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A motivational approach to recruitment.

Roland A. Mischke received his undergraduate degree from Pratt Institute (B.Ch.E. '50) and worked for six years as a design engineer with Chemical Construction Corporation before returning to graduate school. Following the completion of his graduate studies (Ph.D. Northwestern '61) he entered the teaching profession. He is currently in his ninth year at Virginia Polytechnic Institute and State University, where he has been involved in the teaching and direction of research in the fields of reaction kinetics, fluid dynamics, thermodynamics and heat transfer. In addition to his teaching responsibilities in the Chemical Engineering Department, he is also Educational Technology Coordinator for the College of Engineering.

The past few years seem to indicate that engineering as a profession is losing favor with the younger generation. Even though the anticipated needs of society for engineers continues to increase, engineering enrollments are falling. This decline then results in a more intense competition for students among the various disciplines. The situation at Virginia Polytechnic Institute may not be typical, but Figure 1 shows what is happening there. This figure shows the percentage of engineering students who elected the various major disciplines for the past ten years. Our students formally elect their curriculum at the end of the freshman year, and these figures reflect only those students who elect to remain in engineering. Since the total number of students has remained remarkably stable (between 550 and 650 students) over this time period (even though the total university enrollment has gone from 5,000 students to 12,000 students), the percentage figures are very nearly representative of actual student enrollments.

The variations in enrollment from year to year are quite erratic, but some trends are evident. If we apply some smoothing to the data in Figure 1, we obtain the trend lines shown in Figure 2. The aerospace field trends follow the emphasis and de-emphasis of government programs. The recent upswing in civil engineering can be attributed to the fact that the environmental courses at VPI are offered by a sub-discipline of civil engineering. The rise in electrical engineering enrollment is probably related to the continued and increasing emphasis on electronics, digital computers, and control systems. However, the variation in chemical engineering enrollment is both unexpected and disturbing. After all, chemical engineers are eminently qualified for work in the control and environmental areas, if they are so inclined. The root of the problem of declining enrollments must lie in our failure to make students aware of this situation before they choose their curriculum. This is the situation to which we turned our attention earlier this year.

AN APPROACH TO THE PROBLEM

Engineers are problem solvers—that is what they are trained to do. Therefore, as engineers we attempted to apply some of this engineering know-how to the analysis and solution of this enrollment problem.

The traditional approach to engineering problem solving involves: (1) definition of the problem, (2) determination of alternate approaches to a solution, (3) detailed analysis of each approach to yield a number of possible solutions, (4) choice of the best solution, and (5) implementation of the chosen solution. More modern systems approaches would include the evaluation of the implemented solution, together with feedback and revision stages.

The intent of this paper is not to consider a complete solution to the problem, but to concentrate on the problem definition and one solution approach.

Definition of the Problem. As we saw it, the drop in chemical engineering enrollment was a symptom of our failure as chemical engineers to be effective evangelists. We had failed to interest

others in the broad field of chemical engineering. To start a campaign to beat the bushes with a high pressure enlistment program would only introduce a new set of problems if people not

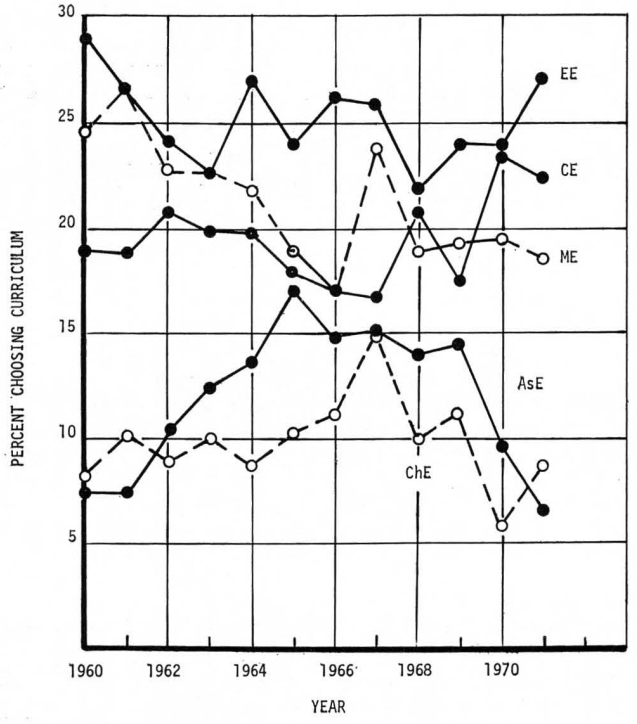

Figure 1.—Curriculum Enrollments at VPI 1960-1971.

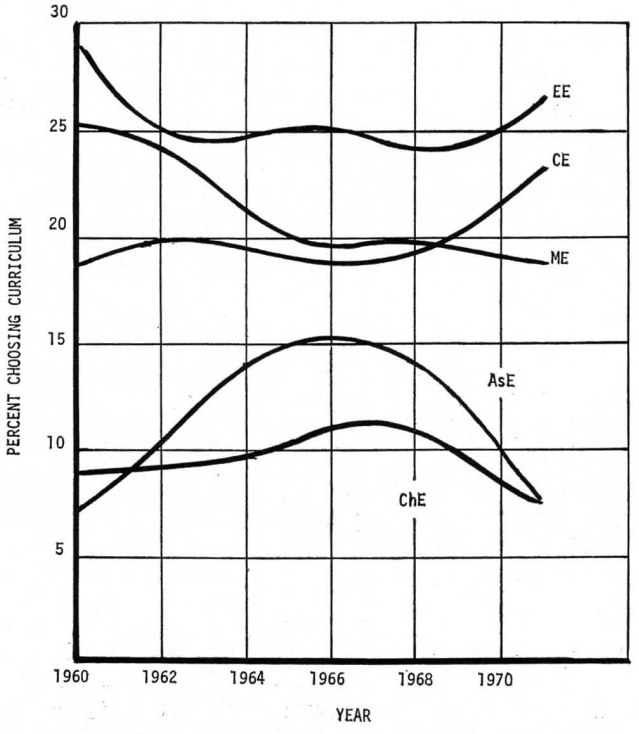

Figure 2.—Enrollment Trends at VPI 1960-1971.

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really interested in the field were lured into it. We wanted to plan a better job of selling than we are now doing, but not to the point of pressuring students into the program. Our problem statement then takes the form:

> **Develop programs for disseminating information about chemical engineering at the high school, junior college and university levels, so that all capable and potentially interested students are aware of the opportunities and challenges of the profession.**

With a problem formulation completed, we were in a position to generate approaches to the solution of the problem. In what follows I have chosen only one approach, and I want to discuss the design background for that approach in some detail.

One Approach to a Solution. In our situation at VPI, we have the responsibility of presenting information about our curriculum to some 25 sections of engineering freshmen. It is not possible for one person to present the same program 25 times during a five or six week period and to make an enthusiastic presentation each and every time. Our approach, therefore, is to automate the heart of the presentation, and then put the person representing the department into the role of a person to answer any specific questions about chemical engineering or the chemical engineering curriculum.

This approach was chosen because it could be readily adapted for use in junior colleges around the state. We would envision sending the automated portion out first to be used as guidance material. Then, at a follow-up visit by a member of the chemical engineering department, specific questions from interested persons could be handled personally.

Therefore, our approach centers around the development of a tape-slide presentation to handle the automated part of the job.

DESIGNING A PRESENTATION

If we accept the fact that communications can be designed to persuade and to inform, then we must know something of the psychological principles we are using, just as in any engineering design we make use of our knowledge of the physical principles involved.

Modern youth are the children of prosperity. The ethic of hard work and education as being the key to a better life no longer seems to apply, as it did in our generation. In a society of affluence, emphasis on humanistic needs (both concerning the self and others) comes to the fore because the physical needs have been satisfied.

Incentives for Change. Attempts to understand what influences and motivates human behavior has occupied psychologists for many years. Unfortunately, no concrete prescriptions have been forthcoming. Numerous theories have been postulated, but substantiation of them seems quite tenuous at best. Most results have been obtained from the study of animals under very closely controlled conditions. Extrapolation to humans operating under very complicated conditions seems quite risky.

Fortunately, Birch and Veroff[1] have presented an organizational scheme which seems to coalesce most of the theories into one structural whole. They have defined seven incentive systems which operate simultaneously, and to varying degrees, in every person:

1. **Sensory Incentive** System—action is motivated as a result of sensory stimulation, i.e. taste, sight, hearing, smell, feeling.
2. **Curiosity Incentive System**—action is motivated by the desire of a person to recognize a change in the pattern of stimulation.
3. **Affiliation Incentive System**—action is motivated by an attraction to another person in order to feel reassured from the other person that the self is acceptable.
4. **Achievement Incentive System**—action is motivated by a desire to perform successfully in competition with standards of excellence or with other person's performance.
5. **Aggressive Incentive System**—action is motivated (usually in response to frustration) to intentionally injure another person; the greater the injury, the greater the incentive.
6. **Power Incentive System**—action is motivated by the desire of a person to control the forces that have power over him, i.e., to have influence on his environment.
7. **Independence Incentive System**—action is motivated by a desire to accomplish an activity without any help from others.

From this array of incentives, we can select three that seem to be the most pertinent in planning our work. The achievement motive (I did something I always wanted to do, so I am somebody), the affiliation motive (I am liked by my fellow human beings, therefore, I am somebody), and the power motive (I have control over people and events, therefore, I am somebody) seem to subsume the other motives. These three motives also work to create a feeling of self-worth in an individual, and seem to represent characteristics or drives which may be fulfilled to varying degrees within the realm of chemical engineering.

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Psychological Needs. The incentive system is important, but so are the particular needs of our audience. A presentation that neglects these needs will not be very effective. High school students and lower division college students cover a wide range of developmental status. Within this group we will probably find everything from middle adolescence to mature adult behavior represented. Probably the needs of most will be closely related to those of the senior high school student. Biehler[2] notes that the age-level characteristics of this group include:

Social Needs—
Dominated by peer group opinion and need to conform; concerned with opposite sex; trying to develop proper social role (masculine or feminine)

Emotional State—
In conflict with parents; striving for independence.

Mental State—
Trying to acquire a value system; trying to select and prepare for an occupation.

Not only are the actual needs important, but the relative strengths and priorities assigned to these needs have a bearing on how we structure our presentation. Maslow[3] has presented an ordering or hierarchy of needs in human beings. According to this theory, certain needs take precedence over others, and thus a hierarchy of needs is formed. Within this hierarchy, the lower level needs must be satisfied before the higher level needs have any significant effect on a person's actions. The hierarchy that Maslow presents is:

1. Aesthetic needs.
2. Desire to know and understand.
3. Need for self-actualization.
4. Esteem needs.
5. Love and belonging needs.
6. Safety needs.
7. Physiological needs.

It is interesting to note that the things which mean most to us as professionals (and therefore the ones we would tend to emphasize in any "selling" of our life-style) fall into the top three or four categories of this hierarchy. Note also that according to Maslow's theory, these points will be meaningless as motivators to persons who have not satisfied the lower level needs of security and belonging. From the listing of age-group

characteristics previously presented, we can see that the high school and lower level college students do not have this sense of security and belonging. This line of reasoning then leads us to a realization that many career guidance activities are of questionable benefit as motivating devices.

Altering Behavior. Motivation theories assume that people act and react only in response to an incentive-reward system, and that this reward or goal may be on any of the levels of the hierarchy noted above. However, the goal or reward must exist in order for action to occur. In addition, the action taken at any given time is determined by the strongest need at that moment. Information, as such, will not cause action. Although the receipt of new information may change the relative strengths of current needs (as when told that we have forgotten to do something) and activate a different incentive system, only as information is able to activate incentive systems will it cause a change in behavior.

If our goal is to influence the behavior of students so that they choose chemical engineering as their life work, then we must show them how that life-style will satisfy *the needs they have at the moment.* If we can do that, then we may proceed to consider the satisfaction of needs which appear further up in the hierarchy.

STRUCTURING A PRESENTATION

Now let's turn our attention to the implications of these motivational theories in what we are trying to do—to show how becoming a chemical engineer can meet a person's needs.

Establishing Communication. The first and most important characteristic of any effective presentation is that it communicate with the audience. One of the most effective ways of doing this is to establish a feeling of *empathy* with the audience—to reflect back to them the feelings that they have. Many of today's youth are concerned with the environment and with humanity. By showing how chemical engineers have solved problems within the social and economic contexts of earlier times, one can show how this limited outlook has created problems for today. Then if one can show a realization that today's youth have concerns about people and the environment, and sympathy with their position, the door is open to show how the chemical engineer is attacking these problems within today's socio-economic context, and why the chemical engineer is best fitted to

. . . relate success . . . to emphasis on affiliation, achievement, and power . . .

solve such problems. To use an overworked word, the topics then become *relevant* to the concerns of the audience.

Using Motivational Incentives. The success of any attempt to change behavior rests upon demonstrating the relevance of the new behavior to needs felt by the individual. Not all people have the same needs, so the presentation should appeal to several types of needs. We have previously noted that one of the overwhelming needs of youth is the need for acceptance in the social and peer group contexts. These needs are tied most closely with the affiliation motive (need for acceptance). Somewhat related to this need is the need for esteem by self and others, and daydreams or fantasies concerning later life. Quite appropriately these needs are closely related to the achievement motive (achieving self-worth by doing something in spite of obstacles). Some young people, particularly those who represent the minority groups, will see control of others as their big need. This is the power motive.

Effective use of such motivational schemes in a presentation requires us to show people receiving the rewards that these incentive systems imply while doing their jobs. This requirement is one of the basic rules of using modeling to cause a change in behavior. If you want to cause a change in behavior, then *you must show a person like a member of your audience receiving the rewards he wants to receive while doing the things you want him to do.* Television commercials are excellent examples of this approach. They depict what wonderful things happen to those people who use the sponsor's product. And they do it by showing people engaged in activities which constitute rewards for one of the incentive systems described.

The planning and use of such motivational schemes must also be keyed to the hierarchy of needs. Going back to the age-group characteristics, we see that a prime concern of youth has to do with security, love and belonging needs. Depiction of home and community life situations which reflect the engineer achieving these goals can be quite valuable because the self-actualization needs do not become important to a person until the lower needs in the hierarchy are satisfied. Such illustrations have much more impact than the pre-

(Continued on page 140.)

Clapeyron equation for multicomponent systems. Classical and lengthy derivations of Clapeyron equation for a binary system in reference 1. This type of derivation was recently extended to a multicomponent system (ref. 2).

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BOOK REVIEW (from p. 131)

earlier, and some of the choices come down to questions of personal taste. However, it seems to me that the author missed at least one good opportunity to reinforce his earlier discussions of polymer synthesis by failing to point out some of the well established connections between flow properties and molecular structure.

In summary, the book gives a good general survey of polymer science. The omissions can be handled by supplementary lectures and outside reading. It should make a very suitable textbook for introductory courses.

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MISCHKE (from p. 117)

sentation of salary statistics or results of surveys which conclude that chemical engineers have happier marriages than other professions.

Emphasis of Presentation. One last point to remember is that our main function is one of guidance rather than that of strong persuasion. Our job is not to get as many people enrolled in chemical engineering as possible, but to attract those to whom chemical engineering will be inherently satisfying. Therefore, we should emphasize the choice of a career over the choice of a discipline. The flexibility and breadth of application and use of chemical engineers in a wide variety of industries—not just the chemical process industries—should be stressed, as well as how other branches of engineering can be served by chemical engineers.

Sources of Information. Some of the most meaningful data that we can present about chemical engineering is our own testimony of what we know about chemical engineering and what chemical engineering means to us. In doing this we should remember that such feelings probably will not be motivating to the audience until the basic needs have been shown to be satisfied. The AIChE publishes an excellent career guidance booklet[4] which contains information on programs for primary schools, secondary schools, junior colleges, and universities. The booklet also contains current statistical data on job opportunities, salary levels, etc., which are needed to answer questions. Incidently, a study of the list of typical questions included in the publication gives insight into the concerns and feelings of students.

SUMMARY

The problem of declining enrollments in chemical engineering is symptomatic of poor effectiveness in the career guidance work now being carried on by chemical engineers.

A number of factors operate during career guidance presentations. If these factors are considered, a presentation's effectiveness can be enhanced. If they are neglected during the design of the presentation, its effectiveness can be severely reduced. These factors include:

- The psychological needs of the audience are very different from those of the speaker.
- Motivational incentives are different for various members of a given group.
- The needs of security and belonging take precedence over the need for success.

Improved presentations may be obtained if:

- Presentations are designed as carefully as the other things which engineers design.
- Current knowledge of motivational systems and student needs is used in the design.
- The hierarchical structure of need fulfillment is recognized and made a part of the design.
- The presentation is made relevant to the current needs of the audience. □

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