Educational Programs at Research Centers

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THE ACUTE SHORTAGE OF COMPETENT scientific personnel, which endangers the research and development programs of the Nation, has been the subject of considerable discussion. An interesting summary of several factors affecting research and some noteworthy suggestions for measures to improve conditions were presented by Charles V. Kidd in the January 24 issue of *Science*. However, this article failed to mention the steps that can be taken at industrial or government research centers to improve the competence of personnel through educational programs within the centers.

In a later issue (May 2), Kenneth A. Meade stated the case of the industrial concern very comprehensively and in considerable detail. In general, his conclusions and comments are very appropriate. For example, the staff at this Laboratory heartily agrees that the essential training to be given by educational institutions should consist of a good grounding in the fundamentals. One point of possible disagreement is Meade's conception that the educational institution can help a young man finally determine whether his interests lie in engineering, teaching, or sales work. Actual work on a job is frequently required to make this determination.

The experience of the Navy Electronics Laboratory in inaugurating and carrying out a program of in-service education may be of interest to others. This program appears to have helped not only in overcoming some of the deficiencies in the backgrounds of available personnel but also in aiding those who are uncertain as to their fields of work to decide on a course of action. Although somewhat simpler of accomplishment in a government research and development center, it is believed that the program, which is based on the good democratic principle that "the Lord helps those who help themselves," is not inapplicable to industrial groups.

A survey showed requirements at four levels. First, there was a need for interchange of scientific knowledge and ideas between more experienced and less experienced scientists at the Laboratory on a general, rather than a work assignment, basis. Second was the requirement for upper-division, college-level courses to afford opportunity to promising younger men to finish undergraduate instruction. There was also the need of older men to extend their knowledge into new fields. Third, men working for higher degrees required assurance of opportunity. Fourth, and most important, was the necessity of tapping the knowledge of eminent scientists in special fields.

The whole in-service educational program is loosely integrated by the Educational Board of senior scientists, which is also responsible for direct action on the more formal portions of the program. The Educational Board also attempts to cover one or two other points raised by Meade. For example, it can advise and all but direct younger men to undertake certain courses of instruction, and it can also discourage those who are ill fitted for other courses in the interest of keeping classes at convenient working size.

The exchange of information and ideas between staff members takes place in two fashions. Several departments operate seminar series, on the basis of mutual contribution of effort. The visits of outside scientists and senior staff members are also seized as opportunities for scientific "bull sessions" with all members of a group contributing.

Regular courses are given that range from straight undergraduate work to graduate-level seminars.

Generally speaking, undergraduate classes are handled by the University of California's Extension Division. Some of the upper-division and graduate courses are given by staff members and some by visiting consultants. These courses and teachers are cleared with the University of California at Los Angeles. By this method, and through arrangements with the Graduate School of the University, staff members acceptable to the Graduate School may obtain graduate credit for such accredited courses taken at the Laboratory. This encouragement of further graduate work has been strongly and enthusiastically supported by the younger men and women of the Laboratory.

It has been found impracticable to establish fixed rules for time scheduling of courses. Instead, each one is considered on its merits, depending upon the direct applicability to Laboratory work, benefits to individuals, and other factors. As a result, some instruction is given during working hours, some out of working hours, and some overlaps at the end of the day.

The most interesting and unique part of the program is that filled by the visiting consultant. Leading scientists of known and outstanding ability in fields related to, or directly in line with, the work of the Laboratory are brought in for limited periods to act as consultants and instructors.

In the role of consultant, the visiting scientist contributes both directly and indirectly to the work of the Laboratory. In some cases he may assume a definite problem in research or development during his residence, planning an investigation and supervising the work of staff scientists. If the project is small, he may complete the investigation during his stay. If the problem involves long-term research, he will plan and organize a program which will be carried on by Laboratory men. The visitor is, therefore, directly responsible for a portion of the research program. He also makes direct contributions, sometimes accidentally, to other related investigations. For example, the informal discussion by a visiting scientist of a new method of mathematical analysis saved two months of work for the Laboratory. The technique, hitherto unknown, was applied to a problem and the solution obtained immediately. The long analysis program previously planned was cancelled.

Instruction may be handled in several ways. The visiting scientist may present a series of lectures covering some specialized field, ordinarily at college upper-division or graduate level. He may, in addition, present even more specialized material, usually the result of his own research, to a smaller group in seminar-type meetings.

The benefits to the Laboratory are obvious, and the program is effective in several ways. The younger staff members have an opportunity not only to increase their knowledge in the basic principles and methods necessary to the conduct of their work but also to learn new techniques and developments. Those scientists directing the research and development program of the Laboratory can learn firsthand the status of research being conducted by other organizations in allied fields. The wider the knowledge and the greater the ability of the staff scientists, the sooner will the research problems be solved. These benefits are not always measurable, but examples of concrete results are frequent. In one case, a research problem assigned by the Bureau of Ships was solved by applying certain newly discovered principles to previously collected data, and a tedious experimental period was avoided. The solution, later checked by a brief series of experiments, proved correct. This was possible only because a visiting scientist had explained the new principles in a series of lectures given several months before assignment of the problem. The Laboratory scientist, by referring to his notes, was able to apply the new information to his data, thus effecting a considerable saving in time and money.

The indirect influence of the visiting scientist, though generally intangible and difficult to identify, is perhaps his most valuable contribution. The spontaneous interchange of ideas among scientists is the best stimulus for scientific progress. The effect on Laboratory personnel of the different outlook, attitude, and ideas, as well as the wide knowledge, of the visiting scientist can only be described as inspirational. Its value to the Laboratory lies in the increased potential ability of the staff scientist rather than in the solution of specific problems.

Many of the results of this program are, of course, of benefit to the visitors as well as to the Navy Electronics Laboratory. The visitors have an opportunity to review much of the Laboratory's program, to discuss their own research problems with staff scientists, and to use the extensive Laboratory facilities for experimental work.

This advanced educational program began in the summer of 1946. The Navy Electronics Laboratory was fortunate that the first scientists to visit the Laboratory as consultant-instructors were R. B. Lindsay, chairman of the Physics Department, Brown University, and S. A. Schelkunoff, of the Bell Telephone Laboratories. Prof. Lindsay lectured on wave motion with particular application to acoustics and radio, while Dr. Schelkunoff gave a series of lectures on special topics in applied mathematics of considerable importance in wave propagation and radiation from antennas. After several conferences and symposia, both scientists were able to make many suggestions of value to present and future investigations.

W. G. Cady, of Wesleyan University, visited the Laboratory from the latter part of February to April of this year, presenting one series of lectures on "Piezoelectric Theory" and another on "Transducer Design." During the summer, Henry Margenau, of the Physics Department, Yale University, presented a course on "The Mathematics of Physics and Engineering" and also offered a seminar on "Transmission of Microwaves Through Gaseous Media." The subject matter covered by these men, both authorities in their fields, has direct and immediate application to the work of the Laboratory.

Every effort is being made to schedule visits of others in a similar capacity during future sabbatical leaves or summer vacations. Present plans include a course on "The Kinetic Theory of Gases" by Leonard B. Loeb, Department of Physics, University of California, Berkeley.

In the future, it is planned to improve continually the available educational opportunities at the Navy Electronics Laboratory. There is no reason why, eventually, the point cannot be reached at which a stimulating atmosphere of learning and free discussion exists throughout the Laboratory to the same degree as at academic institutions, where much smaller scientific groups working in close collaboration make such an ideal situation more easily attainable.

Meade has, further, raised the point that technical schools must be furnished with pertinent information on the policies, management philosophies, and attitudes expected of graduates employed by various institutions. The Navy Electronics Laboratory has recently published a brochure, covering these fundamental points and many others, which has been given wide distribution to educational institutions. It is hoped that, in addition to its uses in recruiting personnel, this information will be helpful to these institutions.

It is the firm conviction of the staff that all of this effort is worth while. The scientific stature of individuals at the Laboratory will be increased, and the whole program of the Laboratory will benefit. In addition, some small contribution to the scientific manpower resources of the country will be made through the encouragement of the younger men.