ChE educator

MAX PETERS

University of Colorado

Max Peters, newly appointed in 1962 as dean of the College of Engineering at the University of Colorado, enthusiastically pushed forward plans for the proposed Engineering Center, dedicated in May, 1966.

If there is a better way of educating engineers, Max S. Peters, dean of the College of Engineering at the University of Colorado, will be in pursuit of it. "Finding a better way" could be the most fitting description characterizing his performance, whether inside or outside the classroom, the administrative halls of higher education, the laboratory, or the smoke-filled committee rooms in which he is such a driving force.

Something of the vigor and hardihood of the Ohio-Pennsylvania early American certainly is evident in Max Peters. He was born in 1920 in Delaware, Ohio, and received his early education in State College, Pennsylvania, and at Penn State University. He earned the PhD degree in chemical engineering at Penn State in 1951, performing research on vacuum distillation.

By the time he was awarded his degree he had already worked as a production supervisor in a wartime powder plant and had served with distinction in the 10th Mountain Division of Italy. For two postwar years he was in charge of all technical work for Treyz Chemicals in Cook Falls, New York.

Colleagues and students alike are apt to address him as Max. They appreciate his capacity for hard work and the sense of humor that is ready to break to the surface in the midst of serious considerations. *His door is always open to his graduate students. As one of them puts it, "I'm amazed that a man with so many responsibilities can be so available."*

The responsibilities he has are the result of his diligent research for "a better way." He heads a college enrolling nearly 2000 undergraduate and some 300 graduate students, with a faculty numbering around 125, housed in a new $8.5 million educational facility which he himself worked hard to make a reality. In addition, he guides engineering programs at two off-campus CU Centers, at Denver and Colorado Springs.

The story of the remarkable growth of the College of Engineering at the University of Colorado since Max Peters arrived on campus in July of 1962 is well known to engineering educators across the country. He hadn't been in office long before the building priority for the proposed Engineering Center moved up from eleventh to first. Then he went to work with the University administration to acquire $7.2 million from the state legislature for construction of the Engineering Center — the largest sum ever requested from the people of Colorado. He further exerted his persuasive and organizing powers to acquire a supplementary $1.325 million from the National Science Foundation.

The Engineering Center at CU can truthfully be said to have been inspired in great part by the enthusiasm and imagination of Max Peters. At ground-breaking ceremonies for the Center in 1964 he revealed the scope of his expectations when he described the Center as "a major milestone . . . in the forward progress of making the State a major industrial and scientific center."

He tackles the challenge at its grassroots — the high school level — with the same bold enthusiasm. "Is there anything wrong," he asks, "with being old fashioned and strongly encouraging our high school students to start preparing themselves while in high school"

"To be what you can be, you must first and foremost decide what you want to be."

Many of his colleagues and students have heard him say, "Engineering is a tremendously exciting and rewarding career!" and in a diversity of situations he proclaims vehemently, "It is time that some of us decide to speak out."

Max showed signs of "speaking out" in his first academic position, as assistant professor, then professor, and then divisional head of chemical engineering at the University of Illinois. There he began the characteristic pattern: to examine and re-examine the curriculum to expose its weaknesses, identify its strength, and take action to improve it. At Illinois he recognized the need for more extensive chemical engineering kinetics study and introduced a course to fill the void.

His first book, *Elementary Chemical Engineering,* (McGraw Hill, 1954) was written at Illinois to fill a gap in engineering education for students of other disciplines such as mechanical engineering and chemistry. The text has been especially valuable in foreign countries where teachers were not capable of using standard texts for chemical engineer majors.

In his second book, *Plant Design and Economics for Chemical Engineers,* (McGraw Hill, 1957) Max Peters tackled another need — that of graduate students who went into design work in the chemical industry with relatively little background in plant design problems and their solutions. *Plant Design* has been adopted by more than half of the chemical engineering curricula across the country. A completely revised edition (1968), written with Klaus D. Timmerhaus, associate dean of the CU College of Engineering, provides greater depth in optimization and economic evaluation.

Both books are considered classics in that they speak to engineers of all disciplines and to scientists and industrial managers who have no formal educational background in chemical engineering.

It was at Illinois that Dean Peters' drive to improve educational standards carried him into the local chapter of the AIChE as faculty representative. Years of committee activity brought him in 1968 to the presidency, where he committed himself wholeheartedly to the quest for improved engineering education and true professionalism by AIChE members, and to the profession's obligation to assist society in the solution of its problems. His improvements in the professional society, (among them he originated the popular Free Forums) are well known to AIChE members. Through the voice of AIChE Max has supported the concept of the chemical engineering degree instead of the general engineering degree as the first professional degree.

When Max Peters takes part in Fun & Games at the E-Days picnic only his plaid shirt distinguishes him from the students.

As head of the chemical engineering division at Illinois, Max Peters recognized that chemical engineering students engage in a wide scope of activities including economics, technical services, laboratory research. Accordingly, he introduced a flexibility into the undergraduate curriculum that allowed the student to substitute advanced mathematics, physics, and chemistry for more conventional courses. His incorporation of fundamental engineering sciences into the undergraduate program has been copied by chemical engineering departments in many institutions throughout the United States.

It was natural for Max to strive toward raising the standards of excellence in the College of Engineering at the University of Colorado. With Dean W. L. Everitt of Illinois he initiated the Bi-University Institutional Liaison for Development (BUILD) program for experimentation and development of faculty innnovative ideas between the two universities. Now concluding its fourth year of support by the Kettering Foundation, BUILD has implemented exchanges for professional development that have involved at one time or another every faculty member of the CU College of Engineering.

Max is a forceful and articulate committee member, as many of his colleagues have learned. As chairman of the CU proposal committee for the National Science Foundation Scientific Development program, he helped bring $3.75 million to the University of Colorado, one million of which want into electrical, aerospace, and mechanical engineering programs in the College of Engineering. As a result, the College has strengthened its programs in control theory, solid state physics, computer logic, fluid mechanics, applied mechanics and mathematics. Growth in these areas is being watched with interest by other institutions.

Behind this vigorous activity Max holds a philosophy that has deeply affected graduate study and research throughout the College. Graduate students, he holds, should be actively involved in research programs under the direction of faculty members. Faculty members who are engaged to fill needs in research areas must be good teachers. Funding for this program has increased during the past five years from less than $200,000 to approximately two million dollars.

In 1961, one PhD degree was awarded by the University of Colorado to a student in engineering. In 1968, 30 engineering students earned the degree. PhD degrees have been made available in aerospace engineering sciences and in mechanics in addition to all the other departments, with the exception of a new department, Engineering Design and Economic Evaluation, which offers the master's degree.

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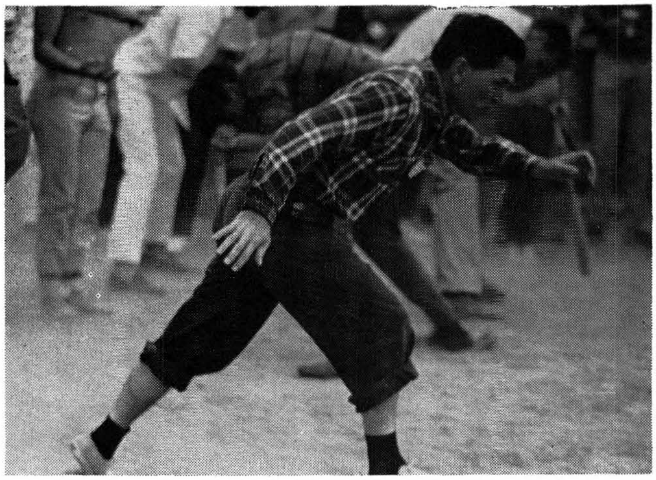
It's easy for graduate students to discuss their research problems with Max Peters; in fact, he is himself making a significant contribution in the laboratory. His research studies in kinetics, particularly on nitrogen oxides and pentaerythritol, have resulted in increased understanding of reaction mechanisms and in the chemical engineer's ability to design reactors. He personally directs graduate work in allied studies.

He gives his students as much freedom as possible in their projects, only outlining the overall view and the goal. He believes that students learn more from doing a thing wrong than from doing it right the first time. This freedom to experiment encourages his students to be creative and analytical.

They recognize his qualities as a teacher. "He took the complex and broke it down into simple integral parts," one of his students comments, or, "He built up the complicated theories of chemical engineering by starting with easily understood building blocks of knowledge."



As usual, Max Peters won the Dean's Challenge Race at the E-Days picnic in May, 1968.

As a teacher, characteristically Max looks for better ways to explain points and ideas; he designs quizzes and exams to test a student's comprehension rather than his memory of equations and data. The secret of his ability is simple: he is truly interested in each of his students as a person. Because of this, he is able to instill in his students the desire to be successful in study and experimental work. Typically, his plant design students have repeatedly won or placed near the top in the national AIChE Student Contest Problems.

Students have discovered their Dean is a formidable contestant on the ski slopes and the Engineers' Days races. They hail him as champion of faculty-student slalom race at the CU Winter Carnival, and know him as an accomplished figure-skater. Every year Dean Peters has won the Dean's Challenge Race at the E-Days picnic.

He wears his more impressive honors with modesty. This spring he was elected a member of the National Academy of Engineering — the highest professional distinction that can be conferred upon an American engineer. He is cited this June by the American Association of Cost Engineers for his "continuing contributions to the field of cost engineering education." He was recently named chairman of the President's Committee on the National Medal of Science.

In 1957 Max Peters received the George Westinghouse Award from the American Society for Engineering Education for outstanding teaching. He has been active in the ASEE for nearly ten years. In 1962 he served as chairman of the

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Chemical Engineering Division and was for six years a member of the long range planning committee of ASEE.

He is active on the air pollution committee of the U. S. Department of Health, Education, and Welfare, which he serves as consultant. He is consulting editor for the McGraw Hill Chemical Engineering Series, and is the author of many technical articles.

Anyone who knows Max knows him as the embodiment of a belief he has expressed to high school students and to AIChE members: "To be what you can be you must first and foremost decide what you want to be." Since he will never be satisfied with things as they are, but must always seek new and better answers, it follows that Max Peters is not only dean, teacher, chemical engineer, researcher, and innovator. He is perhaps first of all a student — a student of education.

OPTIMIZATION

APPLICATIONS AND LIMITATIONS**

RICHARD R. HUGHES*
Shell Development Company
Emeryville, California

Optimization implies logical, even formal, decision making, i.e., the selection, for a set of *decision variables*, of the best attainable (and allowable) values for a designated *objective*. To successfully accomplish optimization of practical non-trivial problems, two major requirements must be met. First, we must have access to computers (normally large digital computers), and we must be able to use them. This, of course, implies optimization of a mathematical model describing the problem; the second requirement is that this model must be the simplest possible one for the job at hand. The calculation will be extremely repetitive; and any but the simplest possible model will require excessive computation and make it uneconomic to use optimization.

In this paper, I first describe my concept of an optimization model. Then I propose guidelines for formulation and simplification of such models. Finally I offer a few remarks on limitations and complications of the optimization approach. My comments are based on several years of study and practical application of optimization, —by myself and many colleagues, — to problems in chemical engineering, process design, and operations research. Most of the rules given are not hard and fast limitations but merely express my observations of difficulties we have encountered.

THE OPTIMIZATION MODEL

To begin with, optimization requires a formal description of the problem. The elements involved and their relationship are indicated in Fig. 1. First, the problem must be isolated by a formal description of the "state-of-nature" and the problem premises. This is often the most difficult part of the problem. A sound treatment requires an assessment of whether the solution will answer the question posed and whether all significant variable elements are included within the system. Obtaining an optimum scale of manufacture at a fixed sale price is absurd if the scale affects the sales price. With the state of nature established we then identify the decisions we are still free to make. As functions of these decisions, we describe the payoff value, and formulate the necessary restrictions which dictate limitations on the problem, — legal, physical, economical, political, etc. These restrictions limit the freedom of action of our decisions, but there is usually some variability left. By optimizing, we take ad-

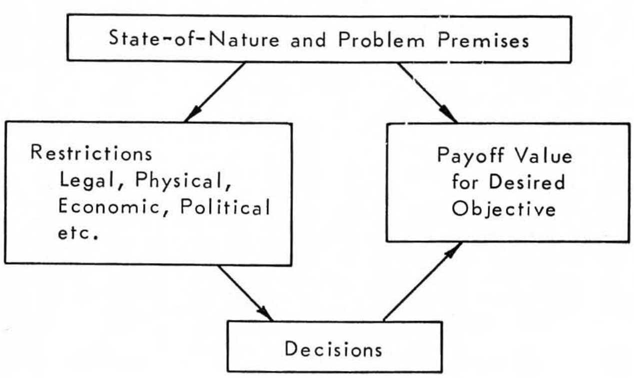

Figure 1.

* Present Address: Univ. of Wisconsin, Madison, Wis.
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