THE CHEMICAL ENGINEERING PROFESSION AND COOPERATIVE EDUCATION

W. H. TUCKER
Tri-State College
Angola, Ind. 46703

COOPERATIVE EDUCATION, STARTING with the program at the University of Cincinnati in 1906, had a linear growth in the United States during its first 40 years. Recently, the expansion rate has become more nearly exponential. For example, the number of United States educational institutions offering the co-op program has increased from 55 to 369 from 1963 to 1973. While part of this growth has resulted from activity in the two-year colleges, it is nevertheless a fact that cooperative education is meeting the present need for relevance in education. Students are more than ever wanting to relate their academic training to life in the real world. In chemical engineering, 55 institutions out of United States total of 110 now offer cooperative education—mostly on an optional basis. [1, 2] From these references, we can estimate that over 15% of United States chemical engineering students are pursuing cooperative education, usually with five years to the B.S. degree. A parallel growth in engineering co-op education has occurred in Canada, and in Britain, the growth has been dramatic.

Reference 1 gives a definition of the cooperative program as follows:

Cooperative education may be defined as the integration of classroom theory with practical experience under which students have specific periods of attendance at the college and specific periods of employment.

The following factors should be adhered to as closely as possible:

• Where possible, the student's work should be closely related to his field of study and individual interest within the field.

• The employment must be considered to be a regular, continuing and essential element in the educational process, and some minimum amount of employment and minimum standard of performance must be included in the requirement for the degree or certificate presented by the school.

• The working experience will ideally increase in difficulty and responsibility as the student progresses through the academic curriculum and, in general, shall closely parallel his progress through the academic phases.

OPERATING THE CO-OP PLAN

WHILE THERE IS CONSIDERABLE diversity in the scheduling of work periods in industry, a typical plan would be to place the student in industry at the end of his freshman year after he has established an academic record. Over the next four years, the student would be on some alternating schedule that would give him in the neighborhood of 20 months of industrial work in his B.S. program. The scheduling will vary between semester and quarter arrangements in the colleges. A given company will thus be faced with a confusing array of student schedules. Formerly, this was a serious matter when co-op students had to be considered as pairs, each pair filling a given job on a continuous basis. The recent trend has been toward giving each student a unique experience with an emphasis on project work. Thus, there is less routine work except where it is desirable in the student's development. Companies tend now to employ students as singles, whatever their schedules.

Most students come to a college-based program, where the college places a student in a situation in which neither he nor the company is

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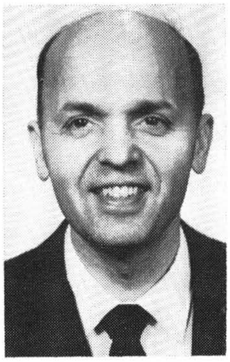

W. Henry Tucker received the B.S. degree from the University of Virginia, and the S.M. and Sc.D. from M.I.T. '47. He has had industrial experience with several companies and was in charge of the chemical engineering cooperative education program while he was on the faculty at Purdue University. In 1969 he received the AIChE Winston Churchill Travelling Fellowship, which included a study of the cooperative education program in Britain. He presently is in charge of the Chemical Engineering Curriculum at Tri-State College, Angola, Indiana, and has absorption refrigeration as his primary engineering interest.

obligated as far as permanent employment is concerned. The industry-based program, in which the company selects one of its employees for a co-op program, is sometimes found. A hybrid arrangement is helpful in this period of declining engineering enrollments. A given company can take the initiative to recruit students in high school for a college-based program, providing that their freshman year in college is academically good. One can also emphasize minority groups who can be encouraged by the co-op idea.

Colleges differ in the matter of placing a student with one company for all of the work periods or with diversified employers. There are advantages for each arrangement in the breadth-depth plane of experience. A single company can certainly provide more responsibility in the latter work periods. It is probably a safe generalization to conclude that a large company, say one with more than 25 engineers, can provide the needed variety for a given student. If a company is small, the student should work with more than one during his program for a comparable variety. Sometimes, a company will shift a student to several locations to give the needed experiences.

As to salary, a co-op student in engineering would be expected to earn in the neighborhood of $12,000 in 20 months of experience. Financially, though, it might be more attractive to graduate in four years on a regular program and have a year of higher salary. The co-op, however, does minimize his debts while in college. But salary alone will not justify the program; the co-op student must have a desire for engineering experience while in college to the same degree as his desire for money.

This article continually refers to co-op employment by companies. It should be pointed out here that the Federal Government is a recent strong entry into the field, though state and local governments are slow to follow suit. The Federal scene is described in a recent article [3].

THREE-WAY CO-OP COORDINATION

THE COORDINATION which must take place between the student, the college coordinator and the company contact official is the key factor in the successful operation of any program. It is still too often the case that academics or employers take the program casually, assuming that the creation of a job is all that is necessary for some osmotic process to take place which will enrich the student's academic experience. It turns out that the co-op program must be *managed*. If a college coordinator does his job properly, his activities are surprisingly complex. Charles Seaverns has developed a meaningful list of 14 functions to be fulfilled by the college coordinator [4], making him a "placement specialist, vocational counselor, salesman, teacher, administrator, educational recruiter, trouble-shooter, mediator, and referral agent."

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The recent *Handbook of Cooperative Education* [5] amplifies many areas in the academic area of coordination. Except in company files, there is a distinct lack of material available to speak to the coordination problems faced by the industrial people where the real action is. To help fill this gap, the author has prepared the publication, *Effective Supervision of Engineering Cooperative Education Programs* [6]. The "company contact official" is the key man in the company organization. He must keep in contact with the student and with his progress by also working through the student's immediate supervisor.

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Dr. J. W. Morris has commented on his organization at a DuPont plant [7]. He describes a high-level Co-op Advisory Committee to set co-op policy. He also mentions the success he has had with extra curricula supervision of co-op students by a young employee who himself had earlier been a co-op student employee. Companies in general find it difficult to sustain effective coordination of a co-op program, since it is likely that the contact officer will spend only a couple of years, enroute to other personnel assignments. The college coordinator finds more permanence in his job.

On the industrial scene, the company contact official will certainly be concerned with three areas: orientation, actual work experience, and evaluation. Proper **orientation** should be spread over all of the work periods rather than to be limited to the first day of the initial work period. Orientation does not just cover the physical plant, but also the organization, procedures and policies of the organization. For an effective **work experience,** the projects to be handled by the co-op student should be pre-planned. The college coordinator is interested in the educational objectives of the work, while the company wants to select experiences which are reasonable within the time frame and the ability of the student. Many companies do not pre-plan, but engage in a flurry of activity when the student shows up for work. Finally, the **evaluation** of the student's work is many times poorly done if one is to accept the heavy student criticism of his evaluation. The company contact officer and the student's supervisors should get together with the student with detailed and meaningful comments on his performance. A summary of this evaluation is then passed on to the college coordinator. One aspect of the evaluation step is to begin the pre-planning for the next work period.

The college coordinator must visit the student and his supervisors for effective coordination. Unfortunately, usually limited travel budgets allow visits only once in two years or more, and this is inadequate. The background of the college coordinator is important, too. In the United States, one usually finds a coordination staff which is completely removed from the college engineering departments. A few colleges use chemical engineering faculty as coordinators for chemical engineers; Purdue University is such an example. But, for the most part, college coordination has developed its own administrative organization. The British represent the opposite extreme. Coordination there is managed by the chemical engineering department chairman. He selects a coordinator in his department, and the visitations are handled by the entire departmental faculty with usually two visits to the student site each work period.

The company contact official should find occasion to visit the college campus. Purdue University has Co-op Days each spring, at which time, company people come in to select their students. Also, the company contact officer might be a member of a policy committee at the college. Professor J. G. Wohlford has described the Co-op Advisory Council in operation at Georgia Tech [6].

CO-OP ORGANIZATIONS

SEVERAL ORGANIZATIONS are presently looking out for the welfare of cooperative education:

- The Cooperative Education Association is the umbrella organization for all of cooperative education [8]. It publishes the *Journal of Cooperative Education.* It encourages regional training centers for developing new coordinators.
- The ASEE maintains the Cooperative Education Division, which is specifically concerned with engineering programs [9].
- A policy organization concerned with establishing new programs and obtaining Federal assistance is the National Commission for Cooperative Education [10]. Federal financial assistance to new or developing programs is available through the 1968 amendments to the Higher Education Act of 1965. Yearly assistance of about two million dollars is presently granted.

ACCREDITATION OF PROGRAMS

Currently, there is a cooperative effort between the Cooperative Education Division, ASEE, and the Engineering Council for Professional Development (ECPD) to develop criteria for the accreditation of engineering and engineering technology co-op programs. A summary of these criteria is given by Professor J. G. Wohlford [11]. Accreditation of co-op programs seems a certainty.

NOT UNRELATED to accreditation of programs by ECPD is the granting of academic credit for work experiences, except that this is an internal matter in each college. Many college faculty members are extremely reluctant to allow credit to be granted for work done entirely away from campus. Nevertheless, the granting of academic credit is growing; and thus, the academic community is asserting that a work experience can have academic value. John H. Sherrill indicates that, as of 1971, about 46% of the co-op programs were granting credit [12] as compared with 21% in 1969. Additional institutions grant meaningless credit; credit that cannot be used to substitute for other courses in the curriculum. The few institutions that require the co-op program for all engineering students do not need to grant credit. There is an extreme variation of amount of credit given and the criteria used to decide on the academic value of the work experience. Tri-State College grants four credits but only after the completion of several effective work periods. In one case, credit was given back at the university for a series of seminars in which the students and the coordinator took up topics of relevance to the program [13].

The trend is for more graduate programs with the co-op flavor. Some of these are summarized in reference [5], page 70. One can imagine that particularly in an urban environment, there can be a great variety of programs, as a student splits his day between work and classroom. It is necessary to judge the relevance of the work experience to determine whether it is truly a cooperative education program. One specific experiment involving the major professor in the industrial program along with the students has been reported [14]. The experiences of a student in a graduate level co-op program are described in a recent article by King [15]. His Ph.D. program was an extension of his B.S. experience at the same company.

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DEVELOPING BROADER PROFESSIONALISM

The excellent co-op programs in Britain and Canada suggest the idea of exchange programs. These could be arranged through college coordinators but the extra effort and paper work are considerable. A United States company can arrange for a co-op student to spend his last work period in any part of the world at considerable advantage to the company and to the student (the use of a foreign language in a working community). The occasions in which exchanges have been tried have not been publicized in the co-op literature.

A different kind of international emphasis is possible—that of students from the developing countries coming to the United States for their work experience, as well as for their college education. The American company would be willing to invest in a foreign student program when the student would indicate his intention to return home and work as a permanent employee of the American affiliate [6].

There are many lost opportunities to develop the student professionally while he is on the job. He could be made more aware of the ethics of his profession as well as the social and political implications of engineering. As a first step, one could involve him in the program and committee activities of the Local Section of AIChE. In the book, *"The Student in Society"* [16], two emphases are found: the student is shown how to settle into a new community with the minimum of hardship, and he is encouraged to use the community as a learning laboratory to develop sociological and political concepts.

SUMMARY COMMENTS

This article is an appeal for the chemical engineering profession to take a greater interest in the co-op movement, to give the student a more professional experience. The AIChE Educational Projects Committee sponsored a cooperative education symposium at the February, 1972 Dallas meeting. Subsequently, it encouraged the preparation of the manual on co-op supervision [6], but the talking is all being done by the academic people. AIChE industrialists related to co-op supervision should organize to discuss ways in which the co-op experience could be an involvement in professionalism so that the latent possibilities of the program could be realized with a larger percentage of the students. At any rate, the fact that 15% of our students are on this program should alert our profession to provide for its special needs. □

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ChE book reviews

Process Synthesis, D. F. Rudd, G. J. Powers, and J. Siirola, Prentice-Hall, Inc., (1973), 320 pp.

Reviewed by
C. M. Thatcher, University of Arkansas

A good textbook must effectively serve a worthwhile objective; and, even then, publication is fully justified only if either the objective itself or the treatment thereof is sufficiently unique. By these standards, Rudd, Powers, and Siirola have written a text which is not merely good, but excellent.

The authors' stated objective is to approach process development via a careful interlacing of synthesis and analysis, and "to present the material in a coherent and attractive form suitable for the students' first exposure to an engineering course". The fact that the presentation reflects the results of recent research in process synthesis makes this objective as timely as it is worthwhile.

As for uniqueness, the distinction between "design" and "synthesis" is subtle, but it is fully and effectively exploited in this text. The major concern is with those qualitative decisions which precede detailed design calculations. Process design texts, in contrast, commonly emphasize the latter and may not even mention the many prior decisions which underlie the "given" information which they present as a starting point for quantitative calculations.

The detailed and well-organized attention given the criteria for selecting a particular process scheme from among a number of possible alternatives is equally unique. Process design texts may consider various alternatives for a specific case at hand; but Rudd, et al, identify with commendable thoroughness and clarity those *general* criteria which are applicable to *all* such cases.

The major thrust of the book is embodied in separate chapters devoted to Reaction-Path Synthesis, Material Balancing and Species Allocation, Separation Technology, Separation Task Selection, and Task Integration (energy considerations, primarily). Each of these chapters develops an appropriate strategy for identifying those processing schemes which are likely to be feasible and then making a specific selection from among the several prospective alternatives.

An introductory, overall view provides some historical prospective and sets the stage for the successive consideration of the foregoing topics. The two final chapters then examine two specific applications in detail: fresh water by freezing, and detergents from petroleum.

Does the book effectively serve the authors' objective? As far as scope, thoroughness, organi-