DOCUMENT RESUME

ED 199 035 SE 033 611

AUTHOR	Schillinger, A. George; And Others
TITLE	New Directions in Continuing Education: Changing Roles of Universities, Industry and Government. Report on a Study of Comparative Perspectives of Decision Makers and R&D Personnel.
INSTITUTION	Industrial Research Inst./Research Corp., St. Louis, Mo.
SPONS AGENCY	National Science Foundation, Washington, D.C.
PUB DATE	Mar 80
GRANT	NSF-SED78-22139
NOTE	105p.
EDRS PRICE	MF01/PC05 Plus Postage.
DESCRIPTORS	Adult Education; Continuing Education; *Educational Change; *Engineering; Federal Government; Government Role; Higher Education; Industry; International Relations; Postsecondary Education; *Professional Continuing Education; *Questionnaires; *Research and Development Centers; *Science Education

ABSTRACT

A major objective of this study was to determine how Research and Development (R&D) managers, executives, training directors, and academic administrators, perceive the future demand for continuing education in R&D as well as what new institutional arrangements, program innovations, and policy changes they believe will be necessary to meet future demands. Other objectives were to determine how such decision-makers view the current state of continuing education in the United States and how it is related to R&D. Interview schedules were developed that included provisional scenarios of projected changing needs for continuing education of scientists and engineers with different interview schedules developed for three relevant groups of decision-makers. Conclusions and recommendations as well as questionnaires are presented in this final report. (Author/DS)

NEW DIRECTIONS IN CONTINUING EDUCATION: CHANGING ROLES OF UNIVERSITIES, INDUSTRY AND GOVERNMENT

Report on a Study
of Comparative Perspectives
of Decision Makers and R&D Personnel

Sponsored by the
Division of Science Education Development and Research
National Science Foundation

SED 78-22139

A. GEORGE SCHILLINGER
Project Director

HAROLD G. KAUFMAN
ANTHONY J. WIENER
Co-Investigators

Polytechnic Institute of New York

and

HOWARD K. NASON
Project Manager

Industrial Research Institute/Research Corporation
7800 Bonhomme Avenue
St. Louis, MO 63105

TABLE OF CONTENTS

ACKNOWLEDGMENT

We are very much indebted to the many people and organizations who made this study possible. To begin with, we are grateful to the Division of Science Education Development and Research of the National Science Foundation, which supported our work under NSF Grant No. SED-78-22139.

This acknowledgment requires the usual disclaimer: any opinions, findings, conclusions or recommendations are solely those of the authors and do not necessarily reflect the views of the National Science Foundation. Of course, this disclaimer applies equally to the Industrial Research Institute/Research Corporation, its officers and our advisory committee, the individuals whom we interviewed, and all of the organizations with which our respondents are affiliated. While many people helped us, the authors alone are responsible for the contents of this report.

Our principal individual debt is to Howard K. Nason, President of the Industrial Research Institute/Research Corporation. As manager of the project, he expedited enormously our access to busy executives in companies both within and outside the I.R.I. His advice was always helpful, and he guided us to many individuals who were particularly interested and informative about the issues we were investigating.

Mr. Nason formed an advisory committee under the able chairmanship of Vincent A. Russo, whose thoughtful comments and criticisms were extraordinarily helpful. Other members of the advisory committee and of the I.R.I./R.C. staff also were generous with constructive advice and comments; we are especially grateful to

Mr. Richard C. Berry, Mr. William P. Hettinger, Jr., Mr. George R. Walker and Mr. Willis H. Waldo. The entire first draft was reviewed by Professor Renato Tagiuri of the Harvard Business School, who gave us many thoughtful and insightful comments.

Our final, and most important, debt is to the cooperating corporations, government laboratories, and universities, and especially to the 47 R&D directors, training directors, university administrators, and others who gave so generously of their time and provided serious and thoughtful judgments in order to contribute to this study. The names of these individuals are listed in Appendix 1, together with their organizations. Since we promised every respondent anonymity in order to encourage the maximum freedom of expression, we must, with regret and apologies, fail to acknowledge our special gratitude to the many individuals who contributed particularly interesting and important ideas and judgments to our report.

A. George Schillinger

Harold G. Kaufman

Anthony J. Wiener

March 1980

EXECUTIVE SUMMARY

1. This report is an analysis of major issues in continuing education (CE) for R&D personnel. It is based in part on the responses of R&D directors and managers, heads of training and development, and academic administrators to interviews designed to discover:

- o what problems exist in industry-university-government relationships for providing CE,
- o what is the future demand for CE, and
- o what needs to be done to meet this demand.

The report also reflects the authors' analysis, based on their own experience with respect to CE and related issues.

2. We began this study expecting to find differences in perceptions within and among the groups interviewed. Instead, respondents in each group were in close agreement on major issues; moreover, industrial and academic respondents rarely disagreed in their response to questions asked of them.

3. We have found an extraordinary diversity of consumers, suppliers, and programs in CE. The need for CE is great and is increasing. Many fields in science and engineering continue to change rapidly, requiring large-scale programs of education and training of professionals.

4. Yet many universities experience difficulty in developing effective CE capabilities in response to this need. This is, in part, due to faculty attitudes that treat CE as unimportant compared to the teaching of degree candidates. Such attitudes are reinforced by academic reward structures that do not encourage those faculty efforts unless they lead directly to research and professional publications.

Also, lack of both organization and venture capital often prevent universities from pursuing CE vigorously.

5. There is an increasing gap between industrial and university salaries. Even more importantly, new opportunities for employment of scientists and engineers on many university faculties have nearly disappeared. Thus, a vicious circle has begun, and in many fields the knowledge base for providing CE is moving increasingly from the university to industry.

6. Some corporations with large R&D establishments have wide-ranging and outstanding programs in CE for their personnel. Courses in proprietary, advanced, state-of-the-art topics are taught by leading professionals, and form the core of in-house CE. However, most corporations have to depend on external sources for CE.

7 Unfortunately, external sources of CE often do not exist, or are unknown and/or inaccessible. Potentially available sources become increasingly proprietary and unavailable to other corporations as the knowledge base for providing CE moves from university to industry. CE deficiencies can be compounded if training directors themselves do not have up-to-date knowledge of who is contributing to the state of the art, and what are the corresponding CE needs of their own organization in relevant areas of science and engineering.

8. Where effective CE programs exist, one usually finds several of the following elements:

- an academic administrator who believes that cooperation with industry is beneficial;
- an R&D training director who understands the organization's CE needs and is thoroughly familiar with potential resources for meeting them;

- close geographic proximity between participating universities and corporations or government laboratories;
- a variety of other useful modes of cooperation in addition to formal course work (e.g., exchanges involving students, faculty, corporate scientists and engineers, equipment, CE technology, etc.).

9. Managers and academic leaders singled out a number of issues or new developments as being important or requiring attention. For example:

(a) Although CE was universally recognized as essential to prevent technical obsolescence among scientists and engineers, providing reliable information about programs as well as easy access to them for those who need it is difficult to achieve at times.

(b) The demand by R&D managers and professionals for CE programs in computer software is increasing. It appears that this situation will continue for some time and will require additional and higher quality programs.

(c) A variety of management skills is increasingly needed by R&D scientists and engineers who are not managers themselves.

(d) New technologies for the delivery of CE will continue to be developed and used but traditional classroom instruction will still play an important if not major role.

(e) High starting salaries in industry for engineers with Bachelor's degrees create lack of incentives to stay in school for higher degrees as had been the case in the past. This increases the need for industry to support CE, both in-house and in the universities.

(f) It would be highly beneficial if R&D industrial professionals became increasingly involved in teaching students at the universities.

(g) Education is not what corporations do best, and they do not wish to compete with universities in this area. Yet they find themselves increasingly forced to do so.

(h) The threatened decline in enrollment in university engineering and science programs that may result from the impending decrease of the college-age population is expected to serve as a powerful incentive for universities and individual faculty members to develop quality CE programs.

Conclusion and Recommendation

Education and training in science and engineering is becoming less and less confined to degree programs. Existence of and access to a system of high-quality continuing education is one of several factors to enable the U.S. to maintain an up-to-date pool of R&D manpower. Present trends point to a decreasing availability of qualified people who are able and willing to provide the needed CE.

Important research takes place increasingly within industry, and universities experience difficulty in recruiting and keeping talented scientists and engineers. These factors, coupled with an erosion of endowment, tuition and research funds, and the resulting bureaucratization of governance procedures, threaten universities with deterioration of faculties and programs.

The loss of competent teachers and researchers from universities to industry threatens to create a misallocation of personnel that would be harmful to both industry and the nation. If allowed to develop, this misallocation would weaken the university's capacity to perform its educational functions and to conduct non-proprietary research from which an entire industry could benefit. This result would be to impose costly new burdens on industry with respect to the training and education of its own R&D personnel.

Building a strong system of continuing education would provide the universities with the opportunity to reverse this trend. But that cannot happen without a concerted effort on the part of the universities and industry to work more closely together.

Our principal recommendation is that serious efforts be made, as quickly and on as large a scale as possible, to bring together universities and R&D organizations (and other appropriate organizations) to identify potential suppliers and consumers of CE in science and engineering and to plan and organize new, cooperative and effective CE programs. This should be carried out under the auspices of a consortium of organizations, such as the National Science Foundation, appropriate committees of the National Academy of Science and National Academy of Engineering, The Industrial Research Institute, the American Society for Engineering Education and other institutions with a commitment to the vitality of U.S. science and engineering education and research. As a first step in this direction we recommend that the Industrial Research Institute assume leadership at an early date in the organization of a symposium to exchange ideas and to improve understanding of these issues. Included in the work of the symposium should be the appointment of a steering committee which would plan and carry out an agenda for further action.

Success in these efforts would result in correcting the loss of CE capabilities incurred by universities and in reducing the excessive costs to R&D organizations that result from the continuing misallocation of R&D expertise to the loss of all concerned.

A concerted effort is essential. To make headway will require initiatives and support from corporations, universities and foundations. Corporations acting alone can invest in supporting the CE programs they will need, but individual efforts, by themselves, are not likely to deal successfully with what appears to emerge as a national problem and needs to be treated as such.

Recommendations for Future Study

First and foremost, we recommend that the key problem areas this pilot study has identified be now examined in depth and with quantitative measures where appropriate and possible. In such a detailed study it would be useful to make a distinction among major industrial sectors or key areas of R&D. We would also urge that an analysis of attitudes and decisions of scientists and engineers, who are the direct consumers of CE, be included.

We believe that the following issues we have identified are sufficiently important to merit separate attention:

1. We have indicated that effective systems of CE are often found where universities and industrial laboratories in close geographic proximity have worked out a variety of mutually beneficial avenues of cooperation. It would be of value to examine some of the more successful regional arrangements to learn how these have developed, and what aspects would be applicable to similar situations elsewhere, or adaptable to less proximate groupings.

2. Our respondents have indicated that if due to a decreasing college-age population the R&D manpower pool should shrink significantly as expected, they may consider massive retraining of people in middle age to meet current needs. But even at present there seems to be a significant number of scientists and engineers who would want to invest their time and energies in education to change careers (with considerable social profit) if only more information about programs and options were available; if they had access to competent counseling; if pursuing such efforts did not imply a risk to employment or, more importantly, if employers themselves would regard such undertaking as investment. A comprehensive study of all aspects of career change for R&D personnel seems desirable.

3. Only a few directories that list CE programs are available. Some of these are not sufficiently known or are incomplete, and the courses listed are necessarily left unevaluated. We recommend that

the National Science Foundation sponsor a study to determine what the market might be for an accurate, up-to-date and informative directory; in what ways evaluations can be furnished that are fair and acceptable to those who provide CE and still be of value to the user; what the economics might be of regularly publishing and distributing (on paper and/or in electronic form) a directory and what it would entail to produce a dependable high quality product.

1. INTRODUCTION

The working hypothesis for this study was that there will be marked changes in the needs for continuing education for R&D scientists and engineers in the coming decade. Furthermore, in response to these changes, a more effective and better articulated system of educational programs than now exists may be necessary. This would require increased cooperation and possibly a new division of labor between industry and academic institutions.

A major objective of this study therefore, was to determine how R&D managers, executives, training directors, and academic administrators perceive the future demand for continuing education (CE) in R&D, as well as what new institutional arrangements, program innovations and policy changes they believe will be necessary to meet the future demand. Other objectives were to determine how such decision-makers view the current state of continuing education in the United States and how it is related to R&D. For the purposes of this study, continuing education included all career-relevant studies undertaken by working scientists or engineers subsequent to being employed in full-time professional level positions.

Clearly, this study was intended to analyze issues and not merely to report on what was learned in the interviews. While the essential material for this study was derived from discussions with respondents, each of the authors also brought to the subject his own different but considerable experience in CE and in research on technical manpower. The authors reflected not only on what they learned in interviewing a large and diverse group of people, but also on what they knew from having been involved with the subject over the years.

In extensive discussions they performed their own analyses and reached their own conclusions about what was happening in CE for R&D, where trends are leading, and what remedies should be recommended.

The research did not involve obtaining a representative sample to characterize continuing education in American Industry and universities as a whole. Other NSF-sponsored studies were doing this. Furthermore, since this was an exploratory study, no attempt was made to project the future of continuing education in quantitative terms, although such an approach would have great value and should be considered as a possible follow-up to this study. Limitations of time and budget precluded that option.

No better method can be found for understanding and planning for the future of CE than to direct the attention of those who are most knowledgeable and concerned about CE issues to the questions of what they believe is most likely to happen and how they plan to deal with the situation. Through this process emerges not only a detailed scenario relating to economic, technological, employment and educational changes affecting CE, but also the basis for a plan to deal with these changes which includes the benefits of foresight and perspective.

The basic strategy, therefore, was the development of interview schedules that included provisional scenarios of projected changing needs for CE among scientists and engineers. Different interview schedules were developed for three relevant groups of decision-makers (see Appendix 2):

1. R&D executives and training directors in major technology-based organizations in both the public as well as private sector;
2. R&D middle managers in these technology-based organizations;
3. Administrators and CE directors at academic institutions that provide education to engineers and scientists.

Selection of the decision-makers was based on a purposive sampling plan which assumed that, with good judgment and an appropriate strategy, one can select the individuals to be included and thereby develop samples that are consistent with the goals of the research. The procedure included close interactions with relevant organizations that have the expert knowledge needed to determine who should be included in the sample. For example, the Industrial Research Institute (I.R.I.), whose membership represents the nation's leading technology-based firms, assisted in selecting representatives of 16 technology-based organizations. Interviews were usually arranged with the vice president (or equivalent) for R&D as well as the chief executive officer responsible for training and development. Similarly, CE directors and administrators from seven academic institutions were selected with the assistance of key individuals from organizations such as the American Society for Engineering Education. The interviews usually took place where the decision-makers were located. In order to reduce the cost of travel, interviews were mainly concentrated in the East, although other regions such as the Southwest were also included to help assure that national rather than regional issues were identified.

The interviews were structured and standardized as much as possible in order to facilitate comparisons. But they were also open-ended, thereby permitting considerable latitude for the respondents to express themselves. This approach helped provide the researchers with data from which to cull potentially useful insights and recommendations based on the collective wisdom of knowledgeable and experienced informants. The researchers did not insist that respondents closely follow the interview schedule. Many interviewees responded to the interview items but then spoke at length about issues which were not included in the schedule. It was considered more productive to encourage respondents to speak to the CE issues of greatest concern to them rather than to require them to address all the items in the schedule. All interviews were recorded and summarized.

Comparisons were made not only between technology-based organizations and between these organizations and academic institutions, but also within organizations as well, by contrasting the views of R&D executives with those of their training and development counterparts and middle managers.

2. THE VARIETY AND ORGANIZATION OF CE PROGRAMS IN SCIENCE AND ENGINEERING

CE Programs in Science and Engineering

No aspect of the study struck the researchers more forceably than the extraordinary diversity of the organizations involved in CE, of their perceptions of CE needs, and of the programs that are available. Table 1 illustrates some of the most prevalent arrangements.

Sources of CE Programs

Types of CE Programs			UNIVERSITY		EMPLOYER		PROFESSIONAL SOCIETY		OTHER	
			Centralized	Departmental	Corporate	Government	Large	Small	Non-Profit	Private
CREDIT	On Campus	Bachelor's Degree		●						
		Master's Degree		●	●					
		Doctoral Degree		●					●	
	In-House	Graduate Courses	●	●						
		Advanced Special Courses		●	●	●				
NON-CREDIT	In-House; On Campus; Other Meeting Facility	Advanced Special Courses	●	●	●	●	●			
		Self Study	●		●	●	●		●	●
		Short Courses	●		●	●	●	●		●
		Meetings Workshops		●	●	●	●	●		●

TABLE 1

It is evident that universities are the major suppliers and that employees or organizations engaged in R&D are the major consumers of CE in science and engineering. The initial decision to undertake CE typically rests with the individual participant. The decision, however, as to whether time or tuition will be provided by the employer is based on existing policy and usually rests with the professional's immediate supervisor. Therefore, in a sense, R&D organizations themselves can be thought of as consumers of CE.

It is not unusual for accomplished R&D professionals to offer courses themselves, frequently as adjunct professors at universities. University professors are also frequently invited to present courses and special seminars to R&D organizations. This might most accurately be regarded as short-term CE, which is concentrated on a specific subject and supplied by an expert in a particular field, rather than by a university.

In addition, practical continuing education takes place as scientists and engineers who ordinarily work in R&D spend what are sometimes called sabbaticals in other departments of the same corporation. For example, a scientist or engineer may work closely with line production management or with marketing of product lines to which his technical work is relevant, and return to his R&D tasks with a much better understanding of the relationship of R&D to the production and marketing decisions of the corporation.

Occasionally R&D personnel are exchanged between corporations. This form of CE is limited, however, by the need to safeguard technical information if it confers some competitive advantage. There are also fears of anti-trust problems that may come from innocently-intended selective sharing of advantages. To a surprising degree, however, it appears that technical information is not treated as proprietary by most R&D organizations, and is often readily available in the literature.*

Given this diversity, it is obviously difficult to generalize about a particular aspect of continuing education. CE can take place in many different forms, and places, and for a variety of purposes. Therefore, in this report we have tried to make clear whenever possible which kind of program, organization, age group, industry, etc., we are referring to with respect to each issue.

Objectives of Education in R&D Organizations

The primary objective of CE in R&D organizations is the maintenance or improvement of the performance of scientists and engineers. One major objective is bringing to the attention of R&D personnel important and interesting developments in their own or related fields. Speakers from universities or from other corporations are often invited for this purpose.

*Scientists and engineers in most companies are encouraged or at least permitted to participate in professional meetings and to present and publish papers on their work. These are, however, subject to review if the information is considered proprietary--something that is much more rare in research than in product development. The protection of technological information rests to a much larger degree upon the effort to keep the information private than on the patent system. Patents all too frequently publicize innovations and encourage competitors to find alternative routes to the same results. The fact that technological advantages are more often preserved temporarily by silence rather than by patents does impose some limits on the participation of R&D employees (especially D) in the continuing education of students at universities or R&D employees or other organizations.

Similarly, in many in-house seminars, important progress made by one group within the company is reported to researchers in adjacent fields. Because of the emphasis on the secrecy of proprietary information, attendance at such meetings is sometimes limited to those who have a "need to know".

Much education is sponsored by industry to foster the professional career development of employees. Thus it is an expected perquisite in any high-technology organization to have the opportunity to attend meetings or courses that are available in-house or from professional societies or at universities. The principal objective is essentially to satisfy the immediate job needs of the employees or to broaden their horizons in fields other than those in which their primary work is concentrated. The availability of subsidized university-based degree programs is attractive to new graduates as a fringe benefit.

Comparison with Formal Degree Programs

Formal degree programs are structured with a great deal more consistency than continuing education programs. However, it was characteristic of the R&D managers in the survey to view formal degree programs as providing only the basic education for the R&D professional. One R&D director put the point especially strongly:

> Everyone hired from a university, whether he or she has a bachelor's in engineering or a Ph.D. in science or engineering, starts as a "greenhorn." The most important part of a graduate's education begins on the job.

Typically, the university graduate--whether at the bachelor's, master's or doctoral level--goes to work in a research or development laboratory under the mentorship of more experienced scientists or engineers. Only after a period of apprenticeship is he likely to contribute substantially to innovation. At that point, he has been educated on the job in a far more specialized and advanced way than a university could accomplish. Clearly this is more true of specific product development, process engineering, and applied research programs than it is of basic research.

While R&D executives contend that the on-the-job portion of employee education was very important, they universally agreed that higher degrees are highly desirable, and are likely to contribute to the future advancement of employees, especially in more versatility and deployability. One recurring policy was that no promises of advancement were made to employees who undertook to earn higher degrees. It was explicit that their work for the corporation would be judged on achievement alone, and that an advanced degree was not in itself a reason for a promotion or a salary increase. However, there was a general expectation that additional education would result in increasingly challenging assignments, which would in turn lead to greater rewards. A major exception to these policies existed in at least one organization which had a different salary schedule for each degree level. Thus, in this organization obtaining a master's degree would typically result in a salary increase since the individual is moved to a new and higher salary schedule.

Speaking of the difference between educational programs at a corporation and a typical university, one manager pointed out the following:

> At a university you have a constantly changing student body. The average stay of a student is four or five years. Here you have a very stable student body. So in our in-house program, we have to change and turn over the program offerings much more rapidly than at a university. We offer a course and if it is a very popular course, you saturate the local market here in two or three years and that course then has to be taken off the offerings for maybe ten years until there are enough new people. So that is the basic difference here--a stable student body and a rapidly changing course offering. At a university it is a rapidly changing student body and the offerings change much more slowly.

3. FACTORS CONTRIBUTING TO THE HETEROGENEITY OF CE IN AMERICA

The Relationship Between Industry and the Universities

Both the educational system and the structure of high technology R&D organizations in the U.S. exhibit certain uniformities and regularities. Education in science and engineering tends to follow similar patterns in universities, with almost predictable curricula leading to the bachelor's, master's, or doctoral degree. Similarly, R&D organizations have management hierarchies typically ranging from project managers to vice presidents.

Some variations do exist. For example, some companies employ what is known as the "matrix" management system in which R&D reporting responsibilities exist not only to the immediate superior in a particular R&D function, but also to a line project or product manager. In some organizations, personnel specialists are in charge of tracking the careers of those involved in R&D, as well as other professional and managerial employees, and become involved in CE and other decisions affecting the progress of the scientist or engineer. Nevertheless, the typical form of an R&D organization is a pyramid up which people climb at various rates, and often on dual ladders (technical or managerial). CE decisions are usually made by the individual and also by his immediate superior if time off or tuition reimbursement is involved.

Given the homogeneity of the educational system and the relatively similar structures of corporations, it is surprising that the relationship between universities and corporations, especially when it comes to continuing education, is so complex and multiform. There are several possible reasons why this is so.

1. Education is considered to be a small and cost-effective expenditure compared to other items in the R&D budget. R&D organizations that have effective educational programs find them essential to maintaining a competitive position. Often only by exposing professional staffs to programs dealing with new ideas, theories, techniques and recent research results in a given area do corporations remain competitive or assume strong positions through innovation. While, in general, corporate policy governs participation in continuing education on company time and at company costs, CE is, in most of the R&D-intensive organizations we studied, readily available to R&D personnel.

2. From the university's point of view, continuing education is often only a marginal product. They continue to devote most of their resources and energies to formal undergraduate and graduate degree programs.

3. Major universities are no longer necessarily the most competent or up-to-date dispensers of new scientific and technical information; therefore, new types of organizations have entered the market as suppliers of continuing education. Among these are the professional societies, which, to some extent, serve the same educational objectives as industrial in-house programs, but have no proprietary content and permit sharing of costs. Also enterprising business groups have appeared in the market which typically employ a handful of outstanding experts from universities or industry and package and market sharply focused programs on technical topics in current demand. These programs often are more responsive to the job needs of working professionals interested in applications than university cur-

ricula with their more general and theoretical emphasis.

4. As young experts, sometimes in groups, move from one institution to another, reputations for excellence in given fields can no longer be depended on for extended periods of time as was the case in the less mobile job environment of earlier days.

These and other factors make it much more difficult to identify suppliers of high-quality continuing education. Since corporations provide most of the participants in CE, and they are both numerous and often competitive, no efficient network of communication exists comparable to that among undergraduates which helps differentiate good instructors or courses from mediocre ones in the university. It takes, therefore, much longer to recognize good sources of CE, and to identify those which are inadequate.

Academic administrators do not appear to be concerned about competition from industry or other institutions. They expect most employers to continue to send students to universities for master's degree programs, and to continue to hire their Ph.D.s. Also, specialized industrial courses usually do not compete with campus instruction. Furthermore, science-based or high-technology industries (i.e., good sources of up-to-date knowledge) are unlikely to become interested in marketing CE because of their need to safeguard proprietary knowledge and personnel. While nonacademic institutions will continue to have a share of the market, and a few are already licensed to grant degrees, their continued growth is projected at a slow pace, and academic leaders in CE do not expect them to become major competitors.

Given so many diverse users, so many diverse sources of additional education and training, it is inevitable that many solutions are essentially ad hoc and deal with particular requirements imposed by special situations. Thus, within continuing education a great many more-or-less-unique arrangements inevitably have grown up and their number will continue to increase for a period of some years, and then be discarded as the need changes. This is in great contrast to the relatively stable organizational structures of the universities and of the research and development groups within corporations.

The Regional Character of Effective CE Markets

Many of our respondents pointed to the importance of having convenient access to a university. Where close geographic proximity exists between universities and industrial laboratories, the amount of course work taken by R&D employees, the amount of in-house courses offered by university faculty, and the number of corporate scientists and engineers teaching as adjunct professors at the university appears significantly greater than where such proximity does not exist. Indeed, the contrast with respect to the amount of interchange between situations in which universities were close by and those in which they were not went far beyond any which could be accounted for by savings in time and expense involved in travel to the proximate institution.

The university must carefully consider the industrial composition of the region in which it is located. With due regard to departments already outstanding in neighboring institutions, it would be wise when hiring new faculty to strengthen those disciplines in which regional industries dominate. Up-to-date faculty in a given field is essential to short-lead times in the development of new CE programs.

One might speculate that this regionalism would tend to decrease in importance as communications and information processing become widespread in the next decade. A qualification should be added: since technological information relevant to current innovations dates rapidly, the freedom from geographical constraints provided by media such as video tapes will continue to be less significant for R&D education than for basic education in science and engineering and both basic and advanced education in other fields. Technological changes affecting the regional character of CE for R&D will be affected more by developments in real-time telecommunications (e.g., satellite) than by recorded material.

These views were echoed in part by several other respondents. Obviously, however, this judgment can be valid only where there is a substantial amount of continuity of subject and technology from project to project. This continuity is far more likely to exist in scientific research than it is in development programs. Indeed, much development engineering requires switching from one product line to another and bringing to bear quite different areas of knowledge on the new project.

Changing technology is a way of life at most R&D laboratories and CE was viewed by most as a necessary element of adapting to such change. One middle manager felt it was relatively easy to transfer engineers into new roles but not necessarily scientists, because of their high degree of specilization. Also the more science-based a given field is, the more difficult the transfer becomes.

4. BARRIERS TO DEVELOPING EFFECTIVE CE CAPABILITIES ON CAMPUS

University Objectives and Policies

R&D executives acknowledge the essential contribution that universities make to the corporate enterprise. They value the role that universities play in the education and training of scientists and engineers, and consider them as their indispensable source of supply of technical manpower. They regard the university as the principal social institution whose general task is the discovery, organization, and dissemination of knowledge. They believe the university does this well and they generally praised the quality of degree programs and the graduates produced. R&D executives and training directors typically agreed that the business of universities is education. One training director went so far as to suggest that it may be advantageous for industry to get out of the education business entirely and develop a closer coupling with universities at the same time.

Some middle managers, however, have been more critical of academic attitudes and practices. Some felt that universities look at CE exclusively as an income-producing venture, and that they are less concerned with achieving excellence in this field than in their regular degree programs. They noted that universities sensitive to industrial needs in CE are the exception rather than the rule. Professors who direct CE operations on campus and serve as liaisons with industry were perceived as being aware of industry's needs, but often not in a position to negotiate commitments. At more senior levels in the academic decision-making hierarchy, however, it often becomes difficult for an R&D training director to get a sympathetic hearing in regard to special needs, and more program arrangements become difficult.

When things work, one usually finds a dean or a president at a university who believes that close two-way cooperation with industry is beneficial, and who has been able to implement policies to stimulate and encourage faculty involvement in the development of quality CE materials and programs. Many R&D executives and managers feel that the internal organizations of universities to deliver quality CE needs to be improved.

Academic administrators do not take issue with the critical view of their industrial colleagues. They ascribe the difficulties to the fact that, historically, universities were not designed to engage in continuing education with the single exception of agriculture in the U.S. Land Grant State Universities. In the past, they found it neither desirable nor necessary to adopt practices and programs in response to the current needs and convenience of industrial clients. It is only recently--because of adverse economic circumstances--that universities are beginning to think in terms of developing and marketing "products" that industrial clients (rather than only individual students) want and are willing to pay for. Even thinking of students as a "market" rather than merely as candidates who may be admitted to the university and its faculty-designed programs is a novel and frequently controversial attitude at many universities.

Faculty Attitudes

Given seemingly compelling reasons for wanting to extend education to non-traditional segments of the student market, such as employed R&D professionals, it may seem surprising that universities often find it difficult to recruit outstanding faculty for such programs. To ask professors to participate in CE is often to ask them to divert their attention from what is most important to them. Only relatively generous extra payment or other rewards can usually make up for the time lost from "real work" in the faculty member's profession.

Indeed, many faculty members cannot be tempted to divert themselves no matter how large the rewards offered. The situation is exacerbated by the fact that the CE organization is most often external to the department. Therefore, teaching CE courses generally does not convey credit or prestige within the professor's own department. On the contrary, CE activity may be perceived as prima facie evidence of dilettantism and lack of seriousness as a first-class scholar within an established discipline.

The training of faculty in the sciences and engineering takes place almost entirely within the universities. They typically go directly from being university students to post-doctoral researchers or faculty members. Their view of the world is one that is shaped almost entirely by the attitudes and values that prevail in universities, with emphasis on basic research and on the mastery of what has been discovered and what remains to be discovered.

The fact that advances in science often lead to socially-useful applications is usually of secondary importance. An even more important, but often ignored, fact is that progress in applications has, at times, led to subsequent discoveries in basic research; that is, technology has often preceded the science that can explain it. Interacbetween basic research and applications, which is so well understood in most corporations, has attracted relatively little attention in science and engineering faculties.

Academic Reward Structure Impedes Faculty Initiative

The reward structure in question is not only that in the university but also that in the particular academic profession to which the faculty member belongs. It is beyond question that the imperative "publish or perish" almost totally dominates the reward structure of most academic professions.

The reality of the genuine conflict between time spent on teaching students and time spent on one's own research is obscured at major universities by the argument that researchers, who are at the frontiers of knowledge, are the most desirable teachers. This argument serves to reinforce the imperative to publish research, and adds no support to teaching for its own sake.

Thus success in the university typically requires professional success first with success with students remaining secondary. Indeed, many would argue that success with students is often perceived by colleagues as prima facie evidence of neglecting "real work." If these attitudes affect the quality of the attention given to students--who are tuition-paying degree candidates in major universities, and who represent to the alumni, to the parents of the students and to many other university benefactors, the major reason for the existence of the university--then it is easy to understand how much lower on the scale CE students must be. The programs are ad hoc, the students

dents are temporary and they do not belong to the age groups normally enrolled in the university and, in many cases, their education is not accepted as a bona fide academic activity.

Providing effective programs for such students requires at least as much learning, planning and preparing of presentations as teaching regularly-enrolled students. Moreover, it requires additional understanding of precisely what it is that the CE market wants and how to provide it. But most faculty members are "product-oriented" rather than "market-oriented," and are highly resistant to pressures to meet the needs of any particular users of their expertise. Also CE "customers" are more critical than ordinary students and many professors seek to avoid the humiliating experience of being "rated" poorly. One manager explained his experience this way:

> We found that even when courses are taught by outside faculty the best way is to contract directly with the faculty member and have him do it on his day off, rather than contract with the university and have him do it as part of his assigned teaching. We tried it both ways and we find the direct contracting with the professors more desirable.... When a professor comes here and teaches as part of his assigned teaching from a university, we found that he considers the principle of academic freedom to be applicable to this classroom situation also, and he does not condone any interference. What we really want is to sit down with somebody and discuss in great detail what our needs are and how they are represented and how the homework problems ought to be taken from our own field here. So it requires a little bit of repackaging and a different evaluation which does not come natural when he does it as part of the assigned teaching--where he simply offers a set university course at a different location. Generally speaking, when a professor teaches here during his own time, he will end up with quite a bit more money in his own pocket.

It follows that, on the whole, the university is rarely organized in a manner that permits it to discover markets for continuing education and mobilize its resources to serve them. Exceptions are universities that treat CE explicitly as a business and run it for maximum profit. Ordinarily, to be put in charge of the university's CE organization is to be put in an office that, by definition, cannot partake of the "legitimate" academic work being carried on within the department. The difficulty of organizing CE, together with serious financial constraints in all universities, leads, in turn, to the inadequacy of the venture capital that can be made available for investing in the design of truly effective CE courses.

Successful campus CE administrators agree that, if the administration of a university communicates its appreciation of CE to the faculty by rewards through benefits, and resources, as well as, salary, and advancement, for persons who are creatively involved, then mutually advantageous relationships between the university and industry develop rapidly. In the current changing social and economic milieu, most universities need to explore new roles and relationships in society. CE is one such avenue. A new climate and arrangements which are conducive to faculty initiatives in CE, however, may have to be developed.

Lack of Organization and Capital

Even in those cases where universities have accepted continuing education as a regular activity, it is the exceptional university that is organized properly to provide the CE that the market is interested in having.

A typical reason for increased interest in CE among many universities today has been the increasing economic difficulties under which universities are laboring as costs increase, as annually rising tuition payments exceed the ability of parents to pay in dramatically increasing percentages of cases, and as enrollment levels off in the 1980s as a result of the decline in birth rates in the late 1960s. Yet the very financial difficulties that motivate a search for additional students often preclude the investment necessary to develop an effective program to meet the needs of these students. This is especially true when the students are working professional persons with much more specialized needs than undergraduates, or Ph.D. candidates preparing for a scientific profession rather than for R&D in a particular field.

Administrators complain that they cannot hope to recover development costs of quality CE programs from tuition alone, and even though a university may wish to enter the continuing education field in a major way, a fragmented and diversified market makes it difficult to overcome capitalization costs and to plan on CE as a major institutional enterprise. To recoup front-end costs, it would appear that new financial arrangements need to be worked out within a given industrial sector or a given region to encourage the growth of CE programs.

Knowledge Base in Many Fields Now in Industry

One of the most significant barriers to providing any significant continuing education for industry is that the university faculty is simply not equipped to teach the things that scientists and engineers in industry already know, let alone the advances with which technical people in industry would like to become acquainted.

Often all that a university can do is to provide the basic instruction and preparation for professionals to work in a new field. It can provide a curriculum for senior people in one field who would like to learn something about another field. A typical example of this kind of CE is the very strong interest in management education on the part of many scientists and engineers. In such cases a university can often mobilize readily to provide an advanced degree or certificate program, if it is already providing a general program in management comparable to general programs in other fields. While this program may be CE for an R&D professional, it is standard for the university, and does not present the problems that a CE program in management, for advanced and experienced managers, would present for most schools of management.

5. CORPORATE POLICIES FOR CE

The Use of CE to Fight Obsolescence

Technical obsolescence is acknowledged as a problem in industry. The degree to which it is regarded and treated as a problem, however, varies. Scientists and engineers in mid-career (e.g., with 15-25 years of seniority) appear to be affected most, and, not surprisingly, in areas with the highest rate of technological change such as electronics and computers.

Several R&D executives and training directors noted that CE still has a long way to go in helping fight obsolescence among mid-career professionals. According to one training director:

> We will see a lot of emphasis at the younger side--35 and below--because those people still tend to get the newest and most demanding assignments. I have not yet found a way to keep the same amount of continuing education going for those 45 and above... That is where the biggest changes can be made.... If I were to define any place where continuing education still has a big job to do it is to reach those people who are above the average age of the profession--because that is half of the people who are still going to work another 20 or 25 years--and we tend to overlook them in the excitement of having a new graduate or a new technologist hired from another company. I think that is weak in nearly every program I have seen.

Two other groups affected by obsolescence have been identified. The first includes younger and very able scientists and engineers who, because of outstanding performance, are under great job pressure for extended periods of time. They lose their up-to-date knowledge of current work in their professional fields and instead become excellent specialists in narrow areas. Some middle-level managers believe that a specific personnel function in large R&D establishments could effectively assist line managers to prevent this phenomenon.

A second group affected by obsolescence is one in which an entire technology (albeit one in which the employee is up-to-date) is abandoned by the organization, or becomes obsolete over an entire industry. Retraining or reeducation through CE seems to have a high probability of success under these circumstances, perhaps, in part, because the program is the result of a deliberate policy decision, and the solution, therefore, has the strong moral and material backing of management.

While obsolescence is generally viewed as a potential hazard, some R&D managers maintain that "good" people don't become obsolete, but keep up with developments in their field as an inevitable by-product of their work at the "state of the art" level. Others do so voluntarily (by reading, attending professional meetings, or attending short courses of their own selection), or through planned programs sponsored by the company over time. In many organizations, these can be done under the tutelage of senior scientists or engineers--usually termed mentors--who guide employees through courses of study.

Financial Support

While the cost of providing education to employees is low in comparison to other R&D costs, it is increasing rapidly. In addition, there are opportunity costs associated with potential developments that are lost when the employee devotes time to continuing education rather than to work in research and development.

Corporations view CE as another benefit expected by employees and tend to be relatively generous in providing tuition payments for employees, especially for courses taken "on their own time." However, they are much more careful about decisions that permit technical employees to take significant amounts of time away from their jobs.

There is also a risk, mentioned by some of our respondents, in providing advanced training to an employee that this may make him more attractive to competitors and increase the chances that he will be hired away. While our respondents noted this possibility, most of them did not consider it a serious problem since they suggested that the risk of an employee leaving is always present. Moreover, they pointed out, they have the same opportunities to hire away competitors' employees. Since, in general, the companies we were speaking to were among the leaders in their industries, our respondents felt perhaps more confident in this respect than a total cross section of the industry would have disclosed.

CE budgets can be allocated via a number of channels or mechanisms and each R&D organization tends to differ in this respect. For example, sources of funds for CE may come from the overhead of a laboratory or division. Responsibility for allocating these funds typically rests with the training and development function. Another approach is to include CE funds in project or program budgets. In this case, the project manager has control over CE allocations. In some laboratories a combination of mechanisms exists. In one case which had the divisional as well as program allocation of CE funds, the purpose of each budget was defined. If CE was job related, it was funded by the program budget. On the other hand, if CE was related to an individual's longer range career development rather than short-range job needs, the divisional budget would pay for it.

Incentives to Seek Continuing Education

The incentives for the individual are similar to the objectives of the corporation. The individual hopes primarily to learn something that will improve his chances of doing notable work, of receiving recognition, of getting increases in salary and of receiving promotions. It is clear that taking courses is not in itself sufficient to gain any of these, but the belief is widespread, and probably justified, that increased education should, in general, increase the chances for advancement. As noted earlier, no amount of CE itself will guarantee advancement within a company. Corporations make it very clear that only good job performance will be rewarded. However, there is the exceptional organization that keys salary to degree level and completion of M.S. or Ph.D. which would result in his or her pay.

Another incentive to seek continuing education is anxiety on the part of the technical worker himself that his knowledge may become obsolete and that he may be replaced by some more recent graduate of a degree program that provides more up-to-date information in the new fields which the corporation is entering. Feeling inadequate is a very painful thing, and keeping up is a great antidote. There is, of course, the danger that those who take courses because they fear being obsolescent may already have become so and CE may not help them very much.

Priorities of Support

Most support in R&D organizations goes to bringing everyone relevant to a particular project up to speed with respect to the state-of-the-art in the corporation in areas relevant to that project. This internal education and updating generally has high priority.

A second priority is often a conversion of obsolescent scientists and engineers to new tasks. However, it should be noted that corporations occasionally choose instead to let these employees go and to hire new ones.

A relatively lower priority is given to employees who wish to pursue a program which amounts essentially to changing fields or to opening up an alternative career track. Some such examples have already been cited. Most prevalent is the decision of an engineering project manager, for example, to enroll for a master's in business administration or management. He now has managerial responsibilities, and feels the need for additional knowledge about human behavior, economics, accounting, marketing, and other areas that were not part of his previous technical education.

Support is generally not withheld from such attempts to acquire additional education or to open an alternative career line in management, which would lead the scientist or engineer outside the R&D establishment. At the same time, however, no promises are made to such employees that they will be given any additional managerial responsibilities simply as a result of their education in these areas. Alert personnel officers while approving such proposed educational programs will explain that formal coursework has a negligible influence on decisions affecting appointments or promotions as a manager. Advancement in management will depend on demonstrations of managerial as well as technical skills on the job, rather than on academic degrees earned.

Special Role of Proprietary In-House Courses

As noted earlier, proprietary in-house courses are the very core of CE and their proliferation is one factor that has contributed to a loss of market share of CE by universities, although the total market has increased dramatically and the volume of CE carried out by universities has also increased. In-house courses, however, have increased much more rapidly, according to our respondents. It is clear that if there were some reason to cut back on all CE, the last form of education to be abandoned would be proprietary in-house courses. The reason for this is obvious: nothing could be more important to a particular R&D organization than coordinating the work of its employees, and this requires that all relevant research and development personnel be fully informed about the technologies that are being pursued within the company.

6. CONSTRAINTS ON INDUSTRY IN MAINTAINING TECHNICALLY UP-TO-DATE PERSONNEL

External Limitations to Hiring

In many high-technology industries, the hiring of personnel is tied to the business cycle. During recessionary periods, most companies will not hire new employees of any kind, including R&D personnel, and will depend upon attrition to reduce their labor force.

In highly cyclical industries, it is not unusual to have large numbers of workers terminated, among them not only production workers but often those engaged in R&D for new products as well. A recession is not a good time to bring out new products, especially if the product requires new investment by the purchaser, as capital goods do.

The manpower pool available in science and engineering is also subject to great variations. Following a period in which there have been widespread and notorious layoffs of engineers, the percentage of undergraduates enrolling in engineering drops sharply. By the time this cohort is ready for graduation, the demand for engineers may be high, but the supply in the pool is low. Thus, the supply side of the market often lags changes in demand, and may be cyclically out of phase either in excess or in shortage.

In addition, there is the general decrease in the number of U.S. graduates of secondary schools beginning in 1976. The number of Americans born each year reached 4.2 million in 1957 and remained over 4 million until 1962, when it began a 10-year decline to little more than 2 million, where it has remained. Those born in 1957 were

18 in 1975. The implication of these demographic data is, inescapably, that--10 to 20 years from now and probably longer--the number of Americans graduating from secondary schools and going on to college each year will be less than half the number graduated in 1973-1980, and born in 1957-1962, unless there is an improbable increase in the already high percentages of each age-group finishing high school and entering college, or an equally improbable increase in immigration.

It was noteworthy that not one of our respondents seemed to have been aware of the implications of these demographic facts until they were pointed out. There were various responses to this suggestion. Typically the response was in terms of the market concept. The assumption was made by our respondents that, if a higher percentage of science and engineering graduates were needed, market forces could double the percentages of high school graduates who went into these fields. (It is doubtful that an increase by a factor of two could be made in the percentage of students who are intellectually qualified to become innovative scientists and engineers). It was sometimes alleged that greater efforts toward the recruitment of women and minorities might help to enlarge the manpower pool. This response ignores the fact that relatively small numbers make up the minority groups and assumes that the dramatic increase of women in science and engineering during the past decade will continue unabated. This response also ignores the fact that other fields also provide attractive markets for unusually-intelligent college graduates and might be able to compete effectively for the limited skilled manpower that will become available.

It is our belief that deficiencies in the available manpower pool will have to be made up increasingly through CE for older workers. Continuing education itself--especially when combined with the recent Congressional action that outlaws most mandatory retirement rules--might play a critical role in maintaining an adequate supply of manpower. Research suggests that older workers are more reliable and productive and, as long as they remain in good health, can master new fields of learning at least as well as younger workers. However, it is unlikely that they will be able to do so without a significant increase in CE programs.

The Effects of Size and Organization of the R&D Function on CE

A great deal of CE can take place entirely in-house within a very large R&D corporation, since it will tend to be engaged in contiguous areas of research, which offers the possibility of synergistic learning and teaching within the company by R&D personnel. Also the larger the R&D function the more likely it is to have adequate access to CE. This is true for at least two important reasons: it is easier to make available leaves of absence for particular persons without creating conspicuous holes in the skills available, and it becomes possible to assign one or several persons to organizing in-house CE and to monitoring the external CE market. The cost of the CE person or group is spread over the work of many more persons and thus becomes very small compared to the benefits.

A small company is much more likely to be highly specialized and to have a greater need to turn outside for CE or for information. It is also less able to invest significantly in basic research as contrasted with applied research and development of specific products, and therefore will more often find itself in need of programs or re-education for a large percentage of its R&D personnel. Paradoxically, a small company finds it difficult to spare those people whose continuing education would benefit it most.

The way the R&D laboratory is organized can result in conflicting perspectives on the appropriateness of CE. For example, in a laboratory which uses a matrix organization, one middle manager reported that program managers want only to get their job done and could not care less about CE and the career development of the professional. The functional managers, on the other hand, are more amenable to encouraging engineers and scientists to continue their education. However, if the CE budget comes from the program, the program managers have primary control over whether or not their scientists or engineers are allowed to continue their education, in spite of the managerial matrix.

An important factor in managerial decisions regarding the funding of CE is the time pressure to complete a project or program. Project or program managers are often reluctant to allow their subordinates to participate in CE during periods of high time pressure. Their reluctance may depend on the stage in the project or program, of course. Obviously, the time pressure in a project is much more intense at some stages than at others. CE seems most appropriate at the start of a project, to bring the professional up to date on job-related areas, and to take advantage of the relatively low-time pressure when deadlines are still distant. Nevertheless, because of time pressure, managers prefer to hire the skills needed rather than to develop them among existing employees.

Relevant Source of CE Nonexistent, Unknown or Inaccessible

Relevant sources about CE are few, and those that exist provide limited information. While there are organizations, such as the American Society for Training and Development, which do share information among their members, because of the nature of the R&D process, relevance and importance of information changes so rapidly that it is difficult to keep such data up to date or complete. This information should be compiled on a systematic and up-to-date basis, as a matter of high priority. The National Science Foundation should support projects to study ways in which this problem could be solved.

Accessibility is a smaller problem. For practical purposes, a large R&D organization is in a position to invite anyone in the world at least for a single appearance. The principal cost associated with releasing a technical employee for CE is the opportunity cost stemming from his or her unavailability to contribute to the work of the research group. Paying tuition and travel expenses to a distant place are relatively minor expenses. However, in tight budget situations, the cost of making CE accessible--although small--are the kinds of costs that are easily cut.

Training and Development Directors Often Unprepared for Leadership in Technical Areas

This complaint was made frequently by university administrators of CE. In many organizations the most competent scientists and engineers remain engaged in research and development while those who are less able often become training and development directors. It is difficult for them, especially after a period of time in that job, to identify relevant CE sources for the highly-specialized technical areas of concern to the R&D group.

Another approach suggested by one university CE administrator involved doing away with some training directors altogether and increasing the CE responsibility of R&D managers.

> (In some companies) the training directors are absolutely the least effective people in the universe. They ought to be done away with. Somehow we've got to get the engineering managers and the R&D type of managers--the people who are accountable for the growth and development of the company... to either have time available or have somebody working for them...to see that these (CE) programs are run well.

Training directors sometimes impeded cooperation between universities and industries in CE because of self-interest. As one CE director at a major university explained:

> We find that we have little difficulty in getting the top management of companies to understand very well what we can do and what we can do well. The training directors are rather another group, however. They are quite understandably interested in preserving their own empires and building them. So it is not uncommon that we do not have a lot of cooperation from the training directors in terms of getting people to come to programs of ours that could be competitive with their own.

In many cases training and development directors come from fields such as personnel and organization development. These people are usually extremely competent in organizing management development programs, but are obviously at a great disadvantage when faced with identifying technical experts who could be most helpful to their own R&D people. It is difficult to see a realistic solution to these problems short of significantly upgrading and changing the training director's job so that it becomes an attractive phase in the career path of outstanding R&D manager.

Costs

In general, the cost of CE is low compared to an overall R&D division budget, but may be more significant in the budgets of particular departments and groups. As noted earlier, except in recessionary periods, costs are not a significant constraint, so long as they remain reasonable. Eliminating CE expenditures during a recession or a temporary "squeeze" for a particular company or industry may be a false economy because it eliminates the very help from the outside that would be most useful to the corporation in dealing with its economic difficulties. This is a cost that can be cut, simply because it is a variable, rather than a fixed expense: the same kind of commitment that exists to employees does not exist with respect to outside help. It would be preferable if, during a period in which budgets must be cut, considerations of long-term cost-effectiveness were taken more seriously and the sometimes irrelevant distinction between fixed and variable (i.e. optional) costs was not used as a crude rule of thumb.

Cutting back on CE expenditures has effects outside the corporation as well. Such cuts can have disproportionately destructive effects on the university organization, which may have made a large investment of its own funds and commitments as a main supplier of CE programs in the region.

At some laboratories which were dependent on federal funding budgets were considered the biggest potential constraint on CE. Increased program evaluation of federally funded projects is further likely to increase budgetary constraints on CE. In one case, the perspective of the training manager regarding budget constraints was quite different from that of a middle manager. The training manager viewed the budget problem (especially increasing university tuition costs) as a key constraint. The middle manager did not see budgetary problems, and expected CE funds to always be available. It was obvious that the middle manager really did not have as broad a picture of CE costs as did the training manager. This different perspective regarding budgets could lead to differing expectations and potential conflict in an environment where CE was apparently the way of life, until threatened by budget cuts.

The way in which CE needs were determined varied from an ad hoc approach to a highly organized committee system. An example of the latter was described by one vice-president for research, who served as head of the CE committee:

> The needs are determined (by) a committee on continuing education headed by a director with members from every major organization at (the company) and their job is to feel the pulse of our professional-technical people, both through knowing people and putting out questionnaires. Also to feel the pulse of technical management, and from the knowledge of both of these to then formulate programs and then offer them as part of the in-house program. So it is, on the one hand, a grass roots need and, on the other hand, a management need--management knows better the direction the company is going--the working population knows their present needs better and so we blend the two together. The upshot of all this is simply the offering of a number of courses and then it is up to our constinuency to vote by enrolling or not enrolling.... We know our constituency well enough that when we offer say 20 courses, we'll find that 3 courses out of 20 perhaps don't find enough interest and we will drop those.

7. EFFECTS OF CHANGING VALUES AND LIFESTYLES ON CE

New Priorities in Personal Commitments

Changing values and lifestyles affect personnel in all age groups, but the effect is strongest and most conspicuous among the younger, most recently hired workers. Major differences in values and attitudes exist between those who are old enough to remember either the Depression or World War II and the younger generation. A very substantial number of scientists and engineers are now over 40 and grew up in periods during which life was hard and priorities were public, rather than personal.

Those whose attitudes were formed during the post-war period of prosperity have quite different priorities and personal commitments. To some extent social changes have affected the attitudes of everyone, but there is a strong tendency for values learned at an early age--beginning with the first awareness of external social and economic circumstances affecting the family to the period of job market entry--to persist in spite of changes in the social environment.

Current emphases of the under-40 group include greatly increased privatism and commitment to self, family, and immediate friends. These commitments are frequently at the expense of commitment to the wider community and expecially to the employer. A widespread alienation from the large institutions of our society exists, including corporations and governments.

There is a greater hedonism and interest in self-fullfulment. More than their predecessors, young scientists and engineers tend to be loyal more to their profession than to their current employers who are viewed, in many cases, as temporary.

In addition to a greatly increased interest in "relationships" with people--especially family--there is a tendency toward introspection leading to doubt and narcissistic exploration of one's inner "identity" with proportionately less interest in the outside world, particularly the outside nonsocial material world involved in the design of artifacts, hardware, or technology.

Expectations and satisfactions, especially for those born after World War II, often become "entitlements" and there is less tolerance today, than there was a generation ago, especially among younger workers, for frustration, disappointment or sacrifice for the sake of work.

CE for Personal Growth as Distinct from Professional Development

As noted above, in many instances CE programs serve as perquisites or rewards for technical and managerial personnel and not as investments in improved performance. In addition, many employees are taking courses for the sake of their own personal growth rather than for the sake of learning something that may increase their usefulness to the corporation. With a few exceptions, however, the kind of personal growth sought is not broadly humanistic. The ideal of the broadly-educated man no longer has great appeal.

There is a strong demand for courses that develop specific personal interests. Thus there has been recently a proliferation of courses in corporate social responsibility, in training to improve people's ability to get along with their colleagues, and in CE with respect to important public issues.

Many corporations put a great deal of emphasis on good works in the community and even provide rewards for employees who are active in such activities, but vary greatly in willingness to sponsor other than job-related courses.

Growing Reluctance to Relocate

As a result of the increasing commitment to family, friends and the local community, workers are reluctant to relocate. The decreased relative importance of the job itself has already been noted. Scientists and engineers are also much more likely these days to put a high value on hobbies, local community activities and friendships--all of which compete with their work for importance. The percentage of researchers who singlemindedly seek opportunities to pursue research to which they are dedicated appears to have substantially decreased.

Another factor contributing to the growing reluctance to relocate has been the increased importance of retaining the jobs of wives who are also employed. These jobs are important not only because the work situation brings valuable gratifications to many wives, but also because the second income is necessary to maintain their standard of living. Thus a decision to move is an extremely difficult one to make in the dual-career family, even if the relocation carries with it a significant raise or promotion for only one spouse. Unless there is also some assurance that the spouse of the scientist or engineer will find a comparable or better job in a new location, there are many R&D professionals who would prefer to lose an opportunity for advancement in order not to relocate.

The high price of real state and of mortgage financing in the current inflationary economy also contributes to the reluctance to sell one's house, since it is clear that buying another house in a new community will probably result in higher housing costs. This is strikingly true in the Palo Alto area. A greater reluctance to relocate contributes to an increasing need for CE.

Increasing Willingness to Change Employers in Local Job Markets

The only increase in willingness to change employers that has developed in recent years derives from a shift in loyalty, from the corporation to one's own professional development. As a result, advancement may no longer necessarily mean promotion with the same R&D establishment, but can mean getting a better job with a different employer. This choice is especially feasible in large metropolitan areas where greater opportunities exist to commute to a different location without moving from one's home.

The willingness to change employers in order to gain advancement in the profession has a clear implication for CE. Inevitably the new work environment will involve a different mix of specialties and a different mix of product development or research tasks. There will be some start-up period during which it will be necessary for the new employee to be oriented to the work of new R&D employer. Many corporations have programs especially designed for this purpose. While apprenticeship is often used for this purpose, CE programs, in which older personnel spend time with recently-hired experienced technical professionals in order to fit them in optimally to the division of labor within the new R&D establishment, are expensive in terms of the costs of the senior person's time. It would seem cost-effective to develop orientation courses that would reduce the time needed utilizing senior R&D mentors.

Move from Academic to Industrial Research Labs by Recent Graduates

Some line managers of research remarked that they no longer experienced difficulty in hiring some of the best graduates who, in the past, preferred academic positions. At least two important reasons account for the dramatic decline in employment of young scientists and engineers in academic institutions, and both derive from financial pressure on universities. First, it is extremely difficult for a new Ph.D. to get a teaching job. If he or she is successful in getting a temporary teaching and/or research contract at a university, the job is almost certain to be terminated at the end of the contract and underpaid relative to the amount the same person could earn in industry. Such jobs are temporary because it is far more cost-effective for the university to employ a series of post-doctoral fellows, research associates, instructors, assistant professors and adjuncts than it would be to promote any of them to tenured positions in which they would become entitled to higher salaries as their seniority increased.

Another reason for this recent trend away from academic employment to industrial research laboratories is the relative scarcity of up-to-date equipment, instruments and other material resources in many university departments. A great deal of equipment available is obsolete and the young graduate in many cases simply cannot develop professionally without the well-equipped laboratories and/or installations that industry offers. Also the working environment and general intellectual climate in industrial labs have become more similar to those in their academic counterparts, making them even more attractive to people who might otherwise have remained in universities.

New Policies to Recruit and Retain Professional Women Employees

During the past decade there was a dramatic rise in the percentage of women who major in science or engineering at college. Women graduating from engineering schools increased from about one percent in 1970 to approximately one out of ten in 1979. In some schools they make up 25 percent of the entering classes. Their numbers in corresponding professional categories in industry are expected to rise proportionally.

Many women who want to pursue professional careers also want to have children while they are young. An increasing number of them want to return to work, at least part time, shortly--sometimes only a few weeks--after childbirth.

Corporations are beginning to find it necessary to revise their rules relating to the employment of women, not only because an increasing number of laws have extended women's rights in this area, but also because it is in their interest to facilitate continuity of employment of productive professionals.

Some respondents confirmed that, if professional women who are employed full time wish to take maternity leaves, they can return to their jobs part time if they wish to spend some time at home. Those who wish to return to full time can do so and are even supported in CE programs if they need to catch up as part of their reentry. As the number of women in science and engineering continues to increase, these and similar retraining policies will become routine, and a considerable role is foreseen for CE to deal with reentry.

8. DEVELOPMENTS IN INTERNATIONAL RELATIONS AFFECTING CE

Influx of Foreign Students and Its Effect on U.S. Engineering Education and Technology

There is an enormous influx of foreign students into American graduate schools of engineering. This is encouraged in large part by the low number of qualified applicants from the decreasing ranks of American-born students, as well as the rapid industrialization of the many developing countries which are the major source of these foreign students.

Some respondents expressed several concerns about the increasing percentage of foreign doctoral students. Many R&D laboratories doing classified work can hire only American or other NATO citizens and their pool of eligible manpower is restricted. Furthermore, there was a concern about the orientation of future facilities in science and engineering: as the pool of Ph.D.s becomes increasingly foreign-born, so will the composition of science and engineering faculties which depend on this pool for hiring. There was general concern that in some ways this may affect the character of science and engineering education and research but exactly how was not clear.

Growth of Retraining Programs for Research in Energy

From time to time the Federal Government sets new priorities as a result of events in international relations, and these, in turn, create the necessary investment for the development of new industries in new technologies. Perhaps the most important case in point is the growth of the computer industry, which was produced primarily by the needs of the War Department during World War II, and later by the needs of the Defense Department for large-scale central processing units.

New priorities for research in energy may follow a similar pattern, since a fundamental objective of current U.S. foreign policy is to reduce dependence on imported oil. What is significant about research in energy is the enormous number of technologies that are relevant, including nuclear, solar, coal liquifaction and gasification, and conservation and improvement in efficiency of energy-using generators, transmission lines, motors, vehicles, buildings and industrial processes. Many engineers already with considerable work experience will find a need for new education with respect to energy problems. As this priority becomes more important with the corporations, it is simply not possible for the university to become able suddenly to turn out enough qualified people to work in the great variety of energy-related fields of research.

CE as an Important Force in Maintaining or Regaining U.S. Lead in Technology

The most important forces that could improve the U.S. lead in technology are not educational. They are changes in those public policies that currently bring about a high rate of inflation, a very low saving rate, and therefore, a very low rate of capital formation and of capital investment in new facilities embodying new technology. Until these basic factors change, the U.S. will continue to lose whatever lead in technology it has, and will have little or no opportunity to regain any that have been lost. Once incentives for investing in new technologies are created CE becomes essential in facilitating U.S.

technological progress. The most important role for CE in this process would be to increase or add to the skills of technical personnel in industries where the U.S. has been relatively stagnant.

9. CE IN MANAGEMENT SKILLS AS DISTINCT FROM TECHNICAL TRAINING

Management Training for R&D Professionals

A variety of management skills are increasingly needed by R&D scientists and engineers who are not managers themselves. The reasons for this are several:

1. The career path of many, if not most, R&D professionals is ultimately toward management.

2. R&D professions increasingly deal directly with officials in government agencies that fund or regulate their work.

3. Researchers in some large corporations are expected to market their expertise within the corporation and find the money to support at least part of their work. They deal with business units directly and negotiate contracts on behalf of the R&D division.

4. Most scientists and engineers need exposure to programs in organizational behavior and communication lacking in their earlier education to help them work with others.

CE courses in management for R&D are relatively new and are increasing in number. Policies and budgets for these programs are typically separate and distinct from those governing advanced technical training.

Scientists and engineers who have been given management responsibilities need administrative skills and pursue programs in management skills as a matter of course. The deficiency very often mentioned by technical people as a reason for undertaking management training is the experience that dealing with people is one of the most difficult aspect of their job. They are often disappointed to discover that books are not an effective source for learning how to deal with people, although they do provide some help with these problems. A broad range of programs is available, ranging from organizational development focusing on human relations to formal degree programs emphasizing many aspects of management.

As mentioned above, R&D managers are typically neutral towards efforts of technical personnel to acquire a master's degree in management. While they approve these attempts, they are uniformly careful to make clear that the people involved will not necessarily benefit from acquiring formal managerial qualifications. Whether such a person is able to enter the management track will depend primarily or entirely upon his showing evidence in his performance as a manager that he is equipped to advance in management positions. However, R&D professionals who have already advanced into management are very often encouraged to pursue graduate-level education in management. In other words, CE in management is seen as relevant and useful for those who are already managers, or being groomed for the role.

The Two Paths for Advancement

Those born during the post-war baby boom have now reached the age when they are eligible for middle management positions. Since they are an unusually large age group, the competition for middle management positions will be unduly great in the immediate future. This pressure can, in part, be relieved by a dual ladder for advancement: (1) managerial and (2) professional. Promotions on the professional ladder theoretically carry monetary rewards and prestige comparable to those of the R&D managerial ladder. The effect of this dual structure on CE is increased efficiency of effort, time and resources since scientists and engineers are more likely to choose training and education programs that are relevant to both job needs and career advancement.

CE for Middle Management in R&D

Several kinds of CE are relevant for middle management in R&D. Advanced training in management subjects is the kind of program most frequently undertaken. The curricula of the programs usually aim at increasing the knowledge and facility of middle managers in three principal areas:

1. Corporation-specific policies and procedures.
2. The social matrix in which the corporations functions, i.e., topics relevant to its interface with government and the public, as well as cultural and socio-economic trends.
3. Human relations and communications.

Programs designed to update R&D middle management in technical fields that they have had to neglect in order to specialize in the activities for which they have responsibility is most frequently the other type of training. These programs are rarer and more difficult to design than management training programs and are designed to convey to the manager the state of the art in a large number of technical fields which have become relevant because of increased responsibilities. The difficulty arises in large measure because program content must be comprehensible to participants who have become highly specialized in a particular field and are not up-to-date in advanced technical developments even in their own field because of the pressures of managerial responsibilities.

10. GOVERNMENT AND CE

The Role of the Federal Government in Continuing Education

Both our academic and executive respondents felt that there are few useful roles that government can play in CE. With the exception of supporting Federally-funded studies to determine CE needs and effective modes and strategies for delivering CE, our respondents felt that neither the Federal nor the various state governments should become involved in trying to "improve" CE directly. This task should be left entirely to the market.

Nevertheless, it has been remarked that just as Federal aid is now given to many students who are enrolled in formal degree programs, and whose family income is low, it would be equally valuable to have Federal assistance made available for CE to increase the competence of the R&D labor force generally. It is becoming extremely clear that education is less and less confined to degree programs of colleges and universities to include continuous adult occupational re-education.

While no government agency has a responsibility to improve or, at least, maintain the quality or range of available CE in science and engineering, several agencies affect CE indirectly through policies and rules which are aimed at achieving other objectives. Unavoidably, the Federal budget affects CE in a major way. The effect of the budget is to sponsor science and engineering R&D in one field or another and to create incentives for companies and universities to respond. This, in turn, creates CE requirements for those entering the new field. We have already discussed how increased emphasis on energy research in the Federal budget will require many R&D professions to move into energy-relevant areas, and in the process to take courses appropriate to this transfer of knowledge and skills. New military spending will have similar consequences for electronics and aerospace specialties, among others.

The Internal Revenue Service: Issues Related to Expenditures on CE

The general view of the IRS has been that money spent in order to earn income is deductible. For this reason just as a carpenter or a mechanic may deduct the cost of buying the tools of his trade, a scientist or engineer may deduct tuition payments and other expenses involved in acquiring education intended to improve his performance in his current job. However, the IRS has taken the position that investment generally is not deductible. Therefore, they have ruled that if the expenditure is in preparation for a new job, it cannot be deducted. This has posed a problem in some cases for people in R&D, since the essence of their work is to innovate and sometimes it can be very difficult to say what is education for the improvement of the old job and what is preparation for a new job.

Other problems derive from IRS rules concerning tuition and other payments when they are made by the employer. Here the controlling doctrine is that payments on behalf of an employee do not constitute taxable income to the employee, and they are expenses deductible by the employer, provided they are made primarily for the convenience or requirements of the employer. This means that the less unequivocal it is that the employer has taken the initiative in sending the employee to CE courses that are clearly relevant to the employee's current work, the more likely it is that the IRS may take the view that the employee should have declared these payments as taxable income, since they were simply additional benefits conveyed by the employer--in effect, perquisites.

One could argue that it is in the public interest to make all expenditures for vocationally relevant education deductible expenses for individual tax payers whether or not a relationship to improving the current job can be shown.

Respondents typically viewed potential IRS regulations taxing CE as jeopardizing professional development. According to one training director:

> If the IRS had really gone as far as it was planning to do, it would have really damaged the continuing education efforts of this country. It certainly would have cut into us. If employees have to put out of their own pockets to just take continuing education, we find they don't participate.

The National Science Foundation: Conflicting Views of Its Potential Role In Supporting CE

The primary mission of NSF is to support research and education in the sciences and engineering. Most of its grants are awarded to universities in support of specific projects. It is clear that NSF does not have a mission to support education in general. The case of continuing education is different, however, since the support of CE in science and engineering would indirectly support research in these fields.

While the argument that NSF should support CE is conceptually valid, as a matter of priorities, direct grants for the support of basic research are far more likely to continue than the more indirect route of supporting CE. This latter mission, however, would seem to rank equally with training grants and research fellowships for graduate students and post-doctoral fellows, both of which the NSF has done in the past.

State Recertification Requiring CE

In recent years, many states have passed laws requiring CE for continued certification or licensing in several professions, including engineering. These laws have been passed as a result of the observation that many professionals do not keep up adequately with changes in their fields. The requirement that a certain number of hours be spent annually on continuing education is intended to insure that recent developments will be brought to the attention of those in the professions. To the extent that many states require CE for recertification of engineers, CE will gain a greatly expanded market.

The problem of what in particular should be required (and taught) will be complex. Most likely this problem will be solved by making available a rather large choice of courses from which the professional can select in order to achieve recertification. It is difficult to envision a single prescribed curriculum which would meet the needs of any particular category of engineers.

Moreover, many in industry are opposed to such recertification requirements. One training director, whose views were typical, felt that:

> The professional societies should fight against any government regulation requiring CE for licensing, registration or recertification. There are many other ways to judge performance and assure competency. Legislation would require CE participation for the wrong reason.

tested periodically, but that freedom of choice of CE (e.g., on-the-job, reading on one's own time, attending courses, etc.) is best left to individual choice.

11. FACTORS AFFECTING CE IN THE '80s

Rapid Technological Change

If a consensus emerged on any one issue among our respondents, it was that the rate of R&D and resultant levels of innovation and technological change will continue unabated, and will probably accelerate in the '80s. Understandably, our respondents found difficulty in predicting specific technological developments that will require substantial CE for large numbers of engineers and scientists. The large and growing problem of software was singled out as an example. Most technological change cannot be predicted and CE cannot be usefully designed to anticipate these. Inevitably, however, innovations will occur, and in combinations will create new CE needs.

Software: A Special Case of CE

It is common knowledge that computing power, memory capacity, speed of computation, capacity of communication, etc., have all decreased dramatically in cost, and increased dramatically in availability. At the same time, however, software development has increased in its relative share of computing costs. The prospect is that these trends will continue and that of each dollar spent less will go to hardware, and more to software for many years to come.

The development of relatively natural languages is likely to play a dramatic role in the next decade. New languages such as APL and Pascal have already contributed to the usefulness of many computing systems. Much work is now underway on easy languages such as BASIC and on fully natural languages which enable the user to communicate directly with the computer.

One can expect that at some point the computer programmer, insofar as the external software is concerned, and the use of language such as FORTRAN and COBOL and other older technical languages, will become obsolete. Here is another case where people with specialized skills will find them no longer useful, and will need CE in order to do the primarily-internal software jobs that will be necessary with the natural-language and comparatively easy-language computers of the future.

Software is a special case for CE also because it becomes increasingly important for managers, professionals, and people in various vocational work roles to learn to use computers for the very tasks they now perform without computers. For example, there is enough to learn about sophisticated hand calculators such as the Hewlett Packard HP 41C to justify a course even for people with a great deal of experience in using such calculators. Such a course might meet for a total of 20 or 30 hours in order to explore this relatively simple device thoroughly. The case for courses for people without calculator experience, and the case for courses for managers without computer experience that would enable them to use BASIC with time-sharing consoles is even stronger, including a demonstrable increase in productivity.

Relative Emphasis on R or D

The relative emphasis on R or D seems to be cyclical. There are periods of intense research when a subject reaches a critical stage in its development and a great deal of new basic science is developed--for example, solid state physics in the '50s. There are other periods in which little seems to be learned from basic research, but during which practical applications and new developments are stressed and devised. According to a widely-shared belief, the current period can be characterized as one in which emphasis has shifted from basic R to D, to application and development which have been receiving greater attention from government, corporations and the academic community. This supposedly is the consequence of a prior flourishing period of basic research, which has created an abundant knowledge base--a rich inventory to be worked up in development. This period then will be followed, once again, by investment and support in basic research. Such a period may have already begun with government concern about the lack of basic research leading to increased funding.

The mechanism governing this oscillation between R & D is complex and depends significantly, among other factors, on domestic and international economic trends, on foreign competition, on the state-of-the-art, on the development of a branch of science rich in potential application, major shifts in public opinion or cultural valuation of science and technology, and changes in public policies and spending with respect to defense, social welfare, the environment, energy, etc.

These cyclical changes in R&D emphasis inevitably result in some reorganization of the technical manpower employed. While these changes affect most uniformly the employment patterns of new graduates, they also produce a period of extra demand for CE as those already employed must adapt to changing priorities in R&D or wish to take advantage of them. Thus, as shifts in emphasis take place in the R&D spectrum, so will there be a need to provide CE to scientists or engineers affected by that shift.

Special CE Needs of Large Age Cohorts Reaching Middle Age

During the post-war baby boom, births rose from about 2.5 million in the early '40s to a peak of around 4.2 million in the 1957 to 1962 period and then by the late '60s dropped down to almost 2 million a year. Those born during the baby boom now range in age from their teens to about their mid-30s. Competition for jobs and for advancement within this age group will grow increasingly intense as they progress in their careers. Within this group, the large numbers make it inevitable that seniority will count for less and ability for more. These people will be competing for positions in organizations which have previously been staffed by much smaller cohorts (about 2 million per year) of people born during the depression. The capacity of existing organizations to absorb this large age group in appropriate jobs is open to question. It is possible that the number of new organizations will proliferate to help absorb the large numbers in the labor market.

There may be especially intense competition for R&D positions by the post-war generation, a group of people who feel, to a much great degree than their predecessors, that they cannot afford to rest on their laurels or to be content with what they have learned at universities. This cohort will be comprised of relatively young people for the next decade. These young and early-middle-aged adults will probably have a greatly increased interest in making use of CE in order to maintain whatever competitive advantages they can with respect to their professional knowledge skills. Moreover, competition for managerial advancement will likely be much more intense, resulting in increased participation in CE focusing on management development.

New Roles for CE as College Populations Decline

The post-war baby boom was followed by the baby bust of the 1960s and 1970s which will result in a declining college-age population. As the student population declines, colleges will be increasingly motivated to reach for new markets in adult education. The traditional pattern, in which education is continuous up to a point of completion, followed by work, is almost certainly going to disappear. Leaving college for a year or two to gain work experience before going back to complete one's studies is gaining in acceptance and has even become institutionalized in the form of cooperative work-study programs with industry. Returning to graduate school will be a reasonable and desirable option for working professionals, even on a full-time basis.

Cooperative relationships between universities and corporations in providing continuing education will probably increase as a result of the threatened decline in enrollment. Moreover, it is noteworthy that few of the respondents, including those from universities, indicated an awareness that demographic changes will present any particular problems. In fact, most had not even considered such changes in planning for future manpower needs, including CE. As we noted above, there appeared to be a widespread faith that they will be able to respond to future manpower requirements, regardless of demographic changes.

Prospects for New Technologies for CE

Two broadly-held views about CE teaching materials, devices and methods emerged during our interviews:

1) There will continue to be room for a variety of modes of delivering continuing education.

2) Classroom instruction with the lecturer physically present will continue to be an important and widespread method of CE training.

Few generalizations can be made about new technologies for CE. There seems to be a consensus that the creator of successful CE programs does not concentrate on the medium, but on the substance. Format is secondary. An important criterion seems to be convenience, both in terms of the characteristics of the device, and the setting in which it can be used. In spite of the belief expressed in 2 above, many managers held that classroom instruction is already obsolete and people who take remote or videotaped courses with experienced engineers as "mentors" do better than those who take formal classes.

In some industries video tapes have become standard because of their convenience to the user. However, this method requires a high-quality tape library of courses which may not be available in many areas of specialization. Some managers feel that the use of tapes will not spread rapidly because (1) the production of quality tapes requires large initial capitalization; (2) tapes are resisted by faculties; and (3) they become obsolete quickly in fields which change very rapidly.

Videotape programs used by groups to sensitize employees to the importance of feelings and emotions in personal interactions have been particularly effective. Great expectations have also been expressed about computers as a future teaching device. They maintain that people are rapidly acquiring an ability to learn with the aid of TV/ computer systems, and there is a new willingness to use them. This will significantly affect the future role of the instructor. There is a great receptivity among engineers and scientists for algorithmic thinking which computerized learning devices require.

Growth of Remote Training Modes to Reduce Travel

There has been a long standing discussion about whether the use of the telephone or of improved communications in general has reduced travel or transportation. A reasonable consensus seems to be that access to many more people through improved communications provided many more reasons for travel than would have existed had the telephone not been invented.

This should not lead to a facile assumption that further improvements in communication may not ultimately reduce travel requirements. We have already alluded to the future growth of picturephones, electronic blackboards, facsimile reproducers, the proliferation of video-tape methods for education and the laser-typewriter-printer-copier-network-communicator. Also less energy is used moving information than moving people. The need to reduce costs will push the technology of CE as well as the technology of communications in general in the direction of substituting electronic communication for travel to a greater degree than has been done in the past.

There are great virtues in having the instructor physically present and speaking to the group. First, much more information about what he is saying comes from observing his facial expressions and gestures than would come from reading his words alone. Second, and much more important, if the instructor is physically present there is feedback to him and the opportunity for discussion, both with the instructor and among the students. This arrangement can be much more productive than a one-way lecture from teacher to students. The opportunity for interaction with colleagues can stimulate learning. It should be noted that these objectives will be increasingly attainable from remote and distributed locations as the technology of communications improves.

It seems only a matter of time before great technical improvements in efficient delivery of continuing education will be adopted by large corporations. At the same time it seems likely that the traditional face-to-face communication of a person talking with a small group will not disappear.

Changing National Priorities

The basic change that may take place in the area of domestic national priorities is an increasing recognition that the extremely serious problem of inflation can be dealt with in the long run, not with monetary or fiscal policies but by fundamental improvements in productivity. Among other things, this would emphasize tax laws that encourage savings and investment. Some movement in this direction has already occurred.

The benefits in terms of productivity from increased Federal funding of R&D and tax laws encouraging continuing education for R&D professionals are quite clear. The specifics related to the issue of tax laws and CE have already been discussed in Section 10. However, these priorities--which, in the long run, could reduce the rate of inflation and help increase national security are likely to come into conflict with other national policies such as those dedicated to welfare and the redistribution of wealth

A striking number of corporate respondents volunteered their views about what they felt were destructive effects of government policies and regulations on R&D. They believed that an overwhelming anti-business attitude, which has prevailed in a large number of powerful Federal bureaucracies over the past few years, has led to policies and regulations adversely affecting R&D. As one vice president put it,

> Scientific fundamentals of what we will be doing are well in place. The research climate is healthy, but the investment scene is sick... My greatest management task is to keep the many bright scientists from being disappointed...

Another respondent pointed to an example in which Federal agencies obstructed his company's competitive foreign operations by insisting on the applicability of domestic regulations on his product. This barrier was created in spite of the host country's acceptance of different criteria--criteria with which the Japanese were able to comply. The degree to which these and similar attitudes prevail in government is likely to influence the degree of demand for CE.

In addition, the establishment of a Department of Education, separate from HEW, may have an influence on CE in the years to come. It is likely that a more integrated Federal approach in support of education will emerge, and that education as a "life-long" process will become an acceptable model in which to establish funding priorities. In that case, the chances for Federal CE support as discussed in Chapter 10 will significantly improve.

International Relations

The example of Sputnik in challenging President Kennedy to make his declaration that the U.S. would put a man on the moon within a decade was often cited as an example of an international force that created a great deal of constructive domestic movement, especially in science, engineering and education. We are currently entering a period in which the Soviet Union will have a serious advantage in military capacities, whether for local conventional wars or for the potential of escalation to a limited, or a large-scale, nuclear war. This situation is increasingly being recognized by decision-makers, not only in the military, but in Congress and in the administration, and it is also becoming part of the knowledge of the various Presidential candidates at the time of this writing. This recognition, coupled with crises caused by the Iranian Revolution and the invasion of Afghanistan, may furnish political support to what President John Kennedy called, "getting this country moving again." Many respondents felt that such recognition could spur an increased national priority for education, research, development and capital formation. All of which would be reflected in an increased demand for continuing education.

12. CONCLUSIONS AND RECOMMENDATIONS

1. Differences in Perception

We began our study expecting to find differences in perceptions of issues on the part of industrial R&D managers and on the part of academic leaders in continuing education. Such differences were not what we found. Instead, our respondents in each group were in broad agreement on most major issues--moreover, both groups of respondents very rarely disagreed on questions asked of them. One difference in perspective, however, did emerge:

a) Academic administrators agreed that there is a widespread feeling among university faculties that offering instruction to industry is, and should remain, a minor function. They also shared the view that training directors in industry often inadequately understood the educational needs of people engaged in research and development.

b) Conversely, while full of praise about the role universities play in the formal basic and graduate education of scientists and engineers, managers perceived universities as unable, for various reasons, to offer advanced state-of-the-art CE. They also felt that university administrators in charge of continuing education were often deficient in their ability to provide the programs required by industry.

c) Both groups agreed that the availability of high-quality university-applied CE programs in a variety of subjects is something that R&D managers would welcome, but at present their training directors often do not know where to find them, or universities are not able to provide them.

2. Prospects for the 1980s

Our consideration of prospects for the 1980s leads us to the conclusion that the unsatisfactory relationship between universities and industry can be improved if national priorities respond to the increasing domestic and international difficulties in which the U.S. is finding itself. Since dangerous inflation and renewed international tensions indicate a need for renewed R&D and increased capital investment--embodying new technology for both civilian and military products--venture capital from government and corporations should become more readily available to universities for developing and providing the advanced education needed in industry.

Academic institutions themselves would respond to the changed national priorities, and a new perception of national needs would reduce the current ideological bias toward theoretical and against industrial or other applications. This change would occur at the same time that the teaching of degree candidates plays a smaller and smaller role (for demographic reasons) in American universities and, therefore, would have a reinforcing effect.

On the other hand, if current trends continue, important research will take place increasingly within industry and decreasingly within the university. Universities will experience increasing difficulty in recruiting and holding talented scientists and engineers. Not only will salaries be much higher within industry, but also opportunities to pursue professional careers with the help of adequate research assistants and other support staff, adequate budgets for equipment and for obtaining information from data banks, libraries, periodicals, adequate secretarial help, travel budgets, etc., will all be much more easily available to first-class researchers in corporations with large and advanced laboratories than in universities or in small technical corporations. The important point is that, by 1990, one might be far more likely to find distinguished young scientists at the top industrial laboratories than at the best research universities. The contrast between R&D professions in second-rank industrial laboratories and second-rank faculties in science and engineering would likely be even more striking.

This excessive transfer of talent from universities to R&D establishments would be detrimental to both institutions as well as to the quality of the manpower pool available to the nation. The resulting imbalance would deprive not only students in science and engineering, but people in other professional and managerial occupations from the benefits that the presence of outstanding scientists on a university faculty implies.

Academic ventures to improve CE offerings without significant industry support could achieve some success, since some of the deficiencies in current CE programs can be justly attributed to academic biases and difficulties in organizing the market research and production of CE offerings that would be required to make significant improvements. Unfortunately, however, a third necessary element, the presence of venture capital to enable universities to enter this market, would still be missing in most cases. If industry support is not available for this purpose, then support from state or Federal governments would have to be forthcoming. While the resources of foundations could not be counted on to make a large difference to the national situation, they could play an important role in sponsoring research on improving CE.

We have said earlier that it is becoming increasingly evident that education is less and less confined to degree programs, and it may be argued that the public interest in supporting education should extend beyond the public school system and formal degree programs of colleges and universities to include continuous adult vocational re-education. A significant step in that direction would be to make all expenditures for vocationally-relevant education tax-deductible whether or not a relationship to improving the current job can be shown. In R&D, the case is especially strong, since the "new" job often grows out of completion of current work.

While the argument that the NSF should support CE would be conceptually valid, as a matter of priorities, direct grants for the support of basic research are far more likely to continue to receive funding than those to the more indirect route of CE support. This latter mission, however, would seem to rank equally with the provision of training grants and research fellowships for graduate students and post-doctoral fellows, both of which the NSF has provided in the past.

Should either industry or government take the initiative and finance the planning, developing, and targeting of CE offerings in science and engineering, we will certainly be more likely to achieve active cooperation between universities and industry in an effective and mutually-supported science and engineering educational system. But such success is not guaranteed unless the universities perceive their responsibilities and opportunities. Indeed, one of our academic respondents stressed that "up front" CE venture capital is now available in significant quantities, but academic efforts to organize and utilize such funds is lagging. Is this problem temporary?

Prospective developments in communications technology will decrease, to some degree, the isolation of industrial laboratories and universities located ... distance apart. In addition, the decrease in the pool of degr... dates may help university faculty members find cooperative re...nships with industry increasingly attractive and practical for economic reasons, in a period when most university salaries will probably lag generally behind comparable salaries in industry and rising costs of living.

The international events we have described, the increasing pressure of foreign competition on U.S. business, the increasing economic difficulty of trying to deal with inflation with the lowest savings rate and the lowest rate of increase in productivity of any industrial country--all of these problems, if they are responded to constructively and in time, should lead to a resurgence of investments in both education and R&D, and, therefore, also in necessary CE. Unfortunately, widespread prompt and constructive spontaneous responses to such problems seem unlikely. First, there must be an ... recognition of what is going wrong and what needs to be done.

3. Recommendations for Restoring the Balance

There must be, therefore, a concerted effort on the part of universities and industry to develop a shared understanding and to work together more closely to provide CE for R&D. This should begin as soon as possible, and be carried out with the investment capital required for development of the expertise to create the needed CE.

Truly active cooperation would also require new understanding on the part of industry that a university is potentially much more than a place to provide education preparatory to advanced education in industry. Corporate respondents uniformly stressed that education is not what they do best, and the opportunity costs of using their own best people to offer large numbers of CE courses could be very much greater than enlisting the aid of intelligent, knowledgeable, and cooperative university faculty members as they become increasingly available.

Our principal recommendation is that serious efforts be made, as quickly and on as large a scale as possible, to bring together universities and R&D organizations (and other appropriate organizations) to identify potential suppliers and consumers of CE in science and engineering and to plan and organize new, cooperative and effective CE programs. This should be carried out under the auspices of a consortium of organizations, such as the National Science Foundation, appropriate committees of the National Academy of Science and National Academy of Engineering, the Industrial Research Institute, the American Society for Engineering Education and other institutions with a commitment to the vitality of U.S. science and engineering education and research. As a first step in this direction we recommend that the Industrial Research Institute assume leadership at an early date in the organization of a symposium to exchange ideas and to improve understanding of these issues. Included in the work of the symposium should be the appointment of a steering committee which would plan and carry out an agenda for further action.

Our conclusion rests on the growing necessity for making CE available and accessible in a systematic way to industry and to the nation's R&D personnel on a much more cost-effective basis, and does not rest merely on the needs of the universities. We believe that, if a more serious effort is not made, the situation will continue to deteriorate. The universities will find themselves in tighter and tighter financial situations, while industry will increasingly lose its most efficient potential resource for CE. Without improved coordination, industry will lose interest in the universities, except as a source of relatively untrained manpower, which the universities will produce in increasingly inadequate quantity and quality. The change in priorities that we advocate and expect is not intended merely to justify an increase in funding for CE programs to be conducted by universities; our recommendations also require that the universities themselves become more willing to supply what is needed.

More importantly, such cooperation would go far towards strengthening both universities and industry, thereby contributing greatly to the effort to regain U.S. leadership in technological innovation.

Recommendations for Future Study

First and foremost we recommend that the key problem areas this pilot study has identified be now examined in depth and with quantative measures where appropriate and possible. In such a detailed study it would be useful to make a distinction among major industrial sectors or key areas of R&D. We would also urge that an analysis of attitudes and decisions of scientists and engineers, who are the direct consumers of CE, be included.

We believe that the following issues we have identified are sufficiently important to merit separate attention:

1. We have indicated that effective systems of CE are often found where universities and industrial laboratories in close geographic proximity have worked out a variety of mutually beneficial avenues of cooperation. It would be of value to examine some of the more successful regional arrangements to learn how these have developed, and what aspects would be applicable to similar situations elsewhere, or adaptable to less proximate groupings.

2. Our respondents have indicated that if due to a decreasing college-age population the R&D manpower pool should shrink significantly as expected, they may consider massive retraining of people in middle age to meet current needs. But even at present there seems to be a significant number of scientists and engineers who would want to invest their time and energies in education to change careers (with considerable social profit) if only more information about programs and options were available; if they had access to competent counseling; if pursuing such efforts did not imply a risk to employment or more importantly, if employers themselves would regard such undertaking as investment. A comprehensive study of all aspects of career change for R&D personnel seems desirable.

3. Only a few directories that list CE programs are available. Some of these are not sufficiently known or are incomplete, and the courses listed are necessarily left unevaluated. We recommend that the National Science Foundation sponsor a study to determine what the market might be for an accurate, up-to-date and informative directory; in what ways evaluations can be furnished that are fair

and acceptable to those who provide CE and still be of value to the user; what the economics might be of regularly publishing and distributing (on paper and/or in electronic form) a directory and what it would entail to produce a dependable high quality product.

BIBLIOGRAPHY

Adams, W.S., Assessment of Scientists/Engineers Continuing Education Needs in Small, Geographically-Dispersed Industries. University of Wisconsin-Oshkosh, NSF Project SED78-2168, 1978.

American Society for Engineering Education, Continuing Engineering Studies Series, Monographs Numbers 1-9, 1967-1976.

Anderson, A.G., "Maintaining Vitality in R&D Organizations," Research Management, July 1971.

Baldwin, L.V. et al., Workshop in Continuing Education for Engineers at Mid-career, Dallas, Texas, August 1974.

Branscomb, L.M. and Gilmore, P.C., "Education in Private Industry," Daedalus, 1975, 104, Vol. II, 222-233.

Decker, W.D., Wilson, T. and Van Atta C.M., "Professional Policies and Practices of R&D Organizations." Reprinted in Kaufman, H.G. (ed.), Career Management: A Guide to Combating Obsolescence. New York: IEEE Press, 1975.

Dubin, S.S. et al. (eds.), Maintaining Professional and Technical Competence of the Older Engineer. Washington: ASEE, 1974, 179-186.

Engineers Council for Professional Development, Continuing Engineering Studies, A Report to the Joint Advisory Committee, 1964.

Holloway, F.A.L., Petrella, A. and Swabb, L.E., Jr., "How to Foster the Continuing Development of Professional People," Research Management, July 1970.

Kaufman, H.G., "A Comparative Analysis of University Versus In-Company Continuing Education for Engineers." In S.S. Dubin et al. (eds.), Maintaining Professional and Technical Competence of the Older Engineer. Washington: ASEE, 1974, 179-186.

Kaufman, H.G., Obsolescence and Professional Career Development. New York: AMACON, 1974.

Kaufman, H.G. (ed.), Career Management: A Guide to Combating Obsolescence. New York: IEEE Press, 1975.

Kaufman, H.G., "Technical Obsolescence: Work and Organizations Are the Key," Engineering Education, May 1979, 68, 826-830.

Klus, J.P. and Jones, J.A., Engineers Involved in Continuing Education. American Society for Engineering Education, 1975.

Landis, F., Engineering Obsolescence and Continuing Education. New York University, July 1967. Prepared for the Office of University Affairs, National Aeronautics and Space Administration, July 1967.

Lc reton, P.P. et al., The Evaluation of Continuing Education for Professionals: A Systems View. Seattle, Washington: Division of Academic and Professional Programs in Continuing Education, University of Washington, 1979.

Lusterman, S., Education in Industry. New York: The Conference Board, 1977.

Maxwell, M., An Evaluation Model for State of the Art Programs for Engineer Practitioners. University Extension, University of California, Berkeley, March 1980.

Morris, A.J., The Return on Investment in Continuing Education of Engineers. Palo Alto, California: Genesys Systems, Inc., June 1978. (NSF Grant No. EPP75-21587.)

National Science Foundation, Continuing Education for R&D Careers. Prepared for the National Science Foundation by Social Research, Inc., NSF 69-20, 1969.

National Science Foundation, Continuing Education in Science and Engineering, SE-78-6. Washington, D.C.: U.S. Government Printing Office, 1978.

Pascal, A.H. et al., An Evaluation of Policy-related Research on Programs for Mid-life Career Redirection: Vol. II Major findings R-1582/2-NSF, Santa Monica, California: Rand, 1975.

Renck, R., Kahn, K.L. and Gardner, B.B. "Continuing Education--Current Policy and Practices in Industrial Research," Research Management September 1970.

Rothenberg, D., Continuing Professional Education: Status, Trends, and Issues Related to Electronic Delivery. St. Louis, MO: Center for Development Technology, 1975. ED 223823 IR002533.

Smith, A.F., "Employer-assisted Education: A Case of Corporate Apathy," The Personnel Administrator, 1973, 18(5), 23-28.

Thompson, P.H. and Dalton, W., "Are R&D Organizations Obsolete?", Harvard Business Review, November-December 1976.

Torpey, W.G., "Company Investment in Continuing Education for Scientists and Engineers," Educational Record, 1964, 45, 408-413.

Trani, E.P. et al., "College Teaching and the Adult Consumer: Toward a More Sophisticated Student Body," Proceedings of the Institute of Electrical and Electronics Engineering, 1978, 66, 838-846.

Tribus, M., "The Challenge of Continuing Education. Will the Universities Be Part of the Solution or Part of the Problem???", Address delivered to the 1977 College-Industry Education Conference, San Antonio, Texas, January 19, 1977.

Welling, L.G., CE Delivery Systems for Scientists and Engineers Employed in Small, Geographically-Dispersed Industry. Batelle Columbus Laboratories, Columbus, OH, 1979. NSF Project SED 7821943.

Wheeler, E.A., "Education for Antiobsolescence," Training and Development Journal, 1968, 22(6), 21-26.

Zelikoff, S.B., "On the Obsolescence and Retraining of Engineering Personnel," Training and Development Journal, 1969, 23(5), 3-15.

AUTHORS OF THIS REPORT

A. GEORGE SCHILLINGER is on sabbatical leave from the Polytechnic Institute of New York during 1980. Since 1977 he has served as the first dean of Polytechnic's new Division of Management, which is comprised of programs in organizational behavior, management, operations research, economic systems and industrial engineering. During his leave Dr. Schillinger is a Distinguished Faculty Fellow at the Yale School of Organization and Management.

From 1974 to 1977, he served as Executive Assistant to the President of Polytechnic, and had managerial responsibilities encompassing the Institute's programs and external relationships.

Earlier, his responsibilities as Dean of Special Programs were to organize all programs addressed to the educational needs of industry and government. These included executive training programs, continuing education, and seminars and symposia on national policy issues in science and technology.

Prior to assuming his administrative duties in 1970, he taught both undergraduate and graduate courses in electrical engineering and operations research. Dr. Schillinger is the author of numerous articles, and has been a consultant to corporations and government agencies. He is co-editor of the book Technology Forecast for 1980, and of the international quarterly, Technology In Society. Dr. Schillinger was awarded the Doctor of Engineering Science degree by Columbia University in 1964.

HAROLD G. KAUFMAN is an associate professor of management at the Polytechnic Institute of New York. He is an industrial psychologist as well as an engineer, who carried out extensive research on problems of obsolescence and continuing education. His books dealing with these issues, Obsolescence and Professional Career Development, and Career Management: A Guide to Combating Obsolescence, integrated the state-of-the-art knowledge in the field and have received widespread recognition.

Dr. Kaufman currently serves as the Manpower Editor of the IEEE Engineering Management Review. He is a founding member of The American Society for Engineering Management, and holds full membership in the American Psychological Association, the Academy of Management, and the American Society for Engineering Education. In 1979, he received the Outstanding Paper Award for significant contributions to the literature from the Continuing Professional Development Division of the ASEE.

Dr. Kaufman completed his Ph.D. in Industrial Psychology as well as a Master's in Industrial Engineering at New York University. He holds a Bachelor's in Mechanical Engineering from Cooper Union.

ANTHONY J. WIENER has been Professor of Management and Director of Policy Studies at Polytechnic Institute of New York since 1975, when he undertook the planning and establishment of PINY's Graduate School of Management, under a grant he obtained from the Alfred P. Sloan Foundation. He is a specialist in long-range planning, problems of corporations and government departments, with a special interest in policy and planning implications of new technologies. From 1965 to 1975, he was Chairman of the Research Management Council at the Hudson Institute, and was responsible for a wide range of planning and policy studies for D.O.D., Department of State, NASA, HUD, NEH, DOE, Department of Commerce, NSF, and other government agencies, as well as for corporations such as Coca Cola, Ford Motors, Citibank and General Foods. He is also Deputy Director at Hudson's Continuing Strategic Planning Study of the Corporate Environment, cosponsored by over 100 multinational corporations. He has also held government positions such as Chairman of the White House Urban Affairs Research Committee.

He is a graduate of Harvard College and Harvard Law School. He has taught at MIT, and has been a consultant on R&D management with Arthur D. Little, Inc. He has been a regular faculty member at executive development programs conducted by universities, professional and trade associations, and major corporations, for many years.

Appendix 1

CORPORATIONS, GOVERNMENT AGENCIES, ACADEMIC INSTITUTIONS, AND INDIVIDUAL RESPONDENTS PARTICIPATING IN THE STUDY

Bell Laboratories
- William O. Baker, Chairman of the Board
- N. Bruce Hannay, Vice President for Research and Patents
- Carl R. Wischmeyer, Director of Education

Bethlehem Steel Corporation
- Robert J. Lohr, Assistant to the Vice President and Director of Research
- William Reusch, Manager of Human Resources, Planning and Development
- Edward A. Zouck, Manager of Administration and Service, Research Department

Colgate-Palmolive Company
- R. T. LaPier, Director of Administration

Eastman Kodak Company
- L. J. Thomas, Jr., Vice President, Kodak Company, and Director, Research Labs.
- Judith A. Schwan, Assistant Director, Research Laboratories
- Howell Hammond, Laboratory Head, Research Laboratories

Exxon Research and Engineering Company
- J. H. Eckert, Director, Technical Education Program
- Charles H. Ehnondorf, Consultant, Technical Education Program

General Electric Company
- Robert Bernstein, Manager of Personnel for R&D, R&D Center

General Foods Corporations
- Adolph Clausi, Vice President and Director of Technical Center
- John Burgess, Director of Logistics

Hewlett-Packard Company
- John Doyle, Vice President, Personnel
- Brian Untar, Manager, division level

IBM Corporation
- L.A. Cookman, Director of Administration, Research Division, Thomas J. Watson Research Center
- James J. Griesmer, Manager Education and Development, Research Division, Thomas J. Watson Research Center
- W.J. Turner, Manager, Research Staff Operations, Research Division, Thomas J. Watson Research Center

Lawrence Livermore Laboratories
- Henry C. McDonald, Associate Director, Engineering
- Wallace D. Decker, Education Officer
- Joe Keller, Division Leader, Energy Systems

NASA Ames Research Center
- Loren Bright, Director of Research Support
- Dale Compton, Chief of Space Sciences Division
- John LeVeen, Chief of Training and Special Programs Branch

Pfizer Corporation
- Barry M. Bloom, President, Pfizer Central Research

Sandia Laboratories
- Eugene Reed, Vice President, Micro-electronic Components
- Howard Shelton, Supervisor, Management Training and University Programs
- Robert Devore, Manager, Computer Aids and Data Department

Union Carbide Corporation
- Samuel Tinsley, Vice President for R&D
- Warren E. Lux, Associate Director of University Relations

Westinghouse Electric Corporation
- Mathias McDonough, Senior Executive Vice President, Corporate Resources
- George F. Mechlin, Vice President, R&D, Research Laboratories
- R.D. Haun, Manager, Applied Sciences, R&D Division
- Nap Head, Manager, Training and Development

Xerox Corporation
- George E. Pake, Vice President, Corporate Research, Palo Alto Research Center
- Frank Squires, Manager of Administration, Palo Alto Research Center
- Fred Strollo, Manager, Engineering and Software, Palo Alto Research Center

Academic Participants
- Joseph Biedenbach, Director of Continuing Education, University of South Carolina
- George Bugliarello, President, Polytechnic Institute of New York
- Karen C. Cohen, Co-director, Project Proceed, Massachusetts Institute of Technology
- Kenneth S. Down, Assistant Dean, Stanford University
- George Hazzard, President Emeritus, Worcester Polytechnic Institute
- Al Ingersoll, Director, Continuing Education in Engineering and Mathematics, UCLA University Extension
- Richard A. Kenyon, Dean, College of Engineering, Rochester Institute of Technology
- Myron Tribus, Professor, School of Engineering, Director, Center for Advanced Engineering Study, Massachusetts Institute of Technology

IRI Advisory Committee

Chairman, Dr. Vincent A. Russo
Vice President, Research and Development
Scott Paper Company

Richard C. Berry
Vice President, R & D
Rogers Corporation

Mr. William P. Hettinger
Director, R & D
Ashland Petroleum Company
Division of Ashland Oil, Inc.

Mr. George Walker
Director, R & D
Glidden Pigments Group
Chemical/Metallurgical Division
SCM Corporation

Appendix 2a

Interview Schedule for R&D Executives and Training Directors

BASIC QUESTIONS

I. How is CE carried out in your organization?

A. How much time is provided now for CE during working hours? How much do you anticipate in the 1980s?

B. Which modes of CE are supported now? How will this change in the 1980s?

Consider:

a. university sponsored courses: credit/noncredit
b. in-house courses
c. self-study modes
d. professional society sponsored courses/meetings
e. leaves of absence: with pay/without pay
f. sabbaticals: short term (several months)/long term (a year or more)

C. How is financial support provided now for CE? How will this change in the 1980s?

Consider:

a. tuition: complete/partial
b. Must CE be job/career relevant in order to receive support?
c. professional society activities

D. What incentives do employees have to pursue CE? How do performance evaluations take CE into account? Will this change in the 1980s?

Consider:

a. salary
b. promotion
c. more challenging and responsible assignments
d. more opportunities for professional development

E. How do you determine CE needs for your scientists or engineers? How might this need assessment change?

II. What prospects for technological change in the 1980s do you see as relevant to your company?

A. Slow or rapid, and what kind?

B. Originating in your company, in a competitive company, in a university or the government (public domain)?

III. What are the CE needs in response to technology changes for different functions in the organization?

IV. How will changing educational technology affect CE? How much movement will there be away from conventional classroom formats?

A. Substitutes for classroom and book will be increasingly available through cheaper electronic means. How much will they be used?

B. Classroom presentations can be distributed geographically (through broadcasts, videophone, facsimile reproducer, etc.) and temporarily (they can be recorded and used at other times).

V. What should be the division of labor between universities, corporations, professional societies and others, in providing CE?

VI. What public policies can have a direct effect on CE?

A. Should IRS distinction between current job-related (deductible) and new-job related tuition payments (not deductible) be continued in light of the fact that R&D personnel must continually undertake new job assignments?

B. At what point should an educational program stop being part of the job and become a fringe benefit, taxable to the employee? Is the current legal situation appropriate?

C. What should be the role of the professional societies and the states vis-a-vis regulations affecting CE?

D. Are there likely to be gaps where NSF or some other agency could fund educational programs of national importance?

VII. Are there changes in CE that should be made in the light of current problems?

EXPLORATORY QUESTIONS

VIII. How do you expect the 1980s to be different?

A. How much economic growth seems likely over 5 years? 10 years?

B. How will this impact your company? Its R&D needs? Its CE needs?

IX. Do you expect to hire new graduates from a larger or smaller pool?

A. Larger--more women, more career orientation of students? Foreign students?

B. Smaller--fewer Americans of graduation age?

X. What are your most important technical manpower needs for the 1980s?

XI. How might domestic issues affect CE requirements?

A. New social priorities such as return to (or continued movement away from) redistributive social programs or changing attitudes (friendliness or hostility) toward business or technology?

B. Changing economic patterns such as growth, inflation, stagflation, recession: scarcity of resources--skills or capital?

XII. How will social and economic changes affect expectations of scientists and engineers?

A. How will expectations with respect to careers affect CE?

B. Do you anticipate more competition for middle management slots resulting from the post-war baby boom? If so, how will this affect CE?

XIII. How might the international situation affect CE requirements?

A. Increase in international tensions: more DOD and NASA spending or the reverse; great SALT success, slowdown in weapons development?

B. Qualitative change in arms race: weapons breakthrough, or new strategic importance of some factor such as energy, e.g., oil import cutoff, fusion success, etc.?

XIV. <u>How do you see the role of universities in meeting your needs for the 1980s</u>?

A. What will be the capabilities of new graduates? e.g., foreign students?

B. Will the schools produce graduates with the knowledge and skills you need?

XV. <u>Are there changes in CE that can be made in the immediate future in anticipation of developments that are likely during the next decade (as distinguished from current problems)</u>?

XVI. <u>Is there any other issue important to the future of CE that you would like to discuss</u>?

Appendix 2b

Interview Schedule for R&D Managers

BASIC QUESTIONS

1. How is CE carried out in your organizations?

   A. Which modes of CE are supported now? How should this change in the 1980s?

      Consider:
      a. university sponsored courses: credit/non-credit
      b. in-house courses
      c. self-study modes
      d. professional society sponsored courses/meetings
      e. leaves of absence: with pay/without pay
      f. sabbaticals: short term (several months)/long term (a year or more)

   B. How much time is provided now for CE during working hours? How much do you anticipate in the 1980s?

   C. How is financial support provided now for CE? How should this change in the 1980s?

      Consider:
      a. source of funds (dept./group/unit/organization's educational fund/and others)
      b. tuition: complete/partial
      c. must CE be job/career relevant in order to receive support
      d. cost of books
      e. travel costs

   D. What incentives do employees have to pursue CE? How do performance evaluations take CE into account? Should this change in the 1980s?

      Consider:
      a. salary
      b. promotion
      c. more challenging and responsible assignments
      d. more opportunities for professional development

   E. How do you determine CE needs for the scientists or engineers you supervise?

   F. Describe your own CE participation and the reasons for doing so. If you participated in CE, what were the outcomes? What are your future CE plans?

II. What prospects for technological change in the 1980s do you see as relevant to your company?

A. Slow or rapid, and what kind?

B. Originating in your company, in a competitive company, in a university or the government (public domain)?

III. What are the CE needs in response to technology changes for your functions in the organization?

IV. How will changing educational technology affect CE? How much movement should there be away from conventional classroom formats?

A. Substitutes for classroom and book will be increasingly available through cheaper electronic means. How much will they be used?

B. Classroom presentations can be distributed geographically (through broadcasts, videophone, facsimile reproducer, etc.) and temporally they can be recorded and used at other times.

V. Do you consider a new "division of labor" possible between industry and the universities in the education and training of scientists and engineers desirable? More recurrent periods of education for R&D personnel? If so, what would be desirable (feasible) in the next ten years?

VI. What public policies can have a direct effect on CE?

A. Should IRS distinction between current job-related (deductible) and new-job related tuition payments (not deductible) be continued in light of the fact that R&D personnel must continually undertake new job assignments?

B. At what point should an educational program stop being part of the job and become a fringe benefit, taxable to the employee? Is the current legal situation appropriate?

C. What should be the role of professional societies and the states vis-a-vis regulations affecting CE?

D. Are there likely to be gaps where NSF or some other agency could fund educational programs of national importance?

VII. Are there changes in CE that should be made in light of current problems?

EXPLORATORY QUESTIONS

VIII. What are your most important technical manpower needs for the 1980s?

IX. How will social and economic changes affect expectations of scientists and engineers?

A. How will expectations and values with respect to careers affect CE?

B. Do you anticipate more competition for management slots resulting from the post-war baby boom? If so, how will this affect CE?

X. Are there changes in CE that can be made in the immediate future in anticipation of developments that are likely during the next decade (as distinguished from current problems)?

XI. Is there any other issue important to the future of CE that you would like to discuss?

Appendix 2c

Interview Schedule for Administrators and CE Directors at Academic Institutions

1. What forms of continuing education, e.g., symposia, short courses, summer institutes, etc., can be most effectively or profitably managed by universities? Which by industry? In what fields?

2. Few institutions of higher education are well organized to offer high quality programs in continuing education for scientists and engineers. Why is this so?

3. What changes in attitudes, organizations and policies are required for universities to become significantly more effective in providing continuing education to scientists and engineers? Unless economic forces (e.g., a serious drop in enrollment, massive government funding, etc.) facilitate drastic changes in attitudes, organization, and policies, what changes do you foresee in the near future?

4. If corporations continue to expand and excel in the in-house advanced training of their technical personnel, could they significantly damage the viability of graduate programs? Of doctoral programs? University sponsored CE programs?

5. There are precedents for nonacademic organizations to be licensed by the State (California, Massachusetts) to grant degrees. Do you foresee an increased tendency in this direction? What impact would it have on universities?

6. Can universities expect to keep up with developments in science and engineering (do they have experts in ever-narrower areas, and expensive specialized equipment?) in order to seriously consider participating in continuing education in other ways than upgrading in basic skills and knowledge?

7. Do you consider a new "division of labor" possible between industry and the universities in the education and training of scientists and engineers desirable? More (different, life-long) recurrent periods of education for R&D personnel? If so, what would be desirable or feasible in the next ten years?

8. If in the course of public and private debates, it became clear that such a new "division of labor" is necessary in the national interest, how should such changes be planned and implemented? With the help of a government agency, e.g., NSF, Commerce? Through the cooperation of professional and business associates?

9. Are there alternate ways to maintain up-to-date technical manpower? (Exchange of faculties between industry and universities, recognition of credit and accreditation of courses taken outside the university, etc.).

10. Are you making plans to service the CE needs of the large number of post-war babies who will be entering mid career in the 1980s?

11. Please comment on any aspect of the above, or other continuing education dilemmas we face as we enter the 1980s.