ChE views and opinions

THE LITTLE RED SCHOOL HOUSE

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THREE THOUSAND years ago the teacher necessarily had to lecture to his classes since the printing press had yet to be invented. Today, despite the printing press, despite the many forms of copying machines, despite the tests of educational psychology, the same inefficient system of teaching is still practiced. As a consequence, the little red school houses are no longer little and threaten to engulf the community both physically and financially. The students produced by the system, like their counterparts of 3,000 years ago, cannot study by themselves and, most important, do not desire self-study, since *they have been conditioned that the learning process requires a teacher and a classroom!*

This last point bears repeating: We are creatures of habit—habit dictates our entire mode of living. Consider the habits instilled in our students. From the time that they are 6 years of age until they are 18 years and graduate from high school, or until they are 22 years and graduate from college, they are conditioned to a teacher lecturing to them at a set hour as the first prerequisite for learning! They graduate and the learning process practically ceases in many cases. Obsolescence at 40? Certainly it can be laid to the habits instilled in the students in their 12 or 16 years of conditioning.

Suppose that the student follows carefully the lecturer's words and thoughts;* here he is being conditioned to accept without thinking! If the student digresses from following the lecturer (if he thinks independently), of what use is most of the lecture material?

It is often argued that the lecturer (at least the good lecturer) stimulates the students to think. This is a valid point if the lecture is used as a flavoring! Recall your own days in school. Did you have a brilliant lecture at 8 A.M. followed by other equally brilliant lectures at 9, 10, and 11 A.M.? Even with the best lecturers it is impossible to listen and be stimplated every hour on the hour, day by day, and week by week.

It is our considered opinions that the over-use of the lecture system has produced in our former students a profound distaste for self-study (and for graduate school) that explains why obsolescence at 40 is not uncommon.

THE AIM PLAN

TO OVERCOME the distaste for self-study and, at the same time, to provide educational opportunities for people who do not have educational institutions and instructional personnel available in their immediate vicinity, The University of Wisconsin initiated its AIM program in 1964. This experimental program, sponsored jointly by The University of Wisconsin and the Carnegie Corporation, titled Articulated Instructional Media (AIM) was to provide undergraduate educational opportunities throughout the State of Wisconsin by using a wide variety of instructional techniques and media.

The Mechanical Engineering Department carried the AIM Concept a step further by developing graduate courses as a means of providing continuing education for practicing engineers who do not have access to graduate programs in their geographical locations.

The Mechanical Engineering program is basically the tutorial system (texts, course outline, assigned and illustrative problems and tests) with the instructor meeting the students once a week, or once every two weeks, as the class needs dictate. Students could also contact instructors by telephone at scheduled hours (say 7-9 P.M. on Tuesday) to discuss problems. In addition, some of the courses such as "Experimental Design" and "Analysis of Metal Cutting and Forming" have a truck-mounted laboratory so that a wide variety of experiments were available to students at various centers throughout the state.

To assure maintenance of course standards, the AIM students are required to take midterm

*Classroom, moving pictures, audio-visual methods and television included.


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and final examinations with the regular students on The University of Wisconsin Campus.

The AIM program provides a number of side benefits as well. For example, once a course has been developed, it can be offered at little extra cost for several years. Almost any number of students from one to one-hundred can be enrolled. Thus, educational opportunities can be provided at the lowest possible cost; and a relatively large graduate program can be offered providing maximum flexibility in fitting the graduate program to the needs of the off-campus student.

The graduate program for off-campus students started in 1964. Each semester since that time four or five courses were offered with an average enrollment per course of about ten. To date there have been two MS graduates but several other graduate students will probably complete degree requirements during 1970.

THE AIM (WISCONSIN) RESULTS

• **Reduction of undergraduate costs.**

TO CHECK the adequacy of the AIM approach in instruction, the undergraduate Mechanical Engineering students enrolled in beginning thermodynamics were divided into two groups by lot with two classes following the traditional lecture system (three one-hour lectures per week), and two classes following the AIM plan (one one-hour lecture per three weeks). All classes had common examinations.

3,000 years ago the teacher had to lecture to his classes . . . the same inefficient system of teaching is still practiced.

The distribution of grades for both the traditional approach and the AIM approach shown in Example 1 exceeded our expectations. The AIM students did as well, if not better, than did "traditional" students.

*Example** 1 *Undergraduate (Jr.) Thermodynamics*

	A=4.0	B=3.0	C=2.0	D=1.0	F=0	Grade Avg.	Background GPA
Lecture	2	11	15	10	3	1.98	2.61
AIM	6	9	12	7	3	2.22	2.59

Note that with a teacher contact-hour load of 6 hours/week, and with twelve 3-hour sections (same subject) meeting on the AIM plan once in two weeks:

*All data are from official records at Madison.

A teacher (plus one graduate assistant) on the AIM plan can replace six teachers on the lecture system (in large schools with multiple-section courses), and requires only one-sixth of the class room space.

With a more-realistic six sections, the reduction is *three-fold,* and the teacher's load is minimal! (Freedom for research.)

• **Expansion and Financing of the Graduate Program**

THE GRADUATE PROGRAM at most engineering schools is limited because of the small number of graduate students enrolled. This limited graduate-course offering results in slow growth because graduate students are not attracted. The AIM plan enables schools to develop additional graduate courses and to schedule greater numbers of courses which will attract greater numbers of graduate students. In addition, these courses can be made available in many localities to meet the needs of personnel employed by industries throughout the State (an incentive for attracting or expanding industrial operations in the State).

Example 2 *Nuclear Power Plants*

(Beginning graduate: El-Wakil)

	No. Enrolled	Grade - A	B	C
Campus	2	-	1	1
AIM	9	3	1	-

The campus enrollment of two students was not sufficient to allow the course to be offered. However, the nine AIM students brought the total to eleven, and therefore the course could be financed.

Even in a large graduate program, the problem of "low-income" courses invariably arises with high-level graduate courses:

Example 3 Advanced Conduction

(Several prerequisites: G. Myers)

	No. Enrolled	Grade - A	B	C
Campus	4	2	2	-
AIM	9	-	5	-

The low-income courses (Examples 2 and 3) can be balanced by basic courses which tend to have a large campus enrollment (and therefore the AIM income is a definite gain):

Example 4 Mechanical Design

(Beginning graduate: Seireg)

	No. Enrolled	Grade - A	B	C
Campus	12	6	5	1
AIM	16	8	4	1

Thus the AIM program not only increases the number of graduate courses offered each term, but also becomes the means for financing low-enrollment specialty courses and advanced courses that are so vital for faculty development. Note, too, that *the AIM plan is a means for financing graduate assistants.*

- **Attrition.**

HILDEGARDE'S 3th Law is as follows: The attrition in graduate off-campus courses is proportional to the work required of the student.

Another generalization: A high-level off-campus graduate course, with the students working full-time in industry, will have an attrition of about 50 per cent.

That these generalizations are approximately true can be deduced by considering that the usual graduate student on-campus carries 12 units of credit and spends about 60 hours/week in study, or about 15 hours/week per 3-hour course. The man in industry thus needs at least two "days" of free time to compete. The AIM program has essentially the same attrition as our older plan of one 3 hour lecture per week given at night to men in industry.

Example 5 Attrition in AIM versus Lecture System

NUMBER OF STUDENTS

Course	Method	1st Class	1st Exam	2nd Exam	Completed (Passed)
A	AIM	12	5	----	4
B	AIM	8	7	6	6
C	AIM	25	24	20	20
A	Lecture	13	9	----	5
X	Lecture	25	17	10	9
Y	Lecture	41	36	----	22

Observe in Example 5 that the attrition for Course A was about the same for the two distinctly different methods of teaching. The attrition varies from course-to-course depending upon the course severity.

The students produced by the system cannot study by themselves and do not desire self-study.

To digress: It is not unusual to find attrition much lower than shown in the above five examples in the various off-campus programs given throughout the country by other schools for the MS degree. At Wisconsin, the AIM MS degree has essentially the same quality as the campus degree, since the AIM students take the same examinations at the same time as the campus students. (Whether a "cheaper" degree should replace our AIM degree is a matter for argument; admittedly, the industrial need is for courses requiring, at most, 8 hours per week of study.)

- **Usual Questions and Criticisms**

Q. Do students prefer the AIM plan?

A. All things being equal, a majority of the students on or off-campus prefer the AIM plan because of

On-campus: The saving of 3 to 5 hr/week by *not* attending classes (for *one* subject.)

Off-campus: The freedom in not being tied to a 3 hour lecture on *one* night—a night on which the man may be tired, sick or out-of-the-city.

Those who dislike the AIM plan say: "I like a lecture first to get some feel for the subject so that it will come easier to me when, later, I study the text".

Query: Will he expect the same briefing *after* graduation on each new topic?

"I attend the lectures to study the teacher—to see what he emphasizes—so the tests can be passed."

Query: Is this good teaching?

"Teacher x delivers a very deliberate, well prepared, lecture and therefore I have a minimum of study after each lecture." ("I don't have to crack the book.")

Query: Is this good teaching?

Q. Do the faculty prefer the AIM plan?

A. No

Q. In your opinion, why the NO to the foregoing question?

A-1. The AIM program demands that the teacher carefully examines all of the material, and the textbook, from the student's viewpoint before the term begins. Thus considerable time (and typing help) is required to develop the printed material which is to replace about 30 hours of verbal instructions. (We pay $500 to $1,000 extra compensation for this work.)

A-2. Most teachers like to lecture.

A-3. They're uneasy in the hidden thought that AIM may cause faculty overloading and a *reduction* in faculty members.

Q. What do faculty members say who oppose AIM?

A-1. "The good teacher inspires (motivates) the student and AIM (prevents) (reduces) (destroys) the inspiration."

[Please—a little self analysis: How many teachers "inspired" you as a student? Where? In the classroom? Or in their offices? Motivation may be necessary at the high-school level but at the college level? Can't the coop plan supply this motivation? What about the graduate level?]

A-2. "Many (most) of my students need to be prodded by being forced to go to class, or to turn in homework, or to have me (the teacher) review the material three times a week."

[Can we afford to accept such a condition at the college level? Isn't this statement an indictment of present educational methods?]

A-3. "I bring to class the latest developments in the literature (or from my research) and so illustrate and extend the textbook as well as the subject."

[A fair answer, *if* we are discussing high-level graduate seminars for the PhD degree; even here a Xerox copy of a Ditto statement of the "new" material could save a good deal of chatter.]

A-4. "The students are not exposed to the presence of other students, and to the questions of other students which may be novel to them, and to the reactions of the students."

[True, but need it be 3 times a week times 5 to 7 subjects? The experienced teacher finds few novel questions, and these should be anticipated in the course printed material.]

Q. Isn't the graduate student (or the professor) overworked in answering the phone (one 2-hour period during the week)?

A. Surprisingly, the phone load is very light *except* for a night or two before an examination. (And therefore we call the phone service a psychological crutch.)

BOOK REVIEWS (Continued from page 93)

Mass Transfer in Heterogeneous Catalysis
Charles N. Satterfield
267 pages, M.I.T. Press, (1970)
Cambridge, Mass.

This book is a sequel to the 1963 volume 'The Role of Diffusion in Catalysis" written by Promessors Satterfield and Sherwood. The arrangement of the material and the point of view are the same as in the earlier work. The new volume retains the objective of emphasizing the practical, problem-solving approach.

The first chapter treats diffusion in gases and liquids in a brief way and then presents in detail mass transport in porous catalysts. Binary mixtures are used almost exclusively to illustrate diffusion phenomena and little attention is given to the molecular theory of diffusivities. However, rather complete up-to-date data are presented for liquid and gaseous, binary systems. Models of pore structure applicable to diffusion calculations are discussed along with a reasonably complete summary of data on tortuosity factors. From a historical viewpoint, Rothfield's work [AIChE Journal *9* 19 (1963)] might have been given credit, along with the other two groups mentioned, for deriving the accepted relations for diffusion at constant pressure in a pore where both Knudsen and bulk transport are significant.

Chapter 2 treats transport resistances between fluids and solid particles and includes a summary of available information for fluidized beds and slurries.

The major share of the book is devoted to the interaction of diffusion and heat transfer and reaction in influencing the effectiveness of porous catalysts. The conventional isothermal problem is considered first (Chapter 3), and then intraparticle temperature effects are introduced. Methods of *predicting* the effective thermal conductivity are mentioned only in passing in order to present the available experimental data. Considerable space is given to the effect of the form of the rate equation on the effectiveness factor, a subject in which the author has done considerable work.

The final chapter describes the effects of poisoning on rates and selectivity and the related subject of regeneration of coked catalysts. Poisoning is analyzed using the Wheeler classification [A. Wheeler, Advances in Catalysis III, p. 249 (1951)]. The data on carbon gasefication is summarized with the objective of presenting working equations for the rate of burnoff. For the high-temperature case of diffusion-controlled burnoff (the shell model) data are given, but the theory is not included. In general, the concepts of gas-solid non-catalytic reactions are not discussed. As the title indicates, the treatment is limited to catalytic reactions.

The book presents a convenient source of data (much of it recent) on transport effects in solid-catalytic reactions and as such will be a most valuable addition to the literature. The material is presented clearly and the data abstracted from the literature are reproduced and analyzed with sufficient detail and care to be useful.

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