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THE IEEE NUCLEAR SCIENCE GROUP PROPOSAL FOR CONTINUING PROFESSIONAL EDUCATION*

I. Introduction

Continuing Education has become a popular theme over the past couple of years. The recent Federal economic cutbacks which have directly or indirectly caused the dislocation of tens of thousands of engineers, have also triggered a small avalanche of new educational efforts by community schools and colleges, universities, private companies, and professional organizations. To name a few examples, some community colleges have greatly expanded programs to include new topics hitherto unexplored, and have encouraged the growth of off-campus instructional centers to better serve a needy public; a local example is Foothill College. Universities such as Stanford are fostering special educational conferences, and short courses appealing to the need for technological "retreading". Private industries, such as Bell Telephone Laboratories and General Electric, continue to support and expand educational programs although in many sectors such programs have been severely curtailed because of the economic situation. And finally the IEEE has cooperated with other professional organizations in Government retraining efforts, and as well has sponsored a number of short courses, management seminars, new publications, and new audio-visual services.

Interwoven in all of these efforts is a newly awakened desire for stability of employment as well as a desire for relevance of engineering to social needs. The engineering profession has been shocked out of the complacency born of the steadily increasing demand for its services of the past 30 years. For the first time in this period of record growth, certain segments of the technological expansion have, at least temporarily, passed through a peak. New directions

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are being sought for the application of surplus engineering manpower; the hope has been expressed in many quarters that with Professional Society stimulus and Government support, some of this manpower can be redirected into socially important programs such as medical and biological instrumentation, and pollution measurement and control. New research and production activities in such fields, it is stated, not only can absorb this manpower but can make the profession more viable than ever.

In a similar vein, recent statements[1] from the Stanford University School of Engineering bravely predict an increasing need for engineers in the 1970's — in fact a total need of 42,000 per year for the rest of the decade. The school emphasizes that the current unemployment is concentrated in the "relatively narrow" sectors of Aerospace and Electronics, implying that the manpower oversupply is not as serious as it might appear. It does not give any figures for graduates expected during this period from present levels of enrollment. The article places the present level of engineering unemployment at about 30,000. A Department of Labor spokesman at the April 1972 IEEE Region 6 Conference, on the other hand, quoted a current figure of 93,000.

II. The Problem

But what are the facts of the matter? First of all, it is a fact that technological change is causing obsolescence among engineers at an ever-increasing rate. Who among us has not been dismayed at the amount of new material in our fields which we feel compelled to "keep up with"? And yet, without narrowing our interests, to absorb such detailed knowledge as the original field keeps expanding is impossible. Thus the current discussions, and some sporadic action, on retraining.

But retraining an engineer is easier said than done. One of the dangers was stated recently[2] by the Electronics Industries Association Government Products Division. In letters to the House Science and Operations Committees and the Senate Labor and Commerce Committees it stated, "To begin a massive program of education at this time without guarantee of job opportunities when

[1] Campus Report, Vol. IV, No. 26, April 26, 1972, Stanford University.

[2] IEEE Spectrum, April 1972, p. 17.

the retraining has been accomplished is . . . unwise." That is to say, retraining must have a long range, stable goal, if it is to be meaningful.

Another fact was clarified during a recent investigation by the IEEE Education Activities Board into opportunities for engineers in the medical field: The discouraging result so far has been that opportunities are almost nonexistent because cutbacks have affected the medical field much the same as they have affected Aerospace.

A third fact is that significant engineering opportunities in new fields such as bio-medicine and environmental systems depend on manufacturing activities in those fields, which in turn depend on the prior accomplishments of a relatively small group engaged in R&D in those areas. This means that retraining and reapplication of engineers into new technological areas must be a long-term, not a short-term, process. New R&D could be stimulated in such fields, but this would affect a relatively small portion of the total engineering population, and as well, would require increased, not decreased Federal support.

What about the predictions of a future shortage of engineers? There may indeed turn out to be a shortage, particularly if one assumes that engineers continue the current trend of confining their activities within increasingly narrow specialties. However, it appears that one of the root problems is that many engineers are greatly under-utilized in their present jobs. If under-utilization of engineers were taken into account, the real surplus of engineers would be far in excess of the current unemployment figure. It is a personal opinion that in many private industries, and not just those related to Defence and Aerospace, the tendency is to hire an overqualified engineer for a relatively short-term job or contract, pay him well, and lay him off without ever having to make an investment in his long-term professional development. If a long-term view were taken, the man could be more efficiently utilized, and could be developed to handle a greater variety of tasks during his career, rather than to be cast into a stereotyped role with only limited capabilities. An example of how compartmentalized our view of engineering has become can be seen in the job titles listed in a single page of a recent issue of Electronics News: "RF Circuit Designer; Microwave Component Engineer; Printed Wire Process Engineer; Guidance System Engineer; Communication Systems Engineer; System Heat Transfer Engineer; Crystal Engineer; Analog Design Engineer; Telecommunications Test Equipment Designer; Signal Processing Engineer; Marketing Engineer; Digital Engineer."

Under-utilization of engineers has the further implication that, as certain engineering tasks become better understood and more routine, they should be taken over by engineering technologists. This would include certain types of design work. Thus tasks which were once performed by engineers should provide areas of future growth for technologists, while those (engineers) with innovative ability move into new fields or new levels of sophistication. This means that engineering and technician manpower requirements cannot be viewed separately in a time of rapidly developing technology.

Although profit-motivated private industry cannot be expected to take the leadership in restructuring its basic methods and fostering the growth and development of engineering manpower, professional societies such as IEEE, in cooperation with industry and educational institutions, can and should take such leadership. Finding new methods to expand the viable employment options of a working engineer, by an expansion of his technical as well as nontechnical capabilities and perspectives, is the important problem. The solution may well hinge on the development of an effective program of Continuing Professional Education.

III. A Goal for Continuing Professional Education

In order to have any impact on the tendency toward obsolescence brought on by technological change, continuing education must be exactly that: continuing. A haphazard or casual approach to the problem will yield little or no result. An individual engineer simply must realize that he should be continually undergoing some learning process on a daily or weekly basis, or he is backsliding.

Any programs must therefore have the basic characteristic that they be integrable into a variety of working environments. They should be economical and flexible, so as to serve a wide range of needs. And they should be designed and utilized with specific goals in mind. The specific goals suggested are:

(a) To broaden, rather than increase in depth, the knowledge of the engineer within his primary specialty. Depth of knowledge within the specialty is not the main concern, since the engineer is usually updated in this respect by the challenges of his normal job.

(b) To develop skills through some form of practice in at least one adjacent area, in order to develop some genuine job mobility.

(c) To develop perspectives on the role of the engineer as a societal problem-solver.

A variety of instructional techniques are appropriate. One of the promising ones appears to be video tape lectures and courses. The level of original preparation of courses is high, but with a minimal amount of additional effort, such courses could be easily and economically updated.

Other techniques are appropriate for other types of problems — for example, short courses, seminars, and individual research projects. Lab projects, tutorials, or independent projects will require special personal instruction or guidance.

The emphasis of such instruction should be broad and interdisciplinary in nature. Professional Groups of the IEEE are uniquely qualified to attack this aspect of continuing education needs. If enough of a variety of Professional Groups cooperate in developing such programs, an individual can have a broad selection of material to choose from in developing his personal program.

It is important to note that not every engineer at all times in his career will want or need to be participating in a formal educational program. There are a significant number of fortunates who manage to continually maintain themselves in an interesting job environment, such that they continually grow in breadth and depth of experience through the challenges of their normal job. But at some point in his career, an engineer will probably find his job becoming routine, which is a sign that he ought to be looking to new fields and opportunities. The proposed program would offer an excellent starting point for either a minor or a major expansion of an individual's interests, activities, and opportunities.

Some measure of the interest of IEEE members in Technology Forecasting, Continuing Education, and Career Guidance is shown in Fig. 1, taken from the current results of the IEEE Constitutional Amendment Survey. Slightly more than 40% of voting members favor a "major expansion" of Continuing Education Programs. The question as stated is unfortunately vague: since the type of program is not defined, one would assume that the question means an expansion of existing activities, which are indeed limited in scope. A program designed to attack some of the root causes of engineering obsolescence, and which embodies a sound philosophy for the long-term needs of the profession, would probably be unanimously supported.

The mechanism by which such a program may be developed in fact already exists. Figure 2 shows the existing IEEE Educational Services organization, which presently serves as a sort of library for educational materials. The types of program suggested would be developed by Professional Group Education Sub-Committees (which already exist in principle) in cooperation with the Education Group of IEEE, as well as specific industries, universities, and Government organizations. The users can be individuals, groups, or organizations. The IEEE Educational Activities Board, as the policy-making organization, provides guidance and coordination for the entire activity. The EAB would also coordinate such activities with other Engineering and Professional Societies.

IV. A Proposed Nuclear Science Program

The field of nuclear science embodies a wide variety of engineering and engineering-physics activities. Within the field, engineers tend to specialize in areas such as machine design, support systems, instrumentation, nuclear power generation, reactor control, radiation effects, nuclear instrumentation, and so on. Very often an engineer working in one area has little or no opportunity to become really competent in a related area: one can only gain a fragmented and partial understanding by observing from the outside. A first step in overcoming barriers between these various subfields would be to develop some fairly comprehensive survey courses. Many such courses would be appropriate to technologists as well as engineers. A partial list of major topics is shown in Fig. 3. Expanded outlines of two of the topics are shown in Figs. 4 and 5.

One of the objectives of such courses would be to explore the topics in a general way, in order to promote a thorough understanding of the underlying principles involved, as well as to emphasize applications outside of the immediate field. An example of a particular subject area is as follows: Although accelerators and detectors are used in a number of areas such as high energy research, medical research and treatment, and materials research, usually an individual engineer is familiar with only one aspect of these various applications; thus his basic understanding is limited, as is his ability to move into these adjacent fields should the opportunity or the necessity arise.

The example outlines given are obviously limited and incomplete, and need to be developed further before production of an actual course or courses can begin. A small committee will make a beginning at this task in the near future.

V. Course Structure and Accreditation

The subject of how Continuing Education courses should be structured and accredited is of concern to members of the Educational Activities Board. What type of structure and accreditation is appropriate to the need which has been described?

The question is important because there are two basic ways to approach the problem. The first is relatively informal, in which case an individual or group program might work as follows: One decides he needs a series of courses, X, Y, and Z. He contracts to obtain these from IEEE, either on his own or through his company. The company presumably provides facilities, and preferably some time, to pursue this activity. If the engineer decides to stop half way through the second course, he simply does so without loss of money, or credits. Accreditation would be simply by the review and endorsement of the IEEE-EAB.

The opposite extreme is as follows: An individual contracts to take courses X, Y, and Z, which are but one group of a series aimed at some specific career goal. The courses are accredited not only by IEEE, but are recognized as fulfilling certain basic requirements in a graduate program at a specific group of universities. The exact nature of this accreditation would be decided by the individual university involved. The company agrees to defray all costs, as well as to provide time off for study, with the proviso that the student meet a minimum performance standard. In this case, the courses would not only have to be well structured, but a final measure of the student's performance would have to be obtained.

Thus, the first case described resembles an informal series of seminars; the second resembles a formal educational program. Although both situations have their respective attractions, Continuing Education programs will be much more meaningful and effective if mechanisms can be developed to accommodate the more formal situation. In the latter case, the goal and commitment of both the engineer and his employer will be much better defined, and the value of any program can be more readily assessed by both parties.

VI. Conclusion

Some of the important questions surrounding Continuing Education for Professionals can only be answered, it seems, if an actual pilot program is developed. At the same time, the general acceptance of such programs in the long run will depend on whether a group such as IEEE can develop a meaningful philosophy which identifies and addresses group resources to the root problems of engineering obsolescence. The Nuclear Science Group, in the belief that IEEE Professional Groups can make a unique contribution to this problem, is seeking ways to develop such a program; and in doing so, to cooperate with all concerned individuals and organizations. Improving the versatility of practicing engineers will not in itself guarantee continued future employment, particularly in the face of such enormous economic problems as exist at the present time; however a Continuing Education program of the type described could be an effective countermeasure against future directional changes in technology.

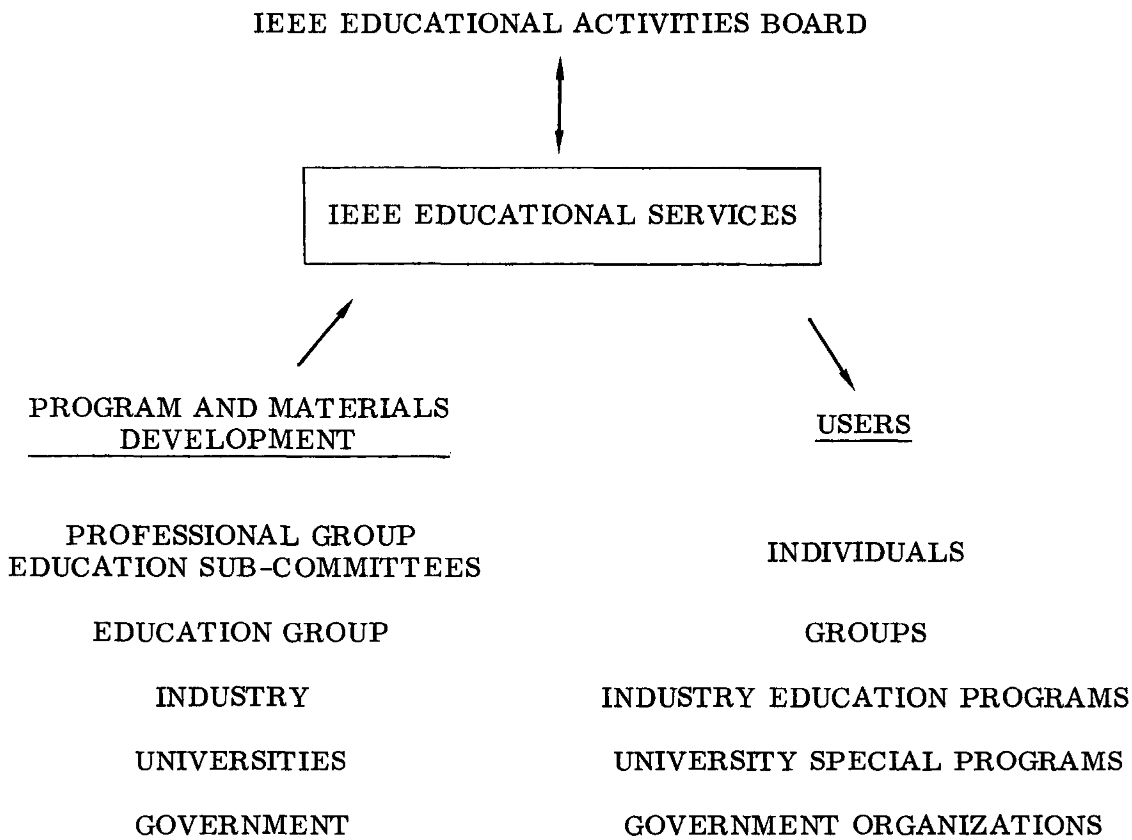
One of the most important implications of such a program is that, rather than hastening the already serious obsolescence of practicing engineers by creating new specialists at the university level, the concern should be to avoid obsolescence throughout the professional life of an engineer by making Continuing Education an integrated part of the job experience. A true estimate of engineering and technological manpower future needs can be made only if existing manpower is fully utilized in the newly emerging technologies.

IEEE CONSTITUTIONAL AMENDMENT SURVEY

(Totals as of 2/11/72 Ref. March 1972 SPECTRUM)

		REGION 6		TOTAL	
Q:		YES	NO	YES	NO
15.	Are you interested in IEEE engaging in technology fore-casting for career planning purposes?	6212	2260	34,200	12,108
17.	Should the IEEE make a major expansion in its Continuing Education Program?	3285	4769	18,769	25,322
19.	Should the IEEE expand its Career Guidance Program?	2790	5138	22,932	20,601

FIG. 1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GOVERNMENT ORGANIZATIONS

FIG. 2

BASIC TOPICS IN NUCLEAR SCIENCE

1. NUCLEAR PHYSICS FOR ENGINEERS

2. FUNDAMENTALS AND APPLICATIONS OF NUCLEAR PARTICLE DETECTORS

3. FUNDAMENTALS OF PARTICLE ACCELERATORS

4. FUNDAMENTALS OF REACTORS AND NUCLEAR POWER GENERATION

FIG. 3

SOME GENERAL OUTLINES

2. FUNDAMENTALS AND APPLICATIONS OF NUCLEAR PARTICLE DETECTORS

   A. Scintillation Counters

   B. Solid State Detectors

   C. Proportional and Geiger Counters

   D. Wire Chambers

   E. Bubble Chambers

   F. Cerenkov Cell

   G. Applications in the Measurement and Identification of Nuclear Particles

FIG. 4

3. FUNDAMENTALS OF PARTICLE ACCELERATORS

A. Principles of Linear Accelerators (various types)

B. Principles of Circular Accelerators (various types)

C. Basic Relativistic Beam Dynamics and Beam Transport

D. Particle Sources (electron, proton, heavy ions, anti-particles)

E. RF and Modulator Systems

F. Injector Systems

G. Applications in Research, Medicine, and Industry

FIG. 5