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# CONTINUING ENGINEERING EDUCATION - WHO REALLY NEEDS IT?

(What is the Market for Continuing Education?)

by

Fred Landis

Department of Mechanical Engineering



Prepared for the

Office of University Affairs

National Aeronautics and Space Administration

Under Research Grant NGL-33-016-067.

New York University
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This report covers an address delivered by Professor Fred Landis at the Continuing Engineering Studies Division (American Society for Engineering Education) Fourth Annual Conference in Pittsburgh, Pennsylvania, on November 6, 1969. It is hoped that this release of the address in report form will meet the large demand for copies expressed at the meeting.

The report should also serve to substantiate some of the assertions regarding continuing education made by the author in his previous report "ENGINEERING OBSOLESCENCE AND CONTINUING EDUCATION" which was released as Report No. C-67-1 under this NASA grant. By providing detailed results from a questionnaire survey, quantitative information useful for continuing engineering education planning has now been supplied.

# CONTINUING ENGINEERING EDUCATION - WHO REALLY NEEDS IT?

(What is the Market for Continuing Education?)

## Introduction

Continuing education has been around for quite a while and this group is a good example of the many devoted men who have tried to develop and promote it. Yet, in spite of all this activity, it seems to have had only moderate success and we should examine whether we have really developed the right programs and whether we have been able to reach those who could benefit most.

One way to examine a product such as ours is to undertake a market research study. We should find out who is really interested in our product and why, whether we are promoting the right product, what the actual and the potential market is, how the product can be improved and, very importantly, how it should be packaged. Finally, we should also review our marketing organization. Since it appears that these questions, which should be basic to any successful enterprise, have never been fully explored in the field of continuing education, I would like to do this with you today.

I am not going to say much about part-time graduate degree efforts; they are already well-established and their aims are fairly well understood. Instead, I would like to focus attention on non-degree programs in their various forms. It should, however, be pointed out that the distinction between these two programs is not always appreciated outside the field of continuous education specialists. A program which is viewed only as a subset of graduate education is doomed to failure.

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Address delivered by the author at the Fourth Annual Conference, Continuing Engineering Studies Division, ASEE, November 5-7, 1969, Pittsburgh, Pennsylvania.

Advanced degree programs are attractive to only a small segment of the profession: its young practitioners. The recent graduate is anxious and willing to learn, especially if his job assignment is challenging. He wants to move ahead, both in his profession and in his company. He is still interested in fairly broad-based learning and is still willing to assume, at least in part, that a college faculty "knows what's good for him." He will also recognize the cash surrender value of his advanced degree; current salary differentials are high enough to entice many a young engineer into graduate work without having him worry whether it will help him right now in his current job.

However, about four to eight years after graduation a change in attitude begins to occur. The engineer becomes more concerned with developing within his company rather than within his profession. He may find himself in a specialized technical area while at the same time his overall job requires less and less engineering. He may be interested in climbing up the managerial ladder. He will have different responsibilities and different pressures; family and financial demands will come strongly to the foreground. He will learn to find his intellectual center of gravity in his overall work and the time demands that are made on him may become more important than the intellectual demands.

This is the engineer, the man over thirty, to whom we should address ourselves today. We will have to understand his needs, his interests and his attitudes. And we will have to recognize that he is likely to look at continuing education with one very specific question in mind: How will it help me right now?

## Results of Previous Studies

Although there have been two major previous analyses, they are only of limited value for a market study. In the first, "Continuing Professional

Education for Engineers in Pennsylvania" by Dubin and Marlow of the Pennsylvania State University, the authors sent out a questionnaire listing a large number of potential university courses and asked respondents to check either "should have," "could use" or "don't really need." Then they combined both "should have" and "could use" replies in their tabulations.

Unfortunately, this is like asking a question on the merits of motherhood. Very few people will indicate that they really don't need any further education. Yet a mild expression of interest, such as "could use," can hardly be useful for planning purposes. A partial summary of the Penn State replies is shown on Table I and, as might be expected, the percentage replies run very high. But when it is noted that the apparent demand for music exceeds that for any technical area, the utility of that survey must be questioned.

The second study, conducted by the ECAC-Relations with Industry "Feedback" Committee of ASEE, fared only slightly better. Here the question asked was: "In what subjects would additional training be helpful?" This is a semi-motherhood question and the percentage replies are somewhat lower although still much too high.

The principal results of that study are summarized on Table II. Nine out of the first ten topics relate to management or communication skills, closely matching the relative emphasis given to these areas in the Penn State survey. Only one technical course (Probability and Statistics) ranks in the top ten and the first engineering course (Heat Transfer) occurs in twelfth position.

The conclusions we can draw from both of these studies are that management and communications skill courses are considered most important, that mathematics plays a significant role and that specific engineering courses rank much lower. But we cannot find out who is likely to take what courses

TABLE I

## TOP RANKED COURSES - PENN STATE STUDY (1965) (SAMPLE 2090)

(Proposed Courses under Penn State University Sponsorship)

Answers Include "Should Have" and "Could Use"

| | |
|---|---|
| **Basic Sciences:** | |
| Probability and Statistics | 62% |
| Review of College Mathematics | 53% |
| **Engineering Sciences:** | |
| Engineering Economy | 68% |
| Engineering Analysis | 61% |
| Computer Programming - Digital | 57% |
| **Communication Skills:** | |
| Rapid Reading | 80% |
| Communication in Organization | 78% |
| Conference Leadership | 77% |
| Public Speaking | 76% |
| Oral Report Presentation | 74% |
| **Managerial Skills:** | |
| Understanding of Behavior in Work Situation | 73% |
| Human Relation Skills | 69% |
| Executive Development | 69% |
| **Social Sciences/Humanities:** | |
| Economics | 63% |
| **Fine Arts:** | |
| Music | 65% |

TABLE II

## RESULTS OF ECAC/ASEE STUDY

(Journal of Engineering Education, May 1965)

1955-1957 B. S. Graduates - Sample 4096

### IN WHAT SUBJECTS WOULD ADDITIONAL TRAINING BE HELPFUL

| Rank | Subject | Number | Percent |
|---|---|---|---|
| 1 | Management Practices | 2660 | 65.4 |
| 2 | Technical Writing | 2601 | 64.0 |
| 3 | Probability and Statistics | 2449 | 60.2 |
| 4 | Public Speaking | 2430 | 59.8 |
| 5 | Creative Thinking | 2315 | 56.9 |
| 6 | Working with Individuals | 2301 | 56.6 |
| 7 | Working with Groups | 2238 | 55.1 |
| 8 | Speed Reading | 2178 | 53.6 |
| 9 | Talking with People | 2171 | 53.4 |
| 10 | Business Practices (Marketing, Finance, Economics) | 2064 | 50.8 |
| 11 | Survey of Computer Uses | 1961 | 48.2 |
| 12 | Heat Transfer | 1751 | 43.1 |
| 13 | Instrumentation and Measurements | 1643 | 40.4 |
| 14 | Data Processing | 1620 | 39.8 |
| 15 | Systems Programming | 1518 | 37.3 |
| 16 | Economics | 1510 | 37.1 |

and when. There is a big difference between being interested in further education and in actually being willing to undertake it. So we can only surmise that all of these percentages will have to be heavily discounted.

The Present Study

This leads us to the present study, which involved both extensive interviews with middle and upper level engineering management and a very detailed questionnaire dealing with attitudes, interests, self-perceived needs, future goals and motivational factors relating to engineers and scientists in industry.

The questionnaire, which took about 50 minutes to complete, was distributed through management to employees in twelve representative companies, was completed anonymously and was mailed directly back to us.

The actual data sample is shown on Table III. Both "old line" and "new line" companies are represented except in the Consumer Goods field where our insistence on a sufficiently large engineering staff to gain statistically significant answers and to assure anonymity limited us to "new line" organizations. For logistic reasons, most of the companies selected were from the larger New York Metropolitan area.

2101 questionnaires were sent out and 1311 useful replies were received. Although engineers, ranking from Indians through Department Heads, formed most of the sample, some scientists were interspersed. They actually formed the majority in the Petro-Chemical Research Organization (Company 8). To eliminate the potentially different replies from scientists, a separate data comparison was made for the 1146 engineering replies received. Most of the subsequent conclusions are based on the engineering sample.

To check the validity of the sample, we compared it to other data available on engineers in industry. The salary distribution and median age closely match those of the 1968 company survey conducted by the Engineering

TABLE III

DATA SAMPLE OF NYU SURVEY

| | | Questionnaires Sent Out | Total Number Returned | Overall Percentage Return | Number Returned Engineers Only |
|---|---|---|---|---|---|
| | Space and Defense Industry | | | | |
| 1. | Military Electronics | 235 | 97 | | 97 |
| 2. | Military Electronics | 50 | 42 | | 40 |
| 3. | Navigation and Guidance | 300 | 106 | | 104 |
| 4. | Airframe Manufacturer | 250 | 211 | | 210 |
| | | 835 | 456 | (54.6%) | 451 |
| | Capital Goods Industry | | | | |
| 5. | Equipment for Communications Industry | 50 | 35 | | 35 |
| 6. | General Machinery-Power Plant Equipment | 100 | 82 | | 82 |
| 7. | Data Processing Equipment | 150 | 117 | | 112 |
| | | 300 | 234 | (78.0%) | 229 |
| | Research Organization | | | | |
| 8. | Petro-Chemical Research | 371 | 281 | | 131 |
| | Consultants | | | | |
| 9. | Electric Utility Industry | 50 | 29 | | 29 |
| 10. | Construction Design | 345 | 165 | | 165 |
| | | 395 | 194 | (49.1%) | 194 |
| | Consumer Goods | | | | |
| 11. | Medical Products | 150 | 111 | | 111 |
| 12. | Food Processing | 50 | 35 | | 30 |
| | | 200 | 146 | (73.0%) | 141 |
| | Grand Total | 2101 | 1311 | (62.4%) | 1146 |

Manpower Commission of the Engineers Joint Council and reported in the May-June 1969 issue of THE ENGINEER. Our sample is slightly better educated than the 1968 National Engineering Register sample, which is based on society membership and over-represents older men. In terms of national employment patterns, we under-represent civil engineers and "others" (e.g., mining, agricultural engineers), have an excess of electrical engineers and a significant over-representation of mechanical engineers. This possible bias, which would be expected in manufacturing industries, should be remembered when some of the detailed results are discussed later.

Who is Really Interested in Continuing Education

To establish the potential market for continuing education courses, we might start with a review of courses actually completed by our respondents during the last three years. 294 engineers out of the total sample of 1146 indicated that they had taken graduate degree courses during the last three years and their replies have been omitted from the subsequent analysis which is based on the replies from 437 individuals. The first column on Table IV shows the kind of course completed and its sponsorship. Since individuals may have completed courses in more than one category, the total number of entries (845) is nearly twice as large as the number of respondents.

Company in-house courses far overshadow college courses and short work shops which run about neck-to-neck and are below the participation in professional society courses. College and professional society courses may be affected by the high availability of these offerings in the larger New York area; this response might be lower in other locations.

Now, let us try to extrapolate these results for market planning. Let us assume that each entry corresponds to one course completed every three years and that we can translate this into an equivalent percentage of the total

TABLE IV

## NON-DEGREE COURSES COMPLETED DURING LAST 3 YEARS

(Individuals may have completed courses in more than one group)

(Total Engineering Sample 1146)

| | Total Numbers | % Per Year | |
|---|---|---|---|
| Regular College Courses | 99 | 2.9 | |
| Short College Courses or Workshops | 91 | 2.6 | |
| * Professional Society Courses | 147 | 4.3 | |
| Professional Licensing Preparatory Courses | 55 | 1.6 | |
| Formal In-Company Courses - Basic Engineering or Science Tools | 227 | 6.6 | |
| Formal In-Company - Manufacturing or Process | 45 | 1.3 | 11.8 |
| **Formal In-Company - Management Training | 132 | 3.8 | |
| Others (incl. Language School, Correspondence) (Informal Company Courses) | 49 | 1.4 | |
| Total | 845 | 24.6 | |

* Important in all industry groups except Aerospace.

**Exceptionally high percentage in Consumer Goods Industry.

engineering work force taking one course every year as shown on the right column of Table IV. To arrive at the potential market, we then have to apply a suitable multiplier. 2.0 may be a good number, 3.0 will undoubtedly be too high since it is very unlikely that even under optimum conditions 74% of all engineers will take one non-degree course per year. Personally, I believe that a multiplier of 1.5 is about correct.

Now apply the multiplier selected to the percentages on the right hand column of Table IV and you will note that the potential college market is rather small. 4-8% of all engineers may possibly take one college non-degree course per year (or a smaller percentage more than one).* This would suggest that the realistic growth potential of college-type continuing education courses will remain rather small and that it will not make much of an impact on the college economy or planning. There might be more of a future for short workshops. These, however, are not likely to compete with or influence college programs significantly. Professional societies look more promising, but it should be obvious that the greatest future lies in company sponsored internal courses.

To find out what type of courses are needed, we can again take a clue from the questionnaire response. Each respondent was asked to list up to three courses and to be as specific as possible in reply to the question: "What Courses Are You Planning To Take Next Year?" These were then combined and ranked in area patterns as shown on Table V.

Again management ranks high but communication skill improvement has dropped quite a bit. Electrical and Mechanical engineering related courses are also near the top, possibly influenced by our sample bias. Mathematics fares

* A Fall 1968 study covering the Clear Lake area (University of Houston-NASA Manned Space Flight Center area) conducted by Paul E. Purser and based on employer generated data suggests that about 15% of all engineers and scientists in that location would be interested in further college work. Assuming that less than half of these courses would be on a non-degree basis, Purser's results agree reasonably well with those of the present study.

TABLE V

NON-DEGREE COURSES TO BE TAKEN NEXT YEAR

(Total Sample 1146)

| | | | |
|---|---|---|---|
| * | 1. | Computer Programming | 56 |
| * | 2. | Management Related Courses | 48 |
| * | 3. | Electrical Engineering Related Courses (Except Computer Science) | 39 |
| * | 4. | Mechanical Engineering Related Courses (All) | 25 |
| * | 5. | General Mathematics (Except Computer Appl., Probability and Statistics) | 22 |
| * | 6. | Computer Sciences (Electrical Engineering) | 17 |
| | 7. | Professional Engineering Exam. Preparation | 16 |
| * | 8. | Report Writing/Improve Communication | 11 |
| | 9. | Physics Related Courses (All) | 10 |
| * | 10. | Computer Applications/Numerical Analysis | 8 |

* Areas also top-ranked in Recommended Courses.

rather well.

The potential sponsorship for some of these courses is summarized on Table VI. Even though in-house company courses already rate very high, they will probably end up even higher. Most men overestimate the likelihood of their taking college courses and underestimate their participation in company courses, many of which are not scheduled far in advance.

There may also be a distinction between what an individual plans to do himself and what he would recommend to his colleagues or to men working for him. To check this potential difference, which could be important in analyzing employer generated data, we asked the question:

"If you had to recommend additional college courses to be taken by a young engineer in your group, what would you recommend? Please be as specific as possible."

Instead of providing a check-off list which could precondition the response, we allowed five lines for the reply.

The answers from 812 respondents are shown on Table VII. The asterisks refer to items which were also listed on Table V, although the responses are not necessarily in the same order of importance. The first ranking item on Table VII, Communication Skills and Report Writing, showed up much lower on Table V; apparently it is much more important for the other fellow than for oneself. Electrical and Mechanical engineering as well as General Mathematics do well on both lists. Statistics and Probability appears only on the recommended list while Computer Programming has dropped in importance. This may be due to the rapidly exhausted market; most engineers and almost all recent graduates have already been exposed to the computer.

The percentage shown in parentheses on Table VII deserve special discussion. Although they include whole areas of study rather than just single courses, they could serve as a more reliable upper bound to the <u>total</u> engineer-

TABLE VI

SPONSORSHIP OF SPECIFIC NON-DEGREE COURSES PLANNED FOR "NEXT YEAR"

(Engineers Only, Sample = 1146)

| | Univ. | Profess. Society | Company In-House | Other | Not Indicated |
|---|---|---|---|---|---|
| General Management/ Business Administration | 15 | - | 11 | - | 4 |
| Computer Programming | 12 | 4 | 29 | 1 | 10 |
| Electrical Engineering Computer Systems Logic and Switching | 3 | - | 12 | - | 1 |
| Professional Engineering Exam.- Preparation Course | 6 | 7 | 1 | 3 | 1 |

TABLE VII

RECOMMENDED COLLEGE COURSES

(Total Sample 1146)

| | | Number Recommending | |
|---|---|---|---|
| * 1. | Report Writing/Communications | 361 | (31.5%) |
| * 2. | Management Related Courses | 308 | (26.9%) |
| * 3. | Mechanical Engineering Related Courses | 272 | (23.7%) |
| * 4. | Electrical Engineering Related Courses (Except Computer Sciences) | 238 | (20.8%) |
| * 5. | General Mathematics (Except Probability, Statistics, Computer Courses) | 191 | (16.7%) |
| * 6. | Computer Programming | 170 | (14.8%) |
| 7. | Probability and Statistics | 105 | (9.2%) |
| * 8. | Computer Sciences (Electrical Engineering) | 79 | (6.9%) |
| 9. | Economics | 69 | (6.0%) |
| 10. | Industrial Engineering and Operations Research Related Courses | 61 | (5.3%) |
| *11. | Computer Applications, Numerical Analysis | 60 | (5.2%) |

* Also top-ranked in Non-Degree Courses to be taken next year.

ing work force participation in college courses than either of the previous studies. In actuality, probably less than half this percentage of engineers will ever participate in such courses.

Typical subdivisions in course work areas within each major group are given on Tables VIII for Management course, Table IX for Communications, Table X for Electrical engineering, and Table XI for Mechanical engineering. "Notable Lows" are shown on Table XII which predict a very limited future for certain fields. It might also be noted that there were no recommendations for "Creative Engineering Courses" which so bedevilled the check-off lists used in prior studies.

Obviously, these recommendations may be modified by strong local industry patterns; we would not expect an exceptional interest in rocket propulsion or in petroleum engineering in the New York area. However, the results should be fairly representative for areas with a diverse manufacturing industry.

Where sub-fields have been indicated on the previous tables, each entry may correspond to from 2 - 15 different specific courses. For instance, the listing "Electrical Engineering Circuit Analysis and Design Courses" on Table X includes proposed coursesin Circuit Analysis, Circuit Design, Circuit Design Applications, Network Analysis, Active Circuits and Passive Circuits.

This raises another problem that has frequently been overlooked in the planning for continuing education courses: The specific interests and background capabilities of men from different companies or even of different groups within the same company are so widely diverse that finding a "critical mass" of students interested in and capable of gaining from any given engineering course is a difficult task indeed.

Part of the problem is what might be called the "homogenization" process: how to bring students with different backgrounds together into one

TABLE VIII

MANAGEMENT RELATED COURSES
(Total Sample 1146)

| | To be taken next year | Recommended |
|---|---|---|
| General Management - Business Administration | 30 | 208 |
| Industrial Management | 12 | 32 |
| Personnel Management | 2 | 23 |
| Labor Relations | 1 | 12 |
| Marketing and Sales | 1 | 16 |
| Scheduling/PERT | 2 | 10 |
| Economics | 3 | 69 |
| Psychology/Industrial Psychology | 1 | 41 |
| Accounting | 1 | 34 |
| Finance/Investment Planning (partly personal) | 2 | 22 |

TABLE IX

COMMUNICATIONS RELATED COURSES
(Total Sample 1146)

| | To be taken next year | Recommended |
|---|---|---|
| "General Communications" | 1 | 76 |
| Report Writing/Technical Writing | 2 | 120 |
| Oral Communication | 2 | 67 |
| Proposal/Specification Writing | 0 | 6 |
| Speed reading/writing/memory development | 7 | 10 |

TABLE X

RECOMMENDED MECHANICAL ENGINEERING COURSES (by areas)

| | To be taken next year | Recommended |
|---|---|---|
| Circuit Analysis and Design Courses | 6 | 43 |
| Systems, System Analysis and Synthesis | 2 | 27 |
| Electronics, Microelectronics, Solid State Technology | 13 | 46 |
| Servomechanism, Control theory, Electromechanical Systems | 8 | 64 |
| Computer Systems, Logic and Switching, Sample Data Systems | 17 | 79 |
| Instrumentation and measurement | 4 | 17 |
| Electrical Power Design and Applications | 3 | 13 |
| Field Theory | - | 8 |

TABLE XI

RECOMMENDED MECHANICAL ENGINEERING COURSES (by areas)

| | To be taken next year | Recommended |
|---|---|---|
| Mechanics, Dynamics, Kinematics | 3 | 42 |
| Vibration | 0 | 24 |
| Elasticity, Stress Analysis, Strength of Materials | 3 | 30 |
| Thermodynamics | 2 | 30 |
| Fluid Mechanics | 9 | 41 |
| Heat Transfer | 4 | 29 |
| Machine Design | 1 | 19 |
| Manufacturing processes | - | 28 |

TABLE XII NOTABLE "LOWS" - TOTAL OF ALL COURSES

| | To be taken next year | Recommended |
|---|---|---|
| Aeronautics and Astronautics - all areas | 4 | 30 |
| Material Sciences - all areas | 0 | 22 |
| Nuclear Engineering - all areas | 2 | 6 |
| Physics - all areas | 10 | 41 |
| Chemistry - all areas | 0 | 23 |
| Life Sciences/Bio-engineering | 2 | 1 |

course which neither bores the well prepared listener nor "snows" his slower or more poorly prepared colleague.

The other aspect of the problem is reflected in the economics of any continuing education effort and this becomes even more severe in any location where continuing education is just being started. In such locations, there is usually a one-to two-year backlog of potential students. When this backlog has been processed and the subsequent student population depends primarily on the normal turn-over or growth rate of the region, enrollments will shrink drastically. Good continuing education planning must, therefore, be based on the long range student supply.

Initial Conclusions

The results presented so far permit some definite initial conclusions:

(a) The future for regular college non-degree courses is not too bright. Short workshops and professional society courses may do somewhat better, but the principal growth rate is likely to take place with in-house company sponsored courses.

(b) In-house company courses can best be designed to meet the needs of specific groups; the homogenization and fractional interest problem can be more effectively overcome with students working in related fields and for the same "boss." Only if the industrial pattern in a region is highly focussed and if a sufficient number of common denominators can be found, will an external continuing education program remain effective. Such common denominators could include management courses, general mathematics and programming.

(c) Typical college courses in the basic sciences (Physics, Chemistry and Biology) as well as work in the less populated engineering fields (material sciences, nuclear engineering, etc.) are not likely to attract a significant student body.

Why Take Continuing Education Courses?

Although we have looked at the kinds of courses that might attract a reasonably sized student population, we have so far paid no attention to the more basic question: Who should take such courses and why?

Again, the questionnaire can provide a starting point with the replies to

> "Please indicate how you feel about additional course work (not degree oriented) at a university or through a professional society or within the company"

which are summarized on Table XIII.

Slightly over 40% considered such courses a necessity or a significant help, only about 7% were definitely adverse to further course work and 42% were essentially neutral. The question is, of course, again in the semi-motherhood category although the responses are more realistic than those of prior studies. Certainly only those men who are convinced that further work is necessary or of significant use would be likely to undertake it. Usefulness over the long range is hardly a sufficient enticement for a man to undergo the rigor and the discomfort of formal learning.

We then asked our respondents to rate the relative importance of eleven reasons for taking courses. The rating was done on a 0 - 10 scale with "0" corresponding to "of no importance whatsoever" and "10" to "of utmost importance." The answers were then ranked in terms of their assigned importance as shown on Table XIV. The horizontal lines on the table delineate subgroups within which the difference between adjacent entries is not statistically significant. Parentheses are placed around rankings which fall far from the overall norm.

There is a remarkably uniform pattern for the aerospace industry, the capital goods companies and the research organization. Only the consulting engineers and the consumer goods companies show a widely different pattern.

TABLE XIII

SELF PERCEIVED NEED FOR CONTINUING EDUCATION

Question: "Please indicate how you feel about additional course work (not degree oriented) either at a university or through a professional society or within the company.

(Check one item only)

| | | | |
|---|---|---|---|
| | Total Sample | 1146 Engineers | |
| Replies: | Absolute necessity | 12.7% | |
| | Would help me significantly | 29.7% | |
| | Might be useful over long range | 39.1% | |
| | Really have not given it much thought | 3.3% | |
| | Would be of very little help | 4.0% | 7.1% |
| | Would be an imposition on my time and energy which I cannot afford | 2.7% | |
| | Would take additional course work only if my boss recommended it | 0.4% | |
| | Still engaged in graduate work | 5.8% | |
| | No answer | 2.4% | |

TABLE XIV

REASONS FOR TAKING COURSES (Ranked in Order of Importance)

| Overall Ranking | | Company Distribution: Aerospace Group | | | | Capital Goods | | | Research | | Consult. | | Consumer | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8E | 8S | 9 | 10 | 11 | 12 |
| 1 | KEEP UP WITH PROFESSION | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | (6) | 1 |
| 2 | IMPROVE SALARY/AID IN PROMOTIONS | 2 | 4 | 7 | 2 | 2 | 2 | 5 | 2 | 5 | 5 | 1 | 1 | 3 |
| 3 | BROADER PERSPECTIVE OF WORK FACTORS | 6 | 6 | 5 | 6 | 3 | 7 | 4 | 3 | 6 | 6 | 2 | 3 | 2 |
| 4 | BETTER METHODOLOGY TO HANDLE PROBLEMS | 5 | 5 | 2 | 4 | 4 | 6 | 2 | 4 | 4 | 4 | 5 | 7 | 4 |
| 5 | DELVE INTO ADVANCED TOPICS | 3 | 3 | 4 | 3 | 5 | 3 | 6 | 5 | 2 | 3 | 4 | (9) | (8) |
| 6 | BETTER UNDERSTANDING OF ENGINEERING & SCIENCE PRINCIPLES | 7 | (9) | 3 | 5 | 6 | 4 | 3 | 6 | 3 | 7 | 8 | 8 | (9) |
| 7 | PREPARE FOR ENTRY TO MANAGEMENT | 4 | (2) | (10) | 7 | 8 | 5 | 7 | 7 | (10) | 8 | 7 | (2) | 6 |
| 8 | IMPROVE COMMUNICATION SKILLS | 9 | 7 | 8 | 8 | 7 | 8 | 9 | 9 | 7 | (2) | 6 | (4) | (5) |
| 9 | UNDERSTAND PEOPLE BETTER | 10 | 8 | 9 | 9 | 9 | 9 | 10 | 8 | 9 | 9 | 9 | (5) | (7) |
| 10 | SEEK A DIFFERENT AREA OF COMPETENCE | 8 | 10 | (6) | 10 | 10 | 10 | 8 | 10 | 8 | 10 | 10 | 10 | 11 |
| 11 | AVOCATION OR LEISURE INTERESTS | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 10 |

E = Engineers, S = Scientists

It might be added that company-to-company variations were much larger on the answers to this question than on any other one in the whole questionnaire. This may be significant in itself: continuing education is not one of the prime concerns of working engineers (when compared to salary, job satisfaction, working conditions, future goals, etc.) and therefore attitudes do not appear to have jelled that firmly.

Of importance in the table is not the almost universal first ranking of the rather ill-defined aim "to keep up with my profession" but rather some of the low rankings. The relatively poor showing of "delve into advanced topics" and "better understanding of engineering and scientific principles" offers the first hint: Few engineers are challenged to remain highly current in their field or to have a real understanding of engineering principles. They would rather have the means of improving their salary by being able to handle their current problems better.

It is perhaps somewhat surprising that "entry into management" fares so poorly (except for the Consumer Goods industry), especially since "improvement of salary and aid in promotions" are considered so important. But the reason is actually not surprising: People are interested in taking courses which have an immediate pay-out function and are not willing to undertake course work for the distant and uncertain future. They may or may not become managers in the long run but it is only when they have started along the management ladder that they become sensitive to management-related courses.

This will explain, at least in part, the even lower rating given to communications skills and to interpersonal relations which in the opinion of most engineers are tied to management functions. Here again the consumer goods companies are a notable exception, possibly because here many more engineers are in a quasi-management position. It is rare for an engineer in the aerospace or capital goods field to be a foreman or a sub-department manager who

has to spend a considerable portion of his time to deal with non-professionals where sensitivity to good communications is so important.

There is no obvious answer to the heavy emphasis assigned to improving communication skills in the consulting engineering firms except that possibly the high personnel turn-over in these companies (the highest in the total sample) makes engineers more concerned with the need to establish good communications rapidly. The apparent inconsistency in the answer pattern of Company (3) is due to that corporation's recent history: the company shrank to about one-third its previous size in a few years, forcing many senior men who were retained into junior positions.

The high ranking given to additional course work as an aid to promotions suggested a cross-check with a different portion of the questionnaire which dealt with factors contributing to promotions. The answers shown on Table XV are again based on the ranking of replies to ten questions where each was rated on a 0 - 10 scale.

"Ability to get things done on time" is considered by far the most important attribute for promotions. This is followed by two items related to communications skills and interpersonal relations which were ranked low as a reason for taking additional courses. The direct engineering related factors "Technical Leadership" and "Technical Competence in Specialty" rank only a poor 6th and 7th in the promotion list.

The first five entries on Table XV can be characterized by a single phrase: high visibility. As long as the supervisor is technically competent enough, the highly visible capabilities are much more important than true technical leadership or competence. Furthermore, the obvious pressures exerted on most engineering managers cannot be relieved by additional course work in engineering.

Tables XIV and XV leave a clear message: Engineers take a very

TABLE XV

## FACTORS CONTRIBUTING TOWARDS PROMOTIONS

Ranked in Order of Importance (Total Sample = 1311)

1) ABILITY TO GET THINGS DONE ON TIME.

2) ABILITY TO COMMUNICATE BOTH VERBALLY AND IN WRITING.

3) ABILITY TO GET OTHERS TO WORK EFFECTIVELY FOR YOU.

4) WILLINGNESS TO ASSUME ADDITIONAL WORKLOAD.

5) ABILITY TO FORM RAPID AND EFFECTIVE JUDGMENTS.

6) PROVIDE TECHNICAL LEADERSHIP.

7) TECHNICAL COMPETENCE IN SPECIALTY.

8) BROAD TECHNICAL COMPETENCE IN TERMS OF COMPANY PRODUCTS OR PROCESSES.

9) KNOWING ALL ASPECTS OF THE "BUSINESS".

10) SENIORITY.

short-range view of continued education courses. They are only interested in offerings that will help them right now and that are related to their current job. They are interested in seeing the results of their studies translated into salary increases and eventually into promotions, although promotions are considerably further down the line.

What Should be the Realistic Aims of Continuing Engineering Education.

Up to this point we have seen some of the symptoms that lead to limited interest in continuing education without ever addressing ourselves to the disease. We have noted that engineers are interested in an immediate pay-out when taking additional courses: to perform their current assignment better. We have concluded that basic engineering and science courses fail to generate much enthusiasm because they do not contribute significantly to better job performance. We have also seen that a high level of technical competence or currentness is rarely needed and that technical adequacy rather than leadership and direction is a prerequisite to promotions.

There is a simple underlying reason for most of this: the engineering content of most engineering related jobs is just not very high. In the majority of engineering activities in all segments of industry there is little need for a broad-based engineering point of view or for sophisticated analysis. Instead, most of the work performed by engineers consists of "formatted" tasks* which have a high skill content but which do not require much scientific knowledge, wide-ranging engineering capabilities or intellectual extensions. Most assignments fall into a pattern that has a high degree of near-repetitiveness associated with its engineering content.

The value of engineers working on such formatted tasks lies primarily in their ability to handle "contingency" problems. These may require consider-

* The author is indebted to Robert Miller of IBM for his decisive interpretation of the role of formatted tasks in engineering.

able skill and experience and may cover such diverse aspects as custom engineering for slightly different applications, gadgeteering to solve specific problems, scheduling and expediting or just the ability to "get things done." They require an engineering frame of reference but not much depth in engineering. And they are performed in surroundings which place major emphasis on getting the job done satisfactorily and on time without ever questioning whether the job could be done better. It is usually only the short-term result that counts rather than the way in which it was arrived at. It is the recognition of these facts-of-life that should influence our attitude towards continuing education if we ever hope to reach a larger portion of the engineering work force.

There is also another point which has been argued very persuasively by Miller: Familiarization with the relevant background material, i.e., the underlying scientific and engineering fundamentals, may help in the early phases of learning and may even motivate some excursions to wider horizons. But, by and large, understanding adds very little to the day-by-day performance of the actual engineering assignments, especially if these are highly formatted.

This suggests, at least to me, that continuing education which has long been the domain of academicians, has looked at only half the picture. Academicians want to teach understanding and knowledge rather than skills. They tend to believe that the educational and motivational ideas that are effective with degree students can be directly carried over to adult professionals. They may have a natural reaction against the "handbook" engineering of the past and therefore tend to overemphasize broad fundamentals.

Yet it is only with "skill training" that we can enlarge our continuing education market. This is a field about which we know all too little and although it has been used widely in the training of semi-skilled labor, little of that experience seems to have been carried over into the professional field.

In part this may be due to lack of experience, in part to the high cost of developing diversified training programs for relatively small audiences.

Skill training demands a completely different approach from conventional course work. It requires the compartmentalization of knowledge into small and self-contained building blocks. Within each block, motivation must be continuously reinforced and there must be an apparent pay-out function which is job action related. The use of concrete examples, of visualization and of analogies to the familiar assume a much greater importance than in academic learning. It is a natural for partial programmed instruction and I am sure that the purveyors of programmed learning will enter the scene as soon as it becomes economically feasible to do so.

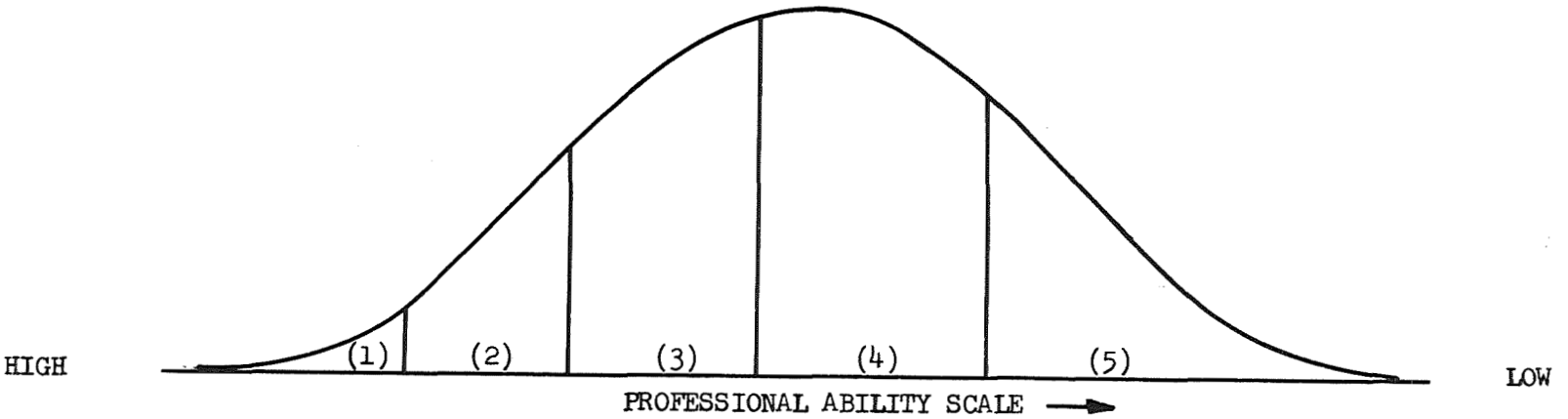
In the few areas where skill training has been attempted, it has been highly successful. Most notable are the long list of computer programming courses which have made such an impact on engineering. But even here we have taken only the first step; there has been no counterpart to programming in the development of training courses in numerical analysis.

What percentage of the engineering work force could we reach with training courses? Let me start with a hypothesis (which is rapidly becoming a thesis) that the professional ability of individuals follows a near-Gaussian distribution similar to the intelligence distribution and that, in general, the position which men occupy in industry is closely related to this overall ability scale. This is illustrated on Figure 1.

There is little we have to worry about in terms of the top 5%; they will remain up-to-date and they will move ahead. They will only require that not too many impediments are placed in their way.

The next 10-15% are the crucial individuals in any company. They form the mainspring of activities, they keep the company going. They also provide the source for management personnel. And here we have the most import-

Figure 1 - PERSONNEL PROFILE AND CONTINUING EDUCATION




1) TOP 5%. OUTSTANDING INDIVIDUALS. REQUIRE ONLY ABSENCE OF DISCOURAGEMENT. PROFESSIONALLY RATHER THAN COMPANY ORIENTED. UP-DATE THEMSELVES.

2) NEXT 10-15%. BALANCE TECHNICAL AND COMPANY COMMITMENT. MOST MANAGERS DRAWN FROM THIS GROUP. THESE MEN MUST SERVE AS "TRANSLATORS". PRIME PROSPECTS FOR DIRECTED CONTINUING EDUCATION.

3) NEXT 30%. COMPETENT ENGINEERS, LITTLE FORMATTED WORK. CAN GAIN FROM SOME CONTINUING EDUCATION, BUT MOSTLY FROM TRAINING.

4) NEXT 30%. PERFORM MOSTLY FORMATTED TASKS. LIMITED UP-DATING BY TRAINING IF POSSIBLE.

5) LOWEST 30%. PERFORM BASICALLY SUB-PROFESSIONAL AND HIGHLY FORMATTED TASKS. PRACTICALLY NO HOPE FOR UP-DATING EXCEPT ON VERY LIMITED AND LOCAL SCALE.

ant conflict in terms of continuing engineering education: the same men who would gain from technical education are also the men management needs most. There is a shortage of competent management personnel and management has the trump card: higher salaries are paid to managers than to technical specialists. Unless an organization learns to reward excellent technical performance as well as excellent managerial performance (and no company has done so in spite of many protestations to the contrary), men will move into management and will not tend to continue to develop technically.

This second group contains the men that are being reached with current continuing education programs. We may even reach a few from the third group which carries out most of the actual technical work. Competent, but uninspired and uninspiring, they generally still rise above formatted tasks. Yet many of them would be much more interested in training courses than in the fare that is currently being offered.

The next 30% in the fourth group can only be reached by training programs. Their work is almost entirely formatted and their aspirations are not very high. They will require specific and strong pressures to up-date themselves and to subject themselves to new challenges, even if these are carefully disguised in skill training programs. Finally we come to the lowest 30%. Although they may be called engineers, they are effectively subprofessionals and I can see little hope of reaching them with any program.

What Can the Company do to Make Continuing Education More Attractive.

It is difficult to list all the ways in which continuing education can be made more attractive by the employer, even assuming that the company is committed to the value of further studies. Rather I would like to show you some of the pitfalls that should be avoided.

Table XVI lists a litany of objections our respondents have raised against taking courses. Most of these objections apply to courses offered away

TABLE XVI

SIGNIFICANT OBSTACLES TO TAKING COURSES

(Multiple Answers Permitted)

| | |
|---|---|
| Not offered nearby | 30.8% |
| Too much time away from family | 33.9% |
| Too much work or irregular hours | 27.3% |
| Too much travel on job | 15.7% |
| Company not really interested | 6.8% |
| Financial burden too high | 7.6% |
| Right course not available or insufficient return | 21.6% |
| Poor instruction | 10.1% |
| Other reasons | 3.4% |
| No real obstacles | 18.4% |

from the company and after hours and again suggest that in-house courses have a greater future. But the list also indicates that all too often the company does not try to take the individual's commitment to his course work seriously enough to make amends in overtime and travel scheduling.

Not only must top management be strongly in favor of continuing studies, but this attitude must filter down the line. Table XVII reviews the answers received on the company's attitude towards in-house courses, an area where high encouragement should have been taken for granted. Yet only 75% of the respondents believe that the company truly encourages its own programs and 5% don't even know what their company's attitude is.

Roughly the same percentages apply to the second question: the company's attitude towards enrollment for advanced degree work (here the "don't knows" have been subtracted out). As a whole, respondents felt that their company attitude was favorable.

This should be compared to the final entry: "How does your immediate supervisor feel about further job-directed education or training?". Here the truly meaningful answers come to the foreground; whatever the overall company's attitude might be, it's the immediate supervisor that counts. If the boss doesn't encourage a man, he will not take any further course work. In this connection, even the reply "somewhat encouraging" is little more than neutrality.

There are other adverse factors that have a bearing on continuing education as suggested on Table XVIII.

A relatively high average age will reduce participation in continuing education programs. This has been the case for the Research Organization and the consulting firms.

Heavy time demands coupled with low intellectual demands point to a lost cause as far as further education is concerned. These, together with spending a high percentage of time on non-engineering tasks (many of which are

TABLE XVII

COMPANY AND SUPERVISOR'S ATTITUDE TOWARDS FURTHER EDUCATION

(Engineers Only - Sample, 1146 - Answers in Percentages)

| | Aero-Space | Capital Goods | Research Org. | Consult-ants | Consumer Goods | Overall |
|---|---|---|---|---|---|---|
| Company Attitude Towards In-House Training Courses: | | | | | | |
| Encourages | 78.3 | 74.0 | 61.0 | 67.5 | 95.0 | 75.8 |
| Non-Committal | 18.4 | 19.3 | 25.2 | 21.4 | 2.8 | 17.9 |
| Discourages | 0.9 | 1.7 | 3.3 | 1.6 | 0 | 1.3 |
| Don't Know | 2.4 | 5.0 | 10.5 | 9.5 | 2.2 | 5.0 |
| Company Attitude Towards Enrollment for Advanced Work: | | | | | | |
| Encourages | 80.2 | 81.3 | 52.1 | 62.0 | 89.4 | 75.4 |
| Non-Committal | 19.4 | 17.4 | 47.0 | 37.4 | 10.6 | 24.0 |
| Discourages | 0.4 | 1.3 | 0.9 | 0.6 | 0 | 0.6 |
| Immediate Supervisor's Attitude Towards Further Job-Directed Education or Training: | | | | | | |
| Very Encouraging | 15.2 | 21.1 | 3.2 | 9.1 | 28.5 | 15.7 |
| Somewhat Encouraging | 48.0 | 51.4 | 38.6 | 41.7 | 54.6 | 47.2 |
| Not Encouraging At All | 36.8 | 27.5 | 58.2 | 49.2 | 16.9 | 37.1 |

TABLE XVIII

FACTORS AFFECTING CONTINUING EDUCATION ADVERSELY

(Engineers Only, Sample = 1146)

| | Aero-Space | Capital Goods | Research Org. | Consult-ants | Consumer Goods | Overall |
|---|---|---|---|---|---|---|
| Mean Age (years) | 38.5 | 36.4 | 43.4 | 44.2 | 38.4 | 39.6 |
| Time Demands on Job (quite heavy and extremely heavy) | 50.2% | 48.1% | 43.8% | 62.8% | 56.1% | 50.7% |
| Intellectual Demands (slightly light-extremely light) | 31.3% | 32.4% | 30.5% | 30.5% | 27.5% | 30.9% |
| More than 30% of Time Spent on Non-Engineering Tasks | 42.0% | 54.8% | 43.4% | 30.9% | 58.8% | 42.2% |
| Denied Promotion Because "Too Valuable" on Job | 18.8% | 16.6% | 13.0% | 29.9% | 11.3% | 18.7% |
| Attendance of University Courses ONLY After Hours (% of total answers) | 61.7% | 43.7% | 37.3% | 93.3% | 77.2% | 62.3% |

highly formatted) rule out between one-third and one-half of the engineering work force from any engineering related continuing education work unless it is both training oriented and attendance is near-compulsory. Incidentally, more than two-thirds of our respondents replied that the large amount of time devoted to non-engineering tasks, shown on Table XVIII, was justified and only an excess of clerical work drew a heavy adverse response.

A man who believes he has been denied promotion because he is too valuable on his current job will do little to make himself more valuable in that same job. Rather he will seek other outlets for his frustrations.

In terms of the commitment of the colleges towards continuing education, the last item is perhaps the most telling one. Many companies are unwilling to co-invest in their engineers by permitting them to take university courses during working hours and often they do not even underwrite tuition costs. Most engineers are very sensitive about their personal investment in time and effort with regard to additional course work (even if it is on company time). They believe that the company will gain as much from the results as they do themselves. Yet the company is rarely willing to share this risk beyond the grudging payment of tuition. This attitude may be one of the reasons for the popularity of short college workshops: Here the company always pays and they are likely to be on company time.

The problem of released time for university courses is one that college administrators will have to face squarely. Only if enough companies can be induced to grant released time will the college influence on continuing education change for the better.

Summary

Let me summarize the results of our study in terms of some specific suggestions:

(1) Most engineers are not interested in continuing education; they are interested in learning how to do their current job better. They will respond to training rather than to education and they will demand an almost immediate pay-off in terms of recognition or salary. Successful courses will have to be structured with this in mind.

(2) The contribution of most engineers to their company may have little to do with their expertise in engineering. The engineering work tends to be formatted and variety is frequently provided only by the non-engineering aspects of the job. Furthermore, most men, especially as they grow older, do not look for additional intellectual challenges. They would rather be busy than seek more demanding work; for most men time challenges tend to supplant intellectual challenges. Continuing education courses should recognize this by focusing on doing the job faster and easier rather than by promising how to do a better job.

(3) Real technical competence is rarely demanded; adequacy rather than excellence is the expected norm. It is only when adequacy falls behind that continuing education has a ready entree. This will be the case when major technological changes suddenly come to the foreground, such as the introduction of the computer into engineering, with the advent of nuclear power in the utility field or with the development of critical path scheduling by major system suppliers. Part of your market analysis should include the timely identification of, and action on, such potential technological growth areas.

(4) Even though corporate management may have expressed a real interest in continuing education, it is the immediate supervisor that counts. Unless he is willing to encourage and accommodate his men in spite of the possible interference with his work schedule, few men will undertake continuing studies. Both lower and corporate management must become fully convinced that you have something worthwhile to sell.

(5) Continuing education planning has frequently been a haphazard effort by enterprising colleges, companies and professional societies. Further development will require a closer relationship between industry and the colleges and all parties should cooperate in the market research that will be needed for a persistent regional effort.

(6) Finally, I would like to leave you with a somewhat utopian plea: to work for the establishment of a better intellectual climate in many of our corporations. Frequently, the atmosphere appears to be almost anti-intellectual. Often it is almost impossible for an engineer to sit quietly at his desk and read in order to learn. Instead, he is expected to look busy by "doing something." Many bitter comments from our questionnaire show how often activity is equated with achievement. In the long run, the success of continuing education may depend as much on the climate it can induce as on what is actually being taught.

Acknowledgment

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