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MAINTAINING TECHNICAL COMPETENCE: INTERNAL EDUCATION AND TRAINING AT APL

Today's technical organizations face the challenge of keeping their employees aware of latest developments in a rapidly changing technical world. As a nation, we spend billions of dollars each year on corporate and business education. In an average year, more than half the professionals in technical organizations enroll in continuing education courses. At APL, the Education and Training Group is a focal point for this staff development process. Over the years, we have developed a system for staff education and training that balances the Laboratory's long-range plans, the technical groups' specific requirements, and the staff members' needs and career goals.

THE NEED FOR INTERNAL EDUCATION AND TRAINING

The researcher's task is an exercise in contradictions. He must work in the present but always be aware of how it is changing and becoming the past. But he must also build on the past, both distant and near. And as he works, he must predict the future and prepare his work for it.

Many technical professionals are plagued by the constant feeling that their own development is falling behind the rapidly occurring changes in contemporary science and technology. The moment a graduate student or working engineer completes a degree program and receives a diploma, he or she is already sliding toward obsolescence. In fact, the process was going on during graduate training. Technical organizations face the same problem when they hire new employees fresh from the university campus. For years many organizations have spent considerable amounts of time and money orienting recent graduates and "bringing them up to speed" on the requirements of their new technical assignments. That technical organizations need to do this kind of training illustrates the degree to which higher education itself struggles with technical obsolescence. Tight university budgets and institutional inertia often lead to outmoded faculty, facilities, hardware, and software. In many instances, universities, with the cooperation of business and industry, are combating the problem, but the pace of new scientific learning is so rapid and its reach so pervasive that the closest our educational systems may ever come to winning might only be a stalemate.

The geometric increase in human knowledge, particularly in the sciences, is not news. It is no longer possible for anyone to keep up. Optimists try to maintain absolute awareness, but fail; the magnitude of the task is too large. Their work suffers, their families suffer, or their own physical well-being suffers. Pragmatists recognize their limits and know they cannot keep pace; they focus on not falling too far behind advances in science and technology. Often, in self-defense, they pursue very narrow, well-defined specialties and are able to limit their focus. Equally as often, they adapt by adjusting their learning to meet the requirements of their work. They seek new information, new training, or formal education in response to specific, short-term demands. Pessimists, many of whom eventually become organizational deadwood, simply give up, perhaps overcome by the magnitude of the task or by an understandable lack of endurance.

During 1988, American businesses, including technical organizations, will have spent more than $30 billion to provide 17.6 million formal training and development courses for their employees.[1] Obviously, education in corporate America is an important and expanding industry. A recent Carnegie Foundation study[2] estimated that during 1981 and 1982 the costs for corporate training amounted to almost $60 billion, nearly as much as the total spent during the same period by all of the nation's four-year colleges and universities, and those dollars trained nearly as many people.

The Carnegie study also points out that two recent and popular books about strategies for corporate excellence seem to neglect the role of training and education in achieving excellence. In their book *In Search of Excellence*,[3] T. J. Peters and R. H. Waterman, Jr., spend little time examining corporate training programs. Likewise, the 1984 report entitled *The 100 Best Companies to Work for in America*[4] fails to discuss the role that training and education have played in making those organizations what they are. If one looks closely at many of the organizations these books describe, however, one obvious contribution to their excellence is their commitment to training.

The most advanced education and training efforts are found typically in industries that have the highest investment in research and development.[5] An organization such as IBM, which spends an estimated $3 billion a year

on research and development, augments and reinforces that research investment with its own substantial program of internal training and development. Similarly, companies such as Hewlett-Packard, AT&T, Xerox, Motorola, Western Electric, and about 400 other corporate giants maintain sophisticated educational facilities with ample budgets and qualified, specialized training staffs.[6]

In 1985, N. P. Eurich stated:

> Beyond the educational demands created by technology in service companies, there is also the need for high level training in the inventing companies themselves. Each new product calls for another round of training for its applied use. Companies dependent on engineering and scientific research for their very existence must provide a most extensive range of training, both in-house and outside, if they intend to stay in the race. Basic training for personnel is essential to maintain an ample pool from which to select those top, so-called sophisticated, few who will invent the future.[2]

Courses offered by research and development organizations for their engineers and scientists are recognized as being very effective because the organizations are able to tailor the courses to meet their needs and the needs of the employees. The technical employees also recognize this benefit. According to a study by the National Research Council, two-thirds of the young engineers and scientists participate in continuing education courses each year, and nearly half of the older engineers still enroll in continuing education activities.[6] The key to success in this essential area of professional education is to make certain the subject matter is current and meets the participants' job-related needs.

To mark its one-hundredth anniversary, MIT's Department of Electrical Engineering and Computer Science recently published a comprehensive report[7] for engineers. It confirms the assumption that a few years of formal education is not enough for a lifetime of professional technical work. Typically, newly graduated technical professionals find that, unless they keep current, they fall seriously behind after only five years. The MIT report argues that education must continue throughout the entire career of most technical professionals and that the responsibility for this new system of continuing engineering education should be shared among industry, academe, and the individual. To meet these lifelong continuing education goals, engineering faculties and their counterparts in industry would have to cooperate in designing special courses that make full use of the intellectual resources of both communities and that concentrate essential technical content to a degree that it is acquired quickly and efficiently by course participants. The report also recommends that working engineers and scientists be afforded greater access to part-time graduate engineering programs, whether the courses are offered on campus, at industrial sites, or via satellite-based instructional television hookups. Finally, it recommends that technical organizations encourage and support formal programs of study for their professionals. The organizations must recognize that the nation's demand for technical leadership cannot be met by replacing obsolete engineers with recent graduates. The supply is just not adquate, and even if it were, the human cost would be undesirable.

Many technical professionals and the organizations they work for view this ever-present and all-pervasive threat of obsolescence as a significant problem. But it need not be so. There are opportunities for growth for all parties. Organizations can regulate and concentrate immense intellectual power on a single, specified set of problems by strategically directing their resources and their employees' efforts. To do this, the organizations must construct strategic plans for research and development, and they must create appropriate systems to communicate those plans internally. Organizational units must develop and communicate their own responses to the plans of the larger organization, and employees need to structure both short- and long-term career development plans that parallel and support organizational strategic plans at all levels. This sort of planning can lead to an efficient use of resources, both human and material, and it can provide a sense of purpose for everyone.

In any organization, the key participants in any system of continuing technical education are management, the individual staff member, and the staff development system. A well-defined scheme for two-way, cyclical communication among the key participants is essential (see Fig. 1).

Although the organization, the individual, and the people who work with staff development share equal responsibility, any effective, organized methodology for solving the obsolescence problem must begin at the organizational level. Organization, in this context, generally refers to central management, but on a secondary level, it also refers to the management of any significant organizational unit. In a matrix organization, the supervisors of the major technical units should be responsible for establishing and communicating the unit's strategic plans and for helping staff members develop education plans that will help them better support the unit's current and anticipated programs. Staff members must develop their own plans for continued education

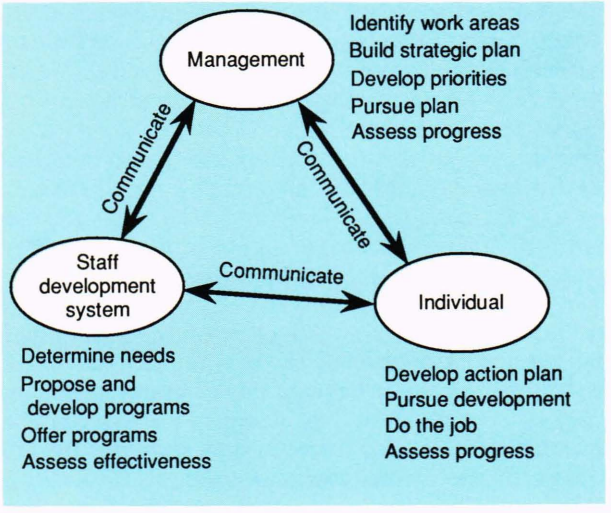

Figure 1—The cycle of continuing professional development.

and development in response to the unit's strategic plan. The individual plans, in most cases, will blend the staff member's development goals with the current needs and future directions of the organizational unit. Finally, the staff development systems must track staff members' educational needs, provide appropriate educational and training opportunities, constantly assess the effectiveness of programs, and assess changes in the staff's educational requirements.

EDUCATION AND TRAINING AT APL

The Education and Training Group is the focal point for many of the staff development systems at APL. It is responsible for providing the needed education and training programs so that the staff can be effective contributors to the work of the Laboratory. To accomplish that, it is essential that the Group maintain regular two-way communication with both management and individual staff members. All activities must be supportive of organizational goals but structured to fulfill individual development needs.

These activities should be developed not only to respond to immediate needs but also to prepare staff members to undertake future assignments. When a person is overloaded with work that must be completed today, he may find it difficult to make the organizational and personal investment to prepare for tomorrow's work. But it is critical that such an investment be made, particularly for technical organizations and their staffs. An appropriate balance is needed between getting today's work accomplished and preparing to meet future challenges. Here again, regular communication with management and individual staff members can help to achieve such a balance.

Education and training activities are not the only elements of effective staff development systems; the most significant element is one's job assignment. For a staff member to maintain technical competence and continue to grow, his work must be technically challenging. A report prepared by the American Association of Engineering Societies[8] says that an extensive survey of engineers revealed that challenging work assignments were ranked as extremely important in maintaining technical skills. Other important development activities outside the education and training area included opportunities for job transfer and reclassification, guidance by senior professionals, and coaching by supervisors. An organization must provide a variety of development opportunities for its staff, but it remains the responsibility of the individual to seize the initiative for his own development. Regular two-way communication, as shown in the figure, is essential to the staff development process.

A frequent result of this two-way commmunication is the identification of a need for an education and training activity. Determining needs is the first step. The sources of information that point to a training need are quite diverse. Needs may be identified through communication between a supervisor and staff member by means of the formal annual Record of Professional Work and performance appraisal, or through informal discussions. A training need may become evident with the advent of a major new technology relating to the work of the Laboratory, such as very-large-scale integrated-circuit technology a few years ago. Sometimes, Laboratory management may decide to enter a major new area of work that requires widespread training; this, too, will often directly affect the development of education and training activities. Follow-up evaluations of current training activities may reveal the need for new topics and subject matter. Regardless of the source, the first step is to determine the need, and that is accomplished most readily by good communication among management, the individual, and staff development personnel.

In an effort to strengthen communication links, an advisory committee composed of senior representatives from each APL department was recently appointed by the Director to work with the Education and Training Group. It was formed as a result of recommendations made by the Fourth Issues Committee of Supervisors and Managers, which studied the subject of staff capability enrichment. With the assistance of the committee, a comprehensive staff development system is being implemented to identify training needs, assess implementation priorities, evaluate the effectiveness of training activities, and communicate development opportunities.

Once a training need has been identified and management has agreed that it is significant and should be addressed, the process of developing the training activity can begin. The next step is to research the various educational alternatives. When considering a specific course, this step will entail determining whether a comparable course already exists, and if so, whether it will meet the need. Staff members already knowledgeable in the subject matter are enlisted to assist in the evaluation process. Even if an ideal course cannot be found, it may be appropriate to customize an existing course to meet our requirements. Only as a last resort, after we have been unable to find an appropriate alternative, do we develop a course in-house.

When it becomes necessary to create a unique course, we work closely with internal subject matter experts. The role of the Education and Training Group is to provide the instructional design expertise; the subject matter experts determine the course content and occasionally serve as instructors. Our experience has shown this team approach to course development to be highly successful in meeting APL's education and training needs. In addition to providing a well-designed course, it ensures that the content is directly relevant to APL's work, including illustrative examples selected from actual APL programs. It also provides the opportunity for staff members who wish to teach to learn and apply this skill. In many instances, such experience has led to the staff member becoming a member of the faculty of the APL Education Center.

After the training activity has been developed, it is the responsibility of the Education and Training Group to communicate the opportunity to the staff, enroll the participants, administer the activity, and assess its effectiveness. The evaluation process sometimes shows that revisions need to be made before the activity is repeated.

Another result may be the identification of additional training needs, and the training development cycle begins again.

To carry out its role as the focal point of staff development systems at APL, the Education and Training Group manages three major areas of responsibility. The areas and some of the ongoing activities in each are

APL Education Center

Operational Support
Admissions Processing
Academic Advising Coordination
Facility Planning and Support
Course and Faculty Evaluation

Educational Support Programs for APL Staff

Part-Time Study Program
External Short-Course Attendance
Educational and Career Advice
Professional Society and Meeting Attendance
Scholarship Program for Dependent Children
APL Group Descriptions Book

Training and Development Programs for APL Staff

Associate Staff Training Program
Management and Supervisory Education
Computer Training
Technical Writing Workshop
Career Development Courses
AIDS Education
Quality Teams Training

Articles elsewhere in this issue provide in-depth views of three of these internal programs.

With this structure and with the support of Laboratory management, the Education and Training Group will continue to serve the development needs of APL's technical staff. As an organization and as individuals, we will be able to keep pace with, and perhaps even stay ahead of, the rapid changes in science and technology. In the long term, APL, its sponsors, and individual staff members will benefit from this cyclical system of continuing technical and professional education and development.

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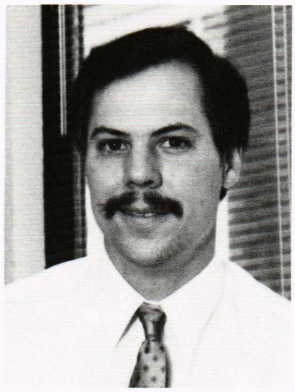
THE AUTHORS



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JAMES L. TEESDALE's biography can be found on p. 107.