence,
Logistics, Electronics and Aviation.
Early in the course a serious deficiency
in Mathematics for practically all students was definitely disclosed. Those who had had adequate undergraduate training in Mathematics had forgotten a large portion of it. Many others simply never had sufficient Mathematics to permit them to perform simple arithmetical problems in Electricity, and Navigation. To correct these shortcomings special instruction in the subject was instituted and although this instruction was elective, practically all students chose to attend. On the experiences gained with the pilot group the General Line School was established at Newport, Rhode Island in July 1946 with an enrollment capacity of 600 students. An additional General Line School was established at Monterey, California, in March of this year, this one with a capacity of 500. These Schools are subordinate activities of the Naval Postgraduate School and are under its general administration. In administering this instruction it has been shocking to note the low level of achievement that has persisted in Mathematics and Physics. A large majority of the students with otherwise acceptable academic records have little or no knowledge of these subjects, display deficiencies which reflect on their high school education as well as their college training. Incidentally many of them are college graduates. A firm grasp of at least the fundamentals of these subjects is equally as essential to success in the Naval profession as it is in any engineering profession. The Society could perform a real service to education generally and to national security in particular by promoting and supporting more effective instruction in elementary forms of mathematics and general science or physics. These subjects should be included in all college curricula, engineering or otherwise.

**Training of Commissioned Officers**

The backlog of officers scheduled to receive this General Line instruction will compel each of these Schools to continue with the present program for about six years. Thereafter, it is contemplated that all officers who hold commissions in the Regular Navy will attend this School at the end of their first tour of sea duty. This later program will include Naval Academy graduates as well as all officers received into the regular service from the 52 colleges and universities under the Holloway Plan. It is pertinent to note at this point the significant role of the Postgraduate School in the achievement of the objectives of the Holloway Plan. No doubt you are quite familiar with the general provisions of the plan, but do not fully appreciate the fact that it will result in 53 different varieties from the cooperating institutions and from the Naval Academy, unless additional provisions are made for consolidating their educational background in professional subjects. Furthermore, although each civilian institution does offer a reasonable program of instruction in naval professional subjects, the coverage cannot compare with that given at the Naval Academy; unless further instruction is given, a large majority of those officers received from the NROTC will be at a disadvantage in comparison with the Naval Academy graduates who are their contemporaries. It is contemplated that all young officers who enter commissioned service in any one year, including Naval Academy graduates, will simultaneously attend the General Line School and receive the additional instruction. This will occur at the beginning of their first tour of shore duty, five to seven years after graduation from undergraduate institutions. Attendance at the School will unify their professional education, place them all on an equivalent educational level and afford opportunities for them to mingle socially. This will probably be the only time in their entire naval service when the entire group will be together in one location and receive a common course of instruction. I firmly believe that the real success of the Holloway Plan will be directly dependent upon the effectiveness of the General Line
School. With it there will be greatly improved solidarity among the officer personnel. Without it there will be 53 different groups, each one containing young officers with a slightly different educational background and professional ability.

Post-War Requirements

The influence of science and technology on National Security and the expansion of the Naval Service in recent years has impelled a revision of the entire postgraduate program. The probable post-war conditions were anticipated prior to V-J Day and it was realized that the post-war educational needs of the Naval Service could not be satisfied with the organization and facilities then available. An expansion of the postgraduate program was plainly evident. Furthermore, it was clear that an expansion of the facilities in the vicinity of its present location at Annapolis could not be gained advantageously without interfering with the activities of the Naval Academy. These views prompted the Navy Department to request appropriate legislation to satisfy the post-war requirements. After extensive hearings before the committees of Congress during which all elements of the expansion program were inquired into, the Congress approved and enacted Public Law 302 in July, 1947, authorizing the purchase of property and the establishment of a Naval Postgraduate School at Monterey, California. At the same time Public Law 303 was enacted granting statutory authorization for the establishment of The United States Naval Postgraduate School, an activity separate from the Naval Academy.

Plans are now in progress for the relocation and construction of a new school at Monterey with facilities and equipment to accommodate an estimated enrollment of 2,600 student officers. The new plant will be designed to accommodate approximately 1,100 General Line students, 900 graduate engineering students, 500 students enrolled in one year courses in Applied Engineering and approximately 100 students in Naval Intelligence. When completed it will permit the consolidation of all postgraduate activities in one location, but this move will not alter the present policy of utilizing civilian institutions. Even though this new institution is being built by the Navy, its facilities will be available to active duty officers of the other Armed Forces as well as to a limited number of foreign officers.

I have attempted this morning to cover as briefly as possible the many aspects of the engineering and technical educational program of the Navy Department. It is a rather broad subject, so broad in fact that I have been able to touch only on a few of the highlights. However, I do hope that I have shown that we in the Naval Service are very conscious of our responsibilities for finding appropriate solutions to the vital problems of selected and advanced educational training of officers for National Defense.