ChE educator

Bob Tanner of Vanderbilt

DENNIS THREADGILL*
Vanderbilt University
Nashville, TN 37235

For Bob Tanner, Associate Professor of Chemical Engineering at Vanderbilt University, education has broad objectives. His ideas about the purposes of education color every facet of his job. He believes that a teacher's role is "to provide the spirit, the motivation for *continuous* learning. Education should be a life-long experience," he explains.

"I think of my role as a teacher as having two related functions. Of course I want to impart specific knowledge and specific skills so that my students can practice their profession; but I am not teaching a trade. I am teaching a way of learning and of approaching problems. The ultimate learning situation I seek for all of my students, graduate and undergraduate alike, is one of self-sufficiency. I try to lead them to that point where they can begin to teach themselves. That is the basis of life-long learning, and as in life itself, it means learning from mistakes as well as successes."

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Creating a provocative educational climate in which this kind of learning can best take place has been a primary objective for Bob while at Vanderbilt. He sees the university environment as special, open surroundings in which new ideas are aired and questions are encouraged.

ACTIVE STUDENT PARTICIPATION

ONE CLASSROOM example of this philosophy in action developed into a senior plant design project that earned the students and their instructor a place on the cover of *Vanderbilt Alumnus* in June, 1976. Nine seniors completed the laboratory work and designed a plant which could provide enough lysine-enriched yeast to meet all the protein needs of the population of Nashville, plus enough by-product alcohol to supply large-scale energy demands. Additionally, it could produce carbon dioxide to supply a dry-ice plant, while

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the waste products generated could fertilize a crop of tomatoes to be grown in five greenhouses. According to their calculations, the whole operation would require a plant covering about ten acres, and it would be profitable.

"I gave them a lot of freedom to define the problem," Bob recalls, "and in the beginning they floundered. They were being called upon to put into use almost everything they had learned in the previous three years of their chemical engineering course work. At the semester's end, all of us, the class-members, Professor Dennis Threadgill, the faculty member in charge of the plant design course work, and I, were pleased with their efforts."

Bob's interest in exposing students to new ideas and to professional role models who stimulate the imagination, led him to develop a seminar program for seniors and graduate students that brought approximately fifty prominent outside speakers to Vanderbilt in recent years. "I invited people who like their work," he explains, "who are excited about it, who like to talk about it, and who open new vistas of experience for the students. I sought fine practitioners, people who are outstanding in their respective specialties, and asked them to talk about how they approach problems and how they deal with the problems they choose."

"It is gratifying to watch seniors come out of a seminar excited by the speaker's enthusiasm for his work," Bob remarks. "I hope that my students will come to understand that learning through exploration is the best part of any job.

SPECIAL INTERESTS ARE VARIED

BOB'S OWN CURRENT RESEARCH interests reflect a journey of personal exploration along varied avenues of professional endeavor. He earned the Ph.D. degree from Case Western Reserve University. From that environment he developed two, long-term interests. His dissertation, under the direction of Coleman Brosilow, taught him sophisticated mathematical modeling techniques, while a private conversation with Department Chairman Robert Adler on the production of single cell protein from hydrocarbons, sparked a continuing interest in biochemical processes, particularly fermentation. Today, Bob is primarily concerned with modeling the dynamics of fermentation processes.

His interests are diverse. An association with Harry Broquist, Professor of Biochemistry and Chairman of the Nutrition Division of the Biochemistry Department at Vanderbilt, started Bob thinking about a simple, exceptionally low-cost way of increasing lysine content in yeast which then could be used in breads and other foods as a protein supplement.

By manipulating the temperature and acidity during fermentation of baker's yeast or glucose, the lysine content of yeast can be increased by 25 percent. Lysine is an essential amino acid needed for correct nutrition and is deficient in corn and many grains and their derived foods.

"By increasing the lysine content of yeast, less yeast would be needed to obtain the minimum daily requirement of lysine, thus avoiding some of the nutritional problems associated with high amino acid intake from single cell protein, namely uric acid poisoning and gout," Bob points out.

This research opens the door to an easily applied engineering approach to increase the nutritional value of food and introduces an alternative to the genetic approach. Baker's yeast can be grown throughout the world on a variety of raw materials.

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A second area of interest which he has been studying for ten years and which is directly related to food and protein alternatives is kinetic hysteresis in enzyme and fermentation systems. Hysteresis is defined in physics as "the failure of a property that has been changed by an external agent to return to its original value when the cause of the change is removed." The word comes from the Greek word, *husteresis*, a shortcoming.

"It has been shown that kinetic hysteresis can be a useful tool in elucidating mechanisms in both enzyme and fermentation systems," Bob reports. Hysteresis may be particularly helpful in suggesting the presence of an enzyme not previously suspected in a fermentation system. Moreover, as a tool for discrimination between models, hysteresis can be used to imply the presence of parallel pathways, of additional intermediate states, and of proteases countering the primary enzyme systems.

Hysteresis may even be used to infer rates of enzyme induction, possibly suggesting constitutive

and induced mechanisms. Used cautiously, in keeping with the limitations of the data, hysteresis curve analysis appears to aid in experimental design by reducing the number of experiments needed for the elucidation of fermentation mechanisms.

THE KUDZU QUEST

A THIRD AREA OF INTEREST, less pedantic than either lysine-enriched yeast production or kinetic hysteresis in fermentation systems, is Bob's curiosity about kudzu, a tenacious, escaped vine that is present throughout the rural Southeast.

Kudzu grows at a phenomenal rate and thrives best in a climate defined by the hot, humid summers and mild winters common to the South. Originally introduced to the region as an answer to soil erosion, kudzu has been known to grow as much as a foot a day and seventy feet a summer. The plant has been referred to as "King Kong Kudzu, Menace to the South," and has received attention in poetry, fiction, film and in numerous articles.

The July 24, 1979 issue of *The Wall Street Journal* reports:

> **"Kudzu has become a Southern joke, but the laughter is tinged with bitterness. Southerners say that kudzu is the only plant whose growth is measured in miles per hour. They assert that the beanstalk that Jack climbed wasn't a beanstalk, but a kudzu stem. And farmers insist that the best way to plant kudzu is to 'throw it over your shoulder and run.'"**

The questions Bob hopes to answer concern potential uses for the ubiquitous plant. He proposes to use the starchy root as a fermentation medium in order to develop a commercial outlet for kudzu, thereby adding a starch supplement to our renewable food and fuel supplies. Preliminary experiments indicate that the root provides a vitamin-enriched source of starch for ethanol and yeast fermentations. In addition to the traditional use of kudzu for hay as an animal feed, Bob suggests that the woody, thicker vines may be used, along with coal, for the production of steam in electric power plants. As a low-sulfur, fast-growing renewable resource, kudzu plants could provide a partial local solution to the twin problems of environmental pollution (by blending with high sulfur coal, the total sulfur content can be reduced to meet air pollution regulations) and an indigenous source of energy for the South.

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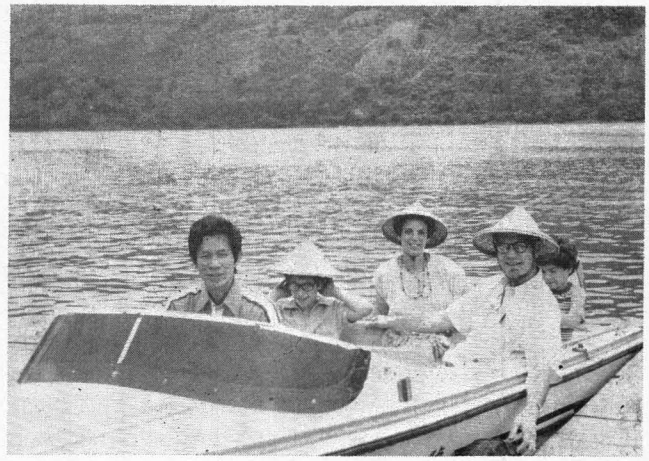

Professor S. Y. Huang of the National Taiwan University shows Bob and his family how to relax Taiwan-style.

Bob's interest in kudzu has made him an authority on the vine, a position he views with humor. The implications for the plant's potential as a presently unused agricultural source for alcohol-based fuels, however, are significant. He receives regular inquiries from the media and from research centers across the country for new information.

BOB, THE COLLABORATOR

WHILE AT VANDERBILT, Bob has maximized the opportunities for collaborative research efforts with other faculty members. "I enjoy sharing ideas with my colleagues," he explains, "I like a situation with give-and-take. I gain new insights when I work with people in other disciplines, as well as with other chemical engineers."

Bob and Philip Crooke, Associate Professor of Mathematics, have collaborated on numerous kinetic modeling studies. They have published several papers jointly, and several more are currently underway. Bob and Phil are the objects of good-natured ribbing for their daily working lunches by other members of the Math faculty whose lunchtime conversations often reflect more down-to-earth concerns.

In addition, Bob's collaborative research at Vanderbilt has included the investigation of the surface chemistry behavior of crack detection penetrant dyes for use in non-destructive testing with Paul Packman, formerly a member of the Materials Science faculty, and presently Chairman of the Department of Civil and Mechanical Engineering, Southern Methodist University, and the development of a rapid method for the identification of pathogenic microorganisms in wastewater with George Malaney, Professor of Environmental Biology. Bob is presently working with David Wilson, Professor of Chemistry, on hysteresis in adsorption processes, and with Donald Pearson, also a Professor of Chemistry on a process to convert alcohols into hydrocarbons.

In 1978, Bob was asked by the former Dean of Engineering, Howard Hartman, to initiate a collaborative energy research project between Vanderbilt and Oak Ridge National Laboratory. Today Bob both coordinates the research efforts and administers the Department of Energy grant to the University.

A glance at the books on his shelves shows Bob's eclectic nature. Apart from engineering and related scientific titles, he has volumes dealing with geology, fibers, medicine, and China, as well as magazines such as Mother Earth News **within reach.**

Bob has remained in contact with colleagues at Merck, Sharp and Dohme Research Laboratories, where he worked for five years before joining the Vanderbilt faculty. A continuing interest in pharmacokinetics prompted an ongoing study with Joseph Bondi of Merck's West Point facility that applies dynamic modeling techniques to drug metabolism.

TAIWAN TRIP SERVES DOUBLE PURPOSE

CONTRACTS MADE AT THE USA/Republic of China Joint Seminar on Fermentation Engineering at the University of Pennsylvania in 1978 led to a very exciting plus for collaborative research. Bob's conversations in Philadelphia with two members of the Chinese delegation, S. Y. Huang, Professor and Head of the Department of Chemical Engineering at National Taiwan University, and C. H. Lin, Professor and Chairman of the Department of Chemical Engineering at Tunghai University, resulted in the commitment to a mutual research project. The groundwork for the project was established in the summer of 1979 when Bob, his wife Ruth, and their sons, David and Benjamin, traveled to Taiwan to meet with his Chinese colleagues. While the family shared the excitement of travel in the Far East, Bob and Professors Huang and Lin agreed to study solid and semi-solid fermentations, building on the Orient's special knowledge of fermented foods. Additionally, one of Professor Lin's graduate students, Chia-Jenn Wei, is continuing his graduate training with Bob at Vanderbilt.

"The trip was a wonderful experience for us," Bob recalls. "Not only did we leave Taiwan feeling as though we had left family behind, so constant was the Chinese warmth and hospitality, but I found Professors Huang and Lin to typify the energy and devotion of Taiwan's researchers to developing and strengthening their country's scientific and industrial base."

On the home front, Bob is an active participant in technical societies. Currently, he serves as Chairman of the Microbial and Biochemical Technology Division of the American Chemical Society. A personal interest in alcohol-based fuels led him to invite a Brazilian researcher to the Washington, DC meeting in September 1979 as a distinguished speaker on his country's work on gasohol.

Bob says that because he gets so much pleasure from his job, he really doesn't separate "work" from "outside activities." In Taichung, Taiwan, while strolling through the open market, he stumbled upon a Chinese medicine shop whose youthful proprietor sold kudzu root as a medicinal

Bob, his wife Ruth and two sons do some sightseeing on their 1979 trip to Taiwan.

staple. The druggist's well-thumbed pharmaceutical index revealed that kudzu broth, made from the dried root, quenches thirst and accelerates perspiration in a feverish patient, combats alcoholism and soothes headaches. "My 30¢ purchase there was the best souvenir of our trip to Taiwan I could buy," Bob admits with a smile. "It's the kind of discovery that adds an extra dimension of pleasure to my research."

Conversation reveals that Bob very much enjoys local events. He has traveled around Tennessee attending local festivities, such as old-time fiddlers' contests and performances at bluegrass music parlors. Civil War history also captures his interest. He and his family particularly enjoy visiting national and state parks, from battlefields to Mississippian Indian digs and ante-bellum homes ornamented with battlescars.

A glance at the books on his shelves shows Bob's eclectic nature. Apart from engineering and related scientific titles, he has volumes dealing with geology, fibers, medicine, and China, as well as magazines such as *Mother Earth News* within reach. This eclectic approach to life and science characterizes him as a scientist and researcher. □

ChE book reviews

TURBULENT MIXING IN NON-REACTIVE AND REACTIVE FLOWS

Edited by S. N. B. Murthy
Plenum Press, New York (1975). 464 pages
Reviewed by William E. Ranz
University of Minnesota

This volume, intended to be a good sampling of science and art in 1974, consists of twenty-four papers by separate authors prepared as proceedings of a Project Squid Workshop on Turbulent Mixing in Non-reactive and Reactive Flows, held at Purdue University, May 20-21, 1973. The workshop was sponsored by the Office of Naval Research and the Air Force Office of Scientific Research.

Content is dominated by continuing developments in statistical fluid mechanics, supported by a modest amount of experimental measurement and by engineering modeling. The next largest group of papers represents rising interest in large scale structures which persist at high Reynolds numbers and resist analysis by probability concepts. Edited discussions which follow each paper help to unify the disparate presentations. They also show a growing division between two schools of thought, those who advocate probability distribution functions and those who chase eddies to achieve better understanding of a mixed-up subject.

Species concentration, diffusion, variation, and structure in mixing flows and with chemical

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