pounds tend to be recoded and thus are not disassembled anyway, nothing is lost by reducing these compounds to acronyms. The ultimate outcome of compounding followed by "acronyming" is the creation of new vocabulary. In effect, acronyms are new words. However, they are words manufactured according to definite principles and so can be coined in abundance.

A Concluding Remark

Professional jargon is a topic that stands at the intersection of several academic fields. Sociology, anthropology, linguistics, and psychology, at least, can find something of interest in it. The emphasis here has been on the psycholinguistic aspects, not because they are the most notable in the study of jargon, but, on the contrary, because they have been the most neglected. However, it is not likely that psychologists or linguists will be entirely satisfied with the results. The psychologist will find the data scanty; the linguist will find the statement of rules informal. Both will be correct, for this psycholinguistic study of jargon should be regarded as preliminary. The purpose here has been merely to indicate some interesting lines of inquiry.

But until further work has been done, we can conclude that the following statement is probably true: space speak is an engineering technology concept expression manuscript sentence grammar device.

References and Notes

1. "Short Glossary of Space Terms," *NASA (Nat. Aeron. Space Admin.) Publ. SP-1* (1962); "Apollo Terminology," *NASA (Nat. Aeron. Space Admin.) Publ. SP-6001* (1963).
2. *Destruct* is another neologism, which in many cases replaces the verb *destroy*; the reason for the neologism, I was told, is to avoid the warlike overtones of *destroy*.
3. T. S. Geisel (Dr. Seuss), *On Beyond Zebra!* (Random House, New York, 1955); I am indebted to Nobuko McNeill for bringing this example to my attention.
4. R. B. Lees, *Intern. J. Amer. Linguistics* **26**, No. 3 (July 1960).
5. Actually, transformations do not operate on phrases, but operate on the abstract structure out of which phrases are built. The distinction is critical in most discussions of syntax. In the present case, however, the reader will not be seriously misled by thinking of phrases rather than structures. It should be borne in mind, nonetheless, that the term *underlying phrase* is really a loose figure of speech. For a complete discussion of the relation between phrases and underlying syntactic structures, see N. Chomsky, *Aspects of the Theory of Syntax* (M.I.T. Press, Cambridge, Mass., 1965).
6. G. A. Miller, *Amer. Psychologist* **17**, 748 (1962).

7. Preparation of this article was supported in part by a grant (No. NsG-253-62) from the National Aeronautics and Space Administration to the American Academy of Arts and Sciences, Committee on Space, and in part by a grant (No. 5-TI-GM-1011-02) from the National Institutes of Health to Harvard University, Center for Cognitive Studies. Final preparation of the article was supported in part by a grant (No. 1PO1 HD01368-01) from the National Institute of Child Health and Human Development to the Project on Language Development. University of Michigan, and in part by a contract (No. OE-5-14-036) between the U.S. Office of Education and the Center for Research on Language and Language Behavior, University of Michigan.

Continuing Education for Engineers

Fundamental questions surrounding this new challenge to the engineering profession are discussed.

Harold A. Foecke

I am convinced that continuing education is *the* educational challenge of the future, that most of what we have been accustomed to regard as education must be judged in relation to continuing education, and that a frontal attack on the problems of continuing education would yield as a by-product benefits of great value to all "pre-continuing education" (if I may use such a term).

In posing and discussing some of the fundamental questions surrounding the challenge of continuing education for engineers, I present my views of both the specific problem facing the engineering profession and the larger problem of which it is a part. Needless to say, a paper of reasonable length cannot deal exhaustively with a subject of this scope and complexity. In trying to focus on basic issues and questions, I rely upon the existing literature to supply background details to those who need them.

Is the Problem Real?

A short time ago a prominent engineering educator told me that he felt that much of the current discussion about continuing education for engineers is just a transient tempest in a teapot —a fashionable subject which will subside to the general noise level as soon as some other topic rockets into prominence. From my experience I believe that many thoughtful people share this view. Consequently, numerous as the discussions of continuing education for engineers have been, we probably should begin by asking, "Is the problem real?"

I feel that some aspects of the problem may have been exaggerated and that we may be blithely proceeding on the basis of some untested assumptions and "myth-information." Fear strikes the heart of the engineer when he hears someone pronounce (but not prove) that the "half-life of an engineering education" is a certain number of years—5, 7, or 10. We stand in awe of the so-called "information explosion," sometimes not appreciating that most measures of this are in terms of quantities of paper, without reference to the decreasing number of significant ideas per printed page. Fuel was added to the concern several years ago when changes in the patterns of federal defense spending caused the dismissal of significant numbers of engineers in various metropolitan areas, the assumption being that

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the more "obsolete" engineers were the ones pounding the pavement.

Finally, one need be neither very perceptive nor snobbish to say that the body of literature on continuing education for engineers is not characterized by a wealth of penetrating discussion. However, in spite of some of the superficiality and mediocrity which exist, and notwithstanding the evidence of some wheel-spinning and self-expanding concern, I still feel that, under the smog, there lurks a very real and important problem.

Is the Problem New?

Not only is it currently fashionable to discuss continuing education for engineers, it is also fashionable in this country to state that something that seems new is really very ancient. So, one can read that the problem of continuing education is really very old and the only thing new is the current concern.

My own view is that lifelong learning is not new but that continuing education is relatively new—and this, I believe, is more than just a semantic quibble. Learning, in a broad but accurate sense, is an unavoidable by-product of any human experience. Learning goes on throughout life—continuously and inescapably, whether consciously or subconsciously, smoothly or erratically, planned or unplanned. Consequently, with on-the-job experience inevitably yielding a certain amount of learning as a by-product, and with the conditions of engineering practice changing at a relatively slow pace, many engineering graduates of past decades were able to build successful life-long careers on 4 years of education plus the learning inevitably associated with their professional duties.

But lifelong learning does not necessarily mean lifelong or continuing education. I reserve the word *education* for those situations in which a *deliberate* effort is made to establish the conditions under which some desired type of learning activity will take place. I think it is precisely this distinction between learning for which we plan and the learning which inevitably results from any human activity that denotes what is relatively new.

In the past, apart from a few ill-heeded commencement warnings to graduating students to remember what it was that was "commencing," and notwithstanding the existence of some deliberate programs of orientation and apprenticeship on the job, the degree of conscious concern for the planning of postbaccalaureate learning experiences was not very large. Furthermore, it did not have to be, because the pace of change was sufficiently slow that reliance could be placed on natural, on-the-job learning. Now the pace of change has passed the point where such learning is adequate, and continuing education enters the scene in a more prominent role. In this sense, I think, continuing education for engineers is relatively new.

What Is the Broader Problem?

In trying to keep the problem of continuing education for engineers in some kind of perspective, it may be fruitful to reflect and speculate on the larger problem of which this is a part. It seems to me that virtually every professional area of activity either already has been, or before long will be, confronted with change at a rate which will render *laissez faire* approaches of the past ineffective. As recognition of the need for continuing education emerges in more areas, the realization will grow that what we now call continuing education will actually be the bulk of education, and that the years of so-called "formal" education constitute a rather special case which must be designed and evaluated in the light of the whole.

If we begin to treat education as a life-spanning entity (and I think eventually we must), this is going to shake our present educational systems to their roots—and not without benefit to those systems. Consignment to a merciful oblivion is long overdue for some of the attitudes and practices to which we in education have clung uncritically for so long. I am willing to wager that even some of the current discussion among engineers and engineering educators about the "role of the academic institutions" is going to look a bit ridiculous in retrospect, although I am too deeply enmeshed in this situation to know just wherein we are blind at present. Therefore, I think the further emergence of continuing education will inevitably—and, I hope, soon—compel some drastic and long-overdue changes in our overall viewpoint on education.

What Is Being Done?

There is virtually no way of including in a single article an adequate summary of what is going on in the area of continuing education for engineers. Entire multi-day conferences have been devoted to the subject; sessions on continuing education are held at the national conventions of engineering societies; surveys have been made of what engineers think they need, what employers are providing, and so on.

Because it is currently bringing all the concern about continuing education for engineers into focus, I confine my attention to the activities of a single group—the Joint Advisory Committee on Continuing Engineering Studies, a group sponsored by the Engineers' Council for Professional Development, the Engineers' Joint Council, the American Society for Engineering Education, and the National Society of Professional Engineers. A preliminary report (*1*) of this group was released in October 1965; the final version is expected this spring (*2*) and should be consulted by anyone who wants a current review of some specific activities, as well as a valuable reference guide to other relevant studies and surveys.

Four separate task forces of the Joint Advisory Committee considered the activities and roles of industry, government, academic institutions, and engineering societies. The industry task force found that industry is gradually accepting greater responsibility for the continuing education of engineers and is translating this sense of responsibility into action, but that the bulk of the activity is still centered in the larger organizations. It recommended a program to convince all segments of industry of the needs in this area.

The government task force found a wide disparity of programs among various federal agencies and relatively limited funds and machinery to provide opportunities for continuing education (even though regulations permit such programs and statistics could justify them). The recommendations included a call for increasing employee awareness of opportunities, more funds, greater cooperation with universities and engineering societies, and better utilization of engineering talent.

The task force on academic institutions found a growing, but as yet in-

sufficient, recognition by academic institutions of their responsibilities for the continuing education of engineers as a part of their normal operation, as well as a need for a different approach in continuing education from that used in traditional formal education. The task force recommended increased acceptance of institutional responsibilities and an experimental approach in the devising of programs.

The engineering societies task force found that, while the societies have always been engaged in activities which provide learning opportunities for their members, some of the long-standing activities and structures might well be reviewed in the light of current needs for continuing education. It recommended the formation of continuing-education committees within each engineering society, increased communication among societies, and closer working relationships with educational institutions.

The committee urged, in its general recommendations, that some national agency of high prestige and unquestioned technical competence, such as the relatively new National Academy of Engineering, immediately assume leadership in a comprehensive and coordinated research effort to deal with this national problem.

What Else Is Needed?

With most of the existing programs, and the recommendations for more, I have no particular quarrel. What is lacking at the moment is sufficient explicit recognition of two points which I think are very important for long-term success. First of all, I see far too little effort to deal with continuing education as an *educational* undertaking. Because of the unusual and stringent conditions under which virtually all continuing-education programs will have to operate, most of these programs simply will not be successful unless those involved can discard their stereotypes and display more ingenuity and originality in the design of learning situations and experiences.

In developing our undergraduate programs we have become accustomed to working largely with full-time students, most of whom live on campus or nearby and most of whom are relatively similar with respect to age, prior education, maturity, educational objectives, and intellectual ability. Most of them, if they have part-time jobs, have working hours that are adaptable to the needs of the educational program. Contrast this with the continuing-education conditions where we must accommodate students from widely separated geographical areas who differ in age; in level, area, and type of previous education; in objectives; in commitment to family and community; and in vulnerability to the demands of their employment. To design satisfactory educational programs for such a group is almost certainly tougher by several orders of magnitude than to design them for our relatively homogeneous body of undergraduates.

For this reason I feel that we have to give up our unconscious allegiance to some of the 12th-century practices which are perpetuated in our formal education programs. Instead of depending exclusively on the pattern of a chalk-wielding jabberbox inflicting himself upon an aggregation of docile notetakers, we must make educational objectives more explicit and operational, analyze the potentialities and limitations of all educational resources, explore the dynamics of every kind of learning situation, identify the financial, legal, geographical, and other constraints, and ruthlessly ascertain the effectiveness of all programs.

The second general need is for recognition that the problem of continuing education for engineers has both transient and steady-state components, which must be tackled simultaneously but in different ways. The steady-state solution will be a system involving conservation and development of engineering manpower through a "preventive maintenance" program; the transient solution involves a "repair" program to overcome deficiencies resulting from past inadequacies in the formal and continuing-education programs and from the inertia of the engineering profession in rousing itself to action.

For our steady-state solution we must learn how to produce graduates who are better prepared for lifelong education (in terms of both attitudes and knowledge) and must mesh this program with a continuing-education program which will forestall rather than try to overcome obsolescence. Simultaneously, lest we place ourselves in the untenable position of writing off as unsalvageable part of our manpower resources, suitable programs must be implemented to restore and redevelop the competencies of engineers in need of such redevelopment—programs designed to succeed in spite of the occasionally weak academic backgrounds of these engineers and a lack, in some cases, of concern for their own professional growth and development.

Whose Responsibility Is This Problem?

Although the question of responsibility has been belabored many times, I think some points have received insufficient emphasis. First, I agree with the standard position that, in the final analysis, an engineer's professional competence is his own responsibility. This does not mean that he can or must manage the job single-handedly; it means merely that, without his initiative and determination, the efforts of others are doomed to failure. However, I think more attention should be paid to the attitude of the engineering student in preparing for his responsibility. He should be made to see that, although perseverance in a lifelong program of education and study will surely require sacrifices of time, money, and personal convenience, such perseverance should be regarded by him not only as a long-term investment in a successful career but also as a professional obligation.

So long as the vast majority of practicing engineers are not self-employed, employers of engineers have an important role in the solution of the continuing-education problem. With a few notable exceptions, past exhortations on this score seem to me not to have been thoroughly heeded. Some employer programs seem to be a sort of patchwork of isolated activities generated in response to specific pressures, prominent among these being recruiting competition. I would like to see more employers adopt a "manpower conservation" frame of mind, viewing a continuing-education program not only as a wise long-term investment but also as a responsibility toward maintaining the manpower resources of the nation. Manpower being our most precious resource, is it not true that the absence of a manpower conservation and development program on the part of an employer is at least as serious and reprehensible as the absence of a soil conservation program in agriculture?

In developing a package of continuing-education programs for engineers, employers could do more than they now do to bring out the learning by-product of regular assignments and to coordinate and take advantage of other "in-house" experiences and practices (orientation programs, seminars, travel, and so on) so as to produce maximum educational benefit. However, in my opinion, employers probably should not, either individually or collectively, undertake educational programs of such scope and magnitude as to duplicate or displace the programs of engineering educators.

This brings up the role of the educational institutions. As I have already indicated, I think that their academic and degree programs should be designed with a lifelong continuing-education program in mind. Second, and no less important, I think that in many cases the institutions should change their attitudes toward providing continuing-education programs for engineers. Unless schools of engineering, which are the educational arm of the engineering profession, develop sufficient flexibility to meet the continuing-education needs of engineers, the profession may have to develop a second educational arm, this one to handle continuing education. This, I believe, would be most unfortunate.

Finally, we come to the role of the engineering societies, or, as I prefer to describe it, the role of the engineering profession as manifested in and through the engineering societies and the overall organizations of which they are a part. It seems to me that it is the engineering profession that must accept the prime responsibility for exercising leadership and direction in matters of continuing education for engineers (by this I do not mean that the profession, as such, should conduct all these programs; I have already urged that engineering educators handle as much of the implementation as is practical). Regardless of where an engineer may have received his formal education and of the various capacities in which he may have pursued his career, the most abiding force in his career, it seems to me, should be the profession.

It is not yet clear whether the engineering profession is sufficiently united and agile to shoulder this central responsibility. Indeed, it may be that the challenge of continuing education for engineers will help to either make or break the engineering profession—will either permit it to demonstrate that it is indeed a profession, sufficiently cohesive and organized to maintain its own vitality and autonomy, or will demonstrate that the so-called profession is little more than a bickering and disparate collection of groups of technical specialists whose careers as employees are buffeted by policies contrived largely to please stockholders, with little reference to the needs of the engineers or their profession. Unless the engineering profession wishes to abdicate responsibility for its own destiny, it must rise to the challenge of continuing education by recognizing the leadership role which it can neither deny nor forswear.

Summary

In summary, I think that continuing education for engineers, viewed as a deliberate and sustained effort to conserve and develop the professional competence of the engineering manpower of this nation, is relatively new and has resulted from a rate of change in engineering practice which will no longer permit reliance upon the inevitable learning by-product of professional experience and related activities.

Coping with this problem successfully will require broader and more explicit recognition of two facts: (i) Continuing education is an *educational* undertaking which will be successful only if we adopt an educational research-and-development frame of mind; (ii) the current continuing-education challenge has both transient and steady-state components which must be attacked simultaneously but in different ways.

Each engineer obviously has responsibility for his own professional growth and development. Above the level of the individual, the central responsibility for leadership and direction in developing a national attack on the problem of continuing education for engineers resides with the engineering profession, as somehow manifested in and through the various engineering societies and the association of these societies.

To the engineering educators, who should adopt a broader view of their responsibilities as the educational arm of the profession, should be given, as much as possible, the task of devising and conducting suitable educational programs. This plan would by no means eliminate the direct educational activities of the societies and of employers, but it should avoid duplication, waste, and inefficiency by giving engineering educators responsibility for doing those things which they should be able to handle better than any other group.

Employers of engineers should be more concerned with the conservation and development of manpower and should devise a coherent, broad, and versatile program for the continuing education of their engineers (not through "in-house" programs alone), looking upon this as both a wise long-term investment and a responsibility toward maintaining the engineering manpower resources of the nation.

Depending upon the kind and degree of success which the engineering profession meets with in solving the problem of continuing education for engineers, the profession will either suffer a decline in unity and vitality or enjoy a remarkable renaissance in the decades ahead.

References

1. "A Report of the Joint Advisory Committee on Continuing Engineering Studies" (preliminary report, Sept. 1965).
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