number of diverse subjects. Although a great deal of interesting material was presented, the goal of an overall perspective was never fully reached.

Much of the course dealt with the waste products of an industrial city and the technology available to remove them. Mr. Walker had to deliver his lectures to a class with backgrounds ranging from a little high school chemistry to a major in science; he handled this problem remarkably well. The lectures were generally informative and frequently very interesting, particularly when he included anecdotes from his personal experience. However, several classes weekly would have been more appropriate than the single two-hour class session.

The readings were a source of added information but did not play a major role in the course. Of greater importance was the gathering of data on inputs and outputs of the city. Small groups were responsible for each area. Toward the end of the term, each group assembled a flow sheet of the data. This was the goal of the course, but its importance seems to have been lost along the way. Ultimately, therefore, the term paper represented most of the work in the course. It gave an opportunity to look deeply at one specific area of a city and its material problems. Despite a knowledgeable and interesting lecturer and an important subject, the course never really pulled the loose ends together.

. . . the most starry-eyed environmentalists begin to recognize the magnitude of the efforts required for significant improvements in the quality of urban environments.

It seems clear that creating the flow sheet at the start would have given the class the needed perspective. This would have provided a much better context in which to judge the different economic and technological alternatives open to a city. The course was an ambitious experiment that met with some success. With better structuring and more rigor, it could be outstanding.

Several of the suggestions made by the students were adopted when the course was offered for the second time.

Further details on data and calculations are available from the author.

ACKNOWLEDGMENT

The flowsheet shown here was developed by two graduate students, John Pestle of Yale and Laurence Walker of M.I.T., during the summer of 1971 after some additional information became available. It is quite similar to the flowsheet developed by undergraduates in the fall term of 1970. □

ChE book reviews

Polymer Science and Engineering, D. J. Williams, Prentice-Hall, Englewood Cliffs, N.J. (1972), 401 pp.

One of the peculiar difficulties in writing an introductory textbook on polymers is the diversity of subjects to be covered, each built upon distinctly separate fields of science. Thus, the subject of polymerization has its roots in the reactions and structural analysis of organic chemistry, solution behavior in regular solution theory, rubber elasticity theory in statistical mechanics, polymer morphology and properties in the techniques of solid state physics and rheology in continuum mechanics. Scattered throughout are various applications of probability theory, and superimposed is the need to relate these principles to the practical properties of polymer systems. No single undergraduate curriculum does justice to more than a fraction of these fields. If a book of reasonable length is to be aimed at both chemical engineers and materials scientists, it becomes necessary to compromise, either by including brief introductions to the fields and showing how they apply to polymers, or by leaving out some subjects entirely and concentrating on the relationships between those aspects which are retained. In the former there tends to be oversimplification and a loss of coherence among the parts; in the latter the result is less than a comprehensive coverage.

Dr. Williams has chosen to follow the second course, and has done so rather successfully. The book is intended for seniors and beginning graduate students in chemistry, chemical engineering and materials science. It opens with an extended

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Nomenclature.

C^{I}, C^{II}, C^{III}	general first-, second-, and third-type dimensionless Eulerian spatial correlation parameters, defined in Table 1.
${}^{M}C$, ${}^{m}C$, ${}^{T}C$	special cases of the corresponding C^{I}, C^{II}, C^{III} parameters for momentum, mass and heat transfer.
C_p	isobaric heat capacity (assumed constant throughout).
D_{XY}	Molecular mass diffusivity of X in binary mixture of X and Y (assumed constant throughout).
$f = f(\underline{r}, t)$	scalar function replacing ${}^{M}\underline{\underline{C}}^{II}$ in isotropic turbulence.
$F = \bar{\bar{F}} + F'$	rate of generation of general property per unit surface area in fluid.
$\underline{g}$	gravity acceleration (assumed to be only body force).
$G = \bar{\bar{G}} + G'$	rate of bulk generation of general property per unit volume of fluid.
$h = h(\underline{r}, t)$	scalar function replacing ${}^{M}\underline{\underline{\underline{C}}}^{III}$ in isotropic turbulence.
$\underline{j}_X = \bar{\bar{\underline{j}}}_X + \underline{j}'_X$	molecular mass flux of component X relative to mass-average velocity.
k_1^*	first-order homogeneous chemical reaction rate constant (assumed to be a true constant).
M	kinematic molecular transport property for general property of system.
$p = \bar{\bar{p}} + p'$	static pressure.
$P = \bar{\bar{P}} + P'$	quantity of general property per unit volume of system.
$\underline{q} = \bar{\bar{\underline{q}}} + \underline{q}'$	conduction heat flux, relative to mass-average velocity.
$q_m = q_m(\underline{r}, t)$, $q_T = q_T(\underline{r}, t)$	scalar functions replacing ${}^{m}C^{II}$ and ${}^{T}C^{II}$, respectively, in isotropic turbulence.
r	scalar radial distance in isotropic turbulence.
$\underline{r} = \delta_i + \delta_j + \delta_k$	vector distance between points at which correlation is determined.
t	time.
T	temperature.
$\underline{v}$, v_j	velocity vector and its components
$w_m = w_m(\underline{r}, t)$, $w_T = w_T(\underline{r}, t)$	scalar functions replacing ${}^{m}\underline{C}^{III}$ and ${}^{T}\underline{C}^{III}$, respectively, in isotropic turbulence.
$\underline{x}$, x_j	Cartesian coordinates.
α	thermal diffusivity (assumed constant throughout).
$\delta_i = x_{iA} - x_{iB}$	x_i-component of distance between points A, B at which correlation is determined.
μ	dynamic viscosity.
ν	kinematic viscosity (assumed constant throughout).
$\pi = \bar{\bar{\pi}} + \pi'$	molecular flux of general intensive property.
ρ	density of fluid (assumed constant throughout).
ρ_X	mass concentration of component X.
$\underline{\underline{\tau}} = \bar{\bar{\underline{\underline{\tau}}}} + \underline{\underline{\tau}}'$	molecular momentum flux (or shear stress) relative to mass-average velocity of fluid.

Subscripts.

A, B	quantities measured at points A, B, distant $\underline{r}$ apart, at same instant in time.
i, j, k	in directions of x_i, x_j, x_k axes.
X, Y	components X, Y of binary mixture.
Q, $\underline{Q}$, $\underline{\underline{Q}}$, $\underline{\underline{\underline{Q}}}$	scalar, vector, tensor (2nd-order tensor), and third-order tensor quantities Q.

Superscripts.

Q'	fluctuating part of Q.
Q''	r.m.s. value of fluctuating part of Q
$\bar{\bar{Q}}$	time-averaged part of Q.
M, m, T	momentum, mass, heat transfer quantity, respectively.

property is a scalar, leading to slightly different forms of the main equation. The appearance of chemical reaction term in the mass transfer case is also of interest. It can also be seen that the generalized equation will make it relatively simple to obtain equations for the dynamic behavior under the conditions considered here of other turbulently pulsating conserved quantities, such as electric charge per unit volume, which may become important in the study of turbulent plasmas. □

REFERENCES

1. G. D. Fulford and D. C. T. Pei, A unified approach to the study of transfer processes, Ind. & Eng. Chem., 61(5), 47-69 (May, 1969).
2. J. O. Hinze, *Turbulence*, McGraw-Hill, New York, 1959.
3. G. K. Batchelor, *The Theory of Homogeneous Turbulence*, Cambridge Univ. Press, 1956.
4. R. S. Brodkey, *The Phenomena of Fluid Motions*, Addison-Wesley, Reading, Mass., 1967.
5. R. B. Bird, W. E. Stewart and E. N. Lightfoot, *Transport Phenomena*, Wiley, New York, 1960.
6. T. von Kármán and L. Howarth, On the statistical theory of isotropic turbulence, Proc. Roy. Soc. (London), A164, 192-215 (1938).
7. S. Corrsin, The decay of turbulent isotropic temperature fluctuations in an isotropic turbulence, J. Aero. Sci., 18, 417-423 (1951).
8. S. Corrsin, Statistical behavior of a reacting mixture in isotropic turbulence, Phys. of Fluids, 1, 42-47 (1958).

BOOK REVIEW (from p. 127)

summary of the principal characteristics of macromolecular systems, followed by the three major sections of the book, dealing with polymer synthesis, solid state properties, and polymer rheology. The author has managed to organize and unify the main features of polymer science quite satisfactorily. The transition from subject to subject is smooth, and the informal style and sense of awareness of the students' background should make the book eminently readable and useful as an introductory text. The introductory section, the section on polymer physics, large portions of the section on polymer systhesis, and the chapter on linear viscoelasticity of polymer solids are especially well done.

The coverage is by no means comprehensive, however. It omits such important subjects as polymer solutions, molecular characterization, the chemistry and statistics of crosslinking, and effects of molecular structure on flow properties. Indeed, the weakest part of the book is its treatment of rheology and polymer processing. Also, the discussions of the glass transition, ionic polymerizations of all kinds, crystallization kinetics, and the quantitative techniques for characterizing crystalline polymers are rather cursory. Some telescoping is necessary for the reasons discussed

(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).

REFERENCES

1. Dodge, B. F. "Chemical Engineering Thermodynamics" McGraw-Hill Book Co. (1944) p. 135 (eq. IV. 156).
2. Edmister, W. C. and Lee, B., Distillation 1969, p.3B:117, Inst. Chem. Eng. (London).
3. Tao, L. C. AIChE Journal *15*, 460 (1969).
4. Tao, L. C. AIChE Journal *15*, 362 (1969).
5. Van Ness, H. C. "Classical Thermodynamics of Non-electrolyte Solutions" McMillian Co., N. Y. (1964) p. 79, eq. 4-21; p. 138, eq. 6-42.

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. □

LITERATURE CITED

1. Birch, D. and J. Veroff, "Motivation: A Study of Action," Brooks/Cole Publishing Co., Calif., 1966.
2. Biehler, R. F., "Psychology Applied to Teaching," Houghton Mifflin Co., Boston, 1971.
3. Maslow, A. H., "A Theory of Human Motivation," Psychological Review, 50, 370 (1943).
4. Galluzo, J. F., "Career Guidance Manual for Chemical Engineers," A.I.Ch.E., Career Guidance Committee, 1970.