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SCHOOL OF CHEMICAL ENGINEERING AND MATERIALS SCIENCE THE UNIVERSITY OF OKLAHOMA

Dr. C. R. Haden and Dr. Jerris Peavey

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By Jerris Peavey
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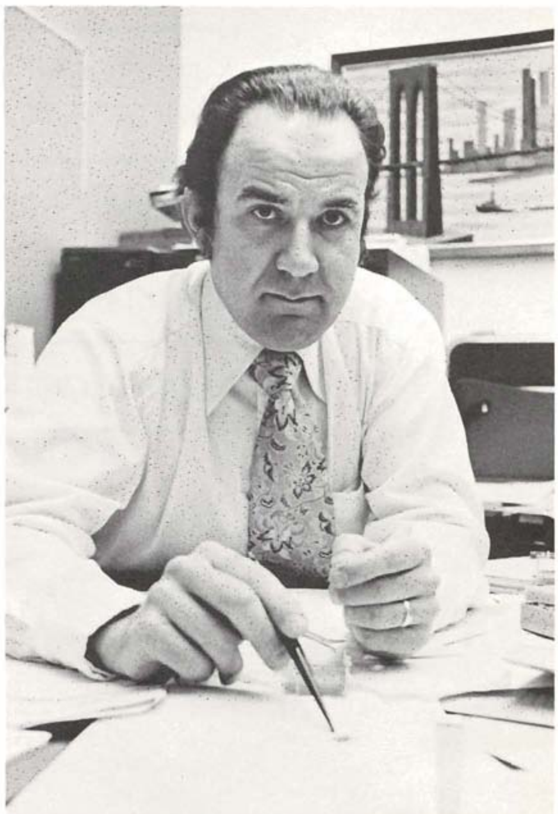
in CEMS



Dr. R. Craig Jerner

Studies are under way to develop a superconductor which has a higher transition temperature and is capable of carrying higher currents than superconductors now available.

Dr. C. R. Haden, director of the School of Electrical Engineering; Dr. R. Craig Jerner, associate professor of metallurgical engineering, and Dr. Jerris Peavey, post-doctoral researcher in CEMS, are working on the project. Assisting are several graduate students: Charles Pellerin and John Harcourt in metallurgical engineering, Koji Moriyama in physics, and Ed Lindsay in electrical engineering.

The studies, which began in April 1973, are funded by a $75,000 grant from the U.S. Air Force and cover approximately two years.

Materials being investigated are niobium and niobium carbonitride. The study may extend to alloys of niobium and germanium, since they have recently been shown to possess superior superconducting properties.

Near absolute zero (zero degrees Kelvin), superconductivity occurs and resistance to an electrical flow ceases. The niobium carbonitrides are presently superconducting up to 19 degrees Kelvin. However, one of the project goals is to raise that upper limit.

The group is also studying the effects of sapphire substrate interactions with the thin film of niobium carbonitride and the effect of these interactions on superconducting properties. As the current is increased through the film a transition occurs, causing the material to lose its property of superconductivity.

The CEMS researchers are involved in making a thin film of niobium carbonitride and analyzing its surface properties. The goal of the project is to correlate surface properties of this film and the film's substrate with the superconducting properties of the thin film.

The surface properties being measured are surface roughness, substrate purity, substrate cleaning techniques and elemental film profiles. The surface roughness measurements are made with a dektak surface profilemeter. This profilemeter has been interfaced with a data acquisition system assembled by Dr. J. H. Christensen, associate professor of CEMS. This instrument allows the researchers to extend present surface roughness measurements by approximately one order of magnitude over existing techniques. This will require new definitions of surface roughness beyond those applicable to present technology. The important feature of the other surface measurements is that they are made in an ultra-high vacuum environment with instrumentation that has the best sensitivity and resolution presently available.

The elemental surface composition is measured with a cylindrical mirror electron spectrometer which is sensitive to the first 4 to 5 monolayers of material (approximately 25 angstroms). This instrument is sensitive to approximately 10^{-12} g/m^3. The primary purpose of measuring substrate purity is to determine the effectiveness of various heating techniques (e.g., heating, ion bombardment), the as-received surface purity, and the amount of segregation if any to the surface of the bulk impurities.

The ultra-thin films ($\approx$ 50 Å thick) will then be deposited using an UHV sputter deposition gun. This unit is unique in that it satisfies both the stringent requirements of UHV equipment and the ability to deposit complex materials. After deposition the elemental composition of the film will be measured with the cylindrical mirror analyzer. Simultaneously with the elemental composition measurements the film is sputter bombarded with an inert gas and the composition of the film is depth-profiled with an accuracy of $\pm$ 10 angstroms; these measurements will be correlated with the following superconducting properties: A) T_C (critical temperature) B) I_C (critical current) C) AC losses. Such correlations will permit the identification of the critical surface parameters.

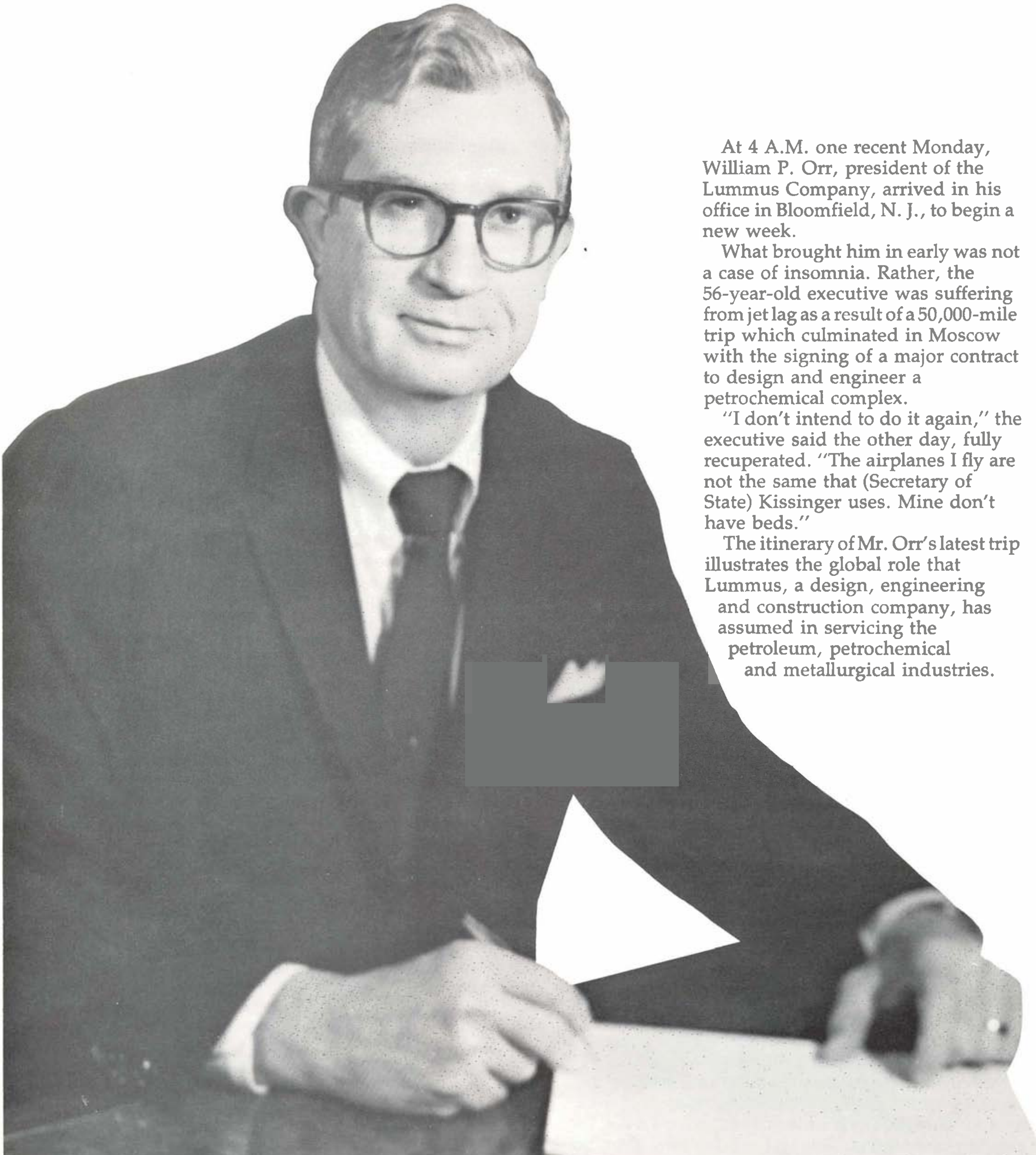
The end result of this project will have direct bearing on the status of the problems of ecology, mass transit and power transmission.

At 4 A.M. one recent Monday, William P. Orr, president of the Lummus Company, arrived in his office in Bloomfield, N. J., to begin a new week.

What brought him in early was not a case of insomnia. Rather, the 56-year-old executive was suffering from jet lag as a result of a 50,000-mile trip which culminated in Moscow with the signing of a major contract to design and engineer a petrochemical complex.

"I don't intend to do it again," the executive said the other day, fully recuperated. "The airplanes I fly are not the same that (Secretary of State) Kissinger uses. Mine don't have beds."

The itinerary of Mr. Orr's latest trip illustrates the global role that Lummus, a design, engineering and construction company, has assumed in servicing the petroleum, petrochemical and metallurgical industries.



GLOBE-TROTTING ENGINEER

By Gerd Wilcke

Things got really tight toward the end of the trip, he recalled the other day in the Park Avenue offices of Combustion Engineering, Inc., the parent of Lummus.

Between Nov. 5 and Nov. 24, a period of less than three weeks, the tall, Oklahoma-born executive visited eight countries and conducted negotiations with 40 companies.

"I left Sydney, Australia, on Nov. 20 at 11 P.M. for Tokyo, where we arrived 17 hours later by way of Manila and Hong Kong," he said.

"We went into immediate negotiations that took five and a half hours. The next morning, we headed for Moscow, a trip that took another 10 hours."

Mr. Orr had gone to Moscow to be on hand for the signing of a deal for the first outright purchase by the Russians of a complete plant from American industry.

The $45-million agreement calls for equipment, engineering and patented processes for a plant to make acetic acid, used in the production of acetates for computer tapes and textile filaments.

The process was developed by the Monsanto Company, which, together with Lummus, was involved in negotiations that lasted for about two years. Mr. Orr estimated that his negotiators made 25 trips to Moscow.

The tediousness of the negotiations was partly reflected in the fact that the development of technical definitions for the project produced a stack of papers two feet deep. "Every page had to be signed," Mr. Orr said, still somewhat incredulous.

But Mr. Orr was no stranger to top-echelon bargaining. He came to Lummus in 1967 as executive vice president after holding managerial positions with Monsanto, Celanese and Mobil Chemical.

Born in Kingfisher, Okla., the 56-year-old executive received a bachelor's degree in chemical engineering from the University of Oklahoma and still serves on the board of directors of the university's School of Chemical Engineering and Materials Science.

He and his wife, the former Mildred Annetta Myers, have two married children and two grandchildren.

About the only diversion in his life is golf, which he plays with a handicap of 10 to 12. His wife shares golf with him and often accompanies him on business trips.

But because Mr. Orr's traveling is so extensive — about 200,000 miles a year — he has had to give up participating in community affairs.

Associates describe Mr. Orr as a shirtsleeve-type executive willing to put in long hours. "He's a tough taskmaster," one observed.

Hard work seemed to have been implanted in him early in life. During his senior year at college he carried 10 subjects. Classes on most days ran from 8 A.M. to 6 P.M., Monday through Saturday. After classes he often worked in an oil company office on a staggered schedule that sometimes kept him until 3 A.M.

Mr. Orr noted that Lummus currently was in various stages of discussion with the Soviet Union about five other projects. One of them involves the production of styrene.

The format of the deals is never the same, he observed. In 1968, Lummus licensed its ethylene technology to the Toyo Engineering Company of Japan, which designed and equipped a plant for the Russians.

He said that the Russians were particularly interested in advancing in the fields of agricultural chemicals and petrochemicals such as fibers.

"In oil refining they feel pretty strong themselves," he added.

Several times during an interview Mr. Orr emphasized that while Lummus considered the Soviet Union an important marketplace, that country was not the main area of its interest.

He estimated, however, that about 75 to 80 per cent of the company's activities were conducted outside the United States — it follows its customers into foreign expansion — but added that this ratio could decline in the next few years to about 60 per cent.

This heavier involvement in the United States would reflect the country's search for new types of supplementary fuels to fill the energy gap, such as synthetic natural gas.

Mr. Orr said that the international chemical business was going through a change as many countries here decided not to export raw materials, such as petroleum, but to process them themselves.

Thus, Lummus today is working in Australia, Brazil, Venezuela and Canada, which are producers of raw materials, and with groups from Japan, Germany or France, which need the finished products.

In Iran, Lummus combined with Japanese companies and the National Iranian Oil Company on a project making ethylene and other olefins. A similar project is underway in Thailand involving Japanese, Dutch and Thai interests.

The worldwide hunger for products derived from oil shows up in data compiled for last year's Combustion Engineering annual report.

The report stated that 1972 worldwide capital spending on goods supplied by Lummus totaled $13.2-billion, most of which was spent in the United States.

These markets, the report said, were expected to grow 62 per cent by 1976 to a total of $21.4-billion.

Lummus, whose volume declined during the first half of the year due to a low level of orders from the domestic petroleum industry in 1972, was described by Mr. Orr as in "a great growth period." (Last year Lummus had sales of $261-million or 22 per cent of Combustion Engineering's total, and pretax profits of $8.2-million, or 11 per cent.)

The parent company, whose main product is steam generating equipment, has been a bright stock-market performer, with its price-earnings multiple doubling to 24 since 1969.

One problem Lummus is experiencing is the lack of technical manpower.

"Engineering schools are graduating one-quarter the number of the engineers needed now," Mr. Orr said.

"Because of our particular needs," he added, "we cannot hire graduates as they leave school. They usually need three or four years of exposure elsewhere before they can come to us."

To solve the shortage problem, Lummus' Bloomfield headquarters has borrowed about 100 engineers from the company's European offices, bringing its engineering staff to 1,000.

Mr. Orr declared that the energy shortages would bring major opportunities to his company.

He said that Combustion Engineering, and, therefore, Lummus, were in the business of supplying energy that was clean.

"We are deeply involved in the treating of high-sulphur oils and coal," he noted, "and we have a process to make clean fuel from coal, although we haven't got a fix on exploiting it."

Mr. Orr asserted that a commercial plant for coal gasification could be a reality by 1977 or 1978, "despite predictions that this won't be possible before 1980 or 1985."

He acknowledged that these plants would be very expensive, but said that the clean-fuel-from-coal process would be competitive with oil if the price of oil reached $8 a barrel.

The company, he said, had entered into several contracts with the Government, such as one covering the design of a pilot plant for the Bureau of Mines, in the area of coal gasification.

Another contract, in which Lummus and the C-E Combustion division of Combustion Engineering are participating, was awarded by the Department of Interior's office of Coal Research.

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A DISCUSSION:

How Can We Best Educate Today's Engineers?

A subject which has been of vital importance to the faculty over the years is whether we are giving the best sort of education to prepare our students for their professional work after graduation. We continue to study the merits of various teaching approaches and methods and, in fact, have used a number of techniques in our course work.

During our OkChE board meeting last year, we set aside part of one morning so that the board members could address the question of how we might improve our teaching methods or approach to produce the sort of background and training industry wants most.

Members of the board participating were: Zane Johnson (B.S. '47), executive vice president of Gulf, Pittsburgh, Pennsylvania; Garman Kimmell (M.S. '37), president of Kimray Corporation, Oklahoma City, Oklahoma; Bill Orr (B.S. '40), president and chief executive officer, Lummus Company, Bloomfield, New Jersey; Charles Perry (B.S. '51), president, Perry Gas Processors, Odessa, Texas; Bob Vaughan (B.S. '63), assistant professor of chemical engineering at California Institute of Technology, Pasadena, and Frank Wolfe (B.S. '61, M.S. '62), division production engineer, Humble Oil and Refining Company, Houston, Texas.

Faculty members taking part in the discussion were: Frank Canfield, Jim Christensen, Carl Locke and Phil Colver.

Here are the principal points made during that discussion:

Orr — One of the things we observe is that about 95% of the engineers out of school have been taught so intensively in black and white they are unable to think in the gray areas. And most of our work comes in the gray area. For example, say we're determining the heat transfer coefficient for a particular application. We might argue on a value from 30 clear up to 100, and we might settle on 59. Now it would be rather senseless to complete the exchanger design using our most carefully exact and rigorous techniques, but most new engineers don't see this. It takes a number of years for most engineers to move away from black and white thinking; and some remain that way to the grave.

Laboratories are a very effective teaching tool, but students still must be challenged to apply their learning to the business world. They don't have the concepts for putting it all together on a competitive, economically viable basis; that part seems to be left out. Certainly, each fellow who is going to be a good engineer has to be well-grounded in all of the things he does get in school. But to the student who is going to enter industrial development, I would suggest that (at least in my business) he continue his schooling another year or get this exposure in other ways, rather than messing up our business teaching him.

Christensen — But will he get it in another year of school?

Orr — If you have the right kind of program, I think the student will, yes. But I think the added program has to relate directly to industrial problems.

Colver — Why do you need an additional year? Why can't you do it in the original four-year period?

Orr — I don't know.

Johnson — Or during summers?

Orr — Well, we work on that too.

Christensen — Do you find the people who have had summer jobs come in with a little bit more realistic approach?

Orr — A little bit — an awareness of what is expected of them. Are you going to give them a problem that is well spelled out for them to solve? Is that their job? No, generally you don't want that to be their job.

Vaughan — Are you looking for people with common horse sense?

Orr — I think that is a good description, yes. In our French office we designed a plant recently in which an engineer missed a decimal on a methanol tower and specified a 7-foot-diameter tower. Nobody caught the error. Anyone looking at the flow sheet would have seen the error. For this engineer, though, his calculation came out that way, and that is what he specified. And I bought a new tower. This is precisely the kind of thing that I am trying to get across: that the problem isn't solved simply because the engineer has *an* answer.

Perry — I was advised as a young engineer that the closer I got to the cash register the better off I was going to be. And I think that what you are driving at is that very point: the closer you get to the cash register or, in other words, the more you recognize the economics of dollars and cents the more value you are to the company and the better chance you are going to have to advance.

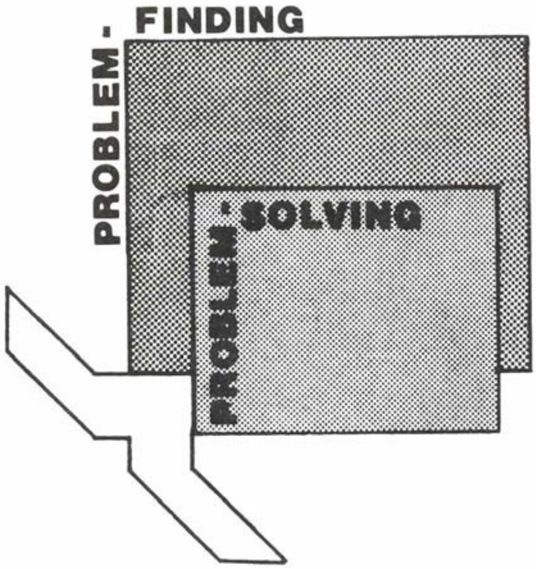
Johnson — I think perhaps we are all saying the same thing. We may look at it somewhat differently and should, because of the varied orientations of our companies. Also, let's take a look at those with different educational backgrounds — for example, a law graduate. Somehow, when a student gets through law school he is well rounded in many things. He is able to absorb a functional approach to engineering, marketing or anything if it involves a case that he is working on. Law training gives a person something that we can't do in engineering, and I don't know why. Is engineering such a pure science that we are blindfolded?

Christensen — Did you find that true of your education: that your education didn't prepare you for business?

Johnson — No, I wasn't a very good engineer either.

Orr — I think it was true of mine. I was probably out five years before I started to get the message.

Johnson — Oh, I agree. So was I.



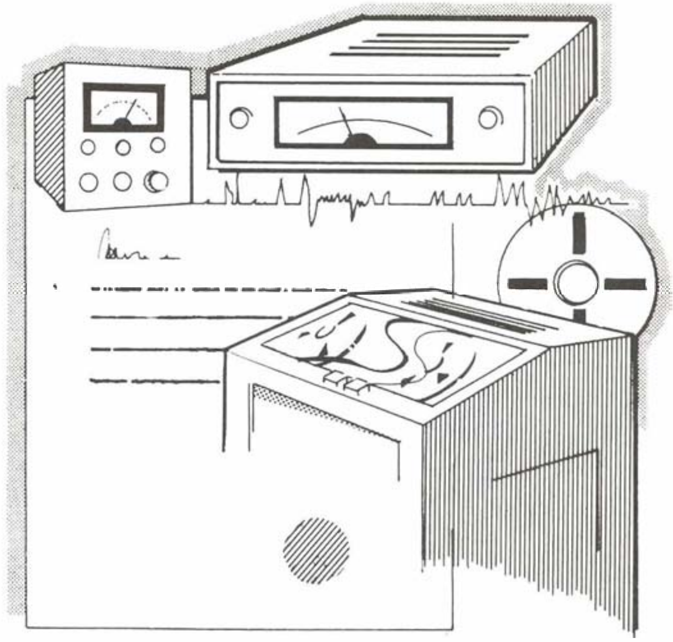
Perry — Zane, you have raised a good point. Many lawyers turn out to be politicians, so somewhere in their education is instilled a sense of public relations that I failed to get. I think what we are all saying is we are looking more for business engineers than we are research engineers.
Johnson — You get a good engineer, put him in charge of 10 people, and he may fall flat on his face. There is something wrong with that.
Wolfe — Now, let me comment a little on the contrary. What we look for in an engineer first and foremost is skill in the basic sciences. And I think by and large the product OU turns out satisfies that requirement. First of all, we don't have real strong reservations about the system as it is operated. And I try to think through some of the things the new engineers have trouble with when they do get into the industrial world. I think the biggest surprise they find is that they have been working in a problem-*solving* framework and we put them in what we call a problem-*finding* framework. Moreover, we frequently don't know what it is that needs to be solved. We know that there are some problems, but we really don't know where they are. This transition is difficult for a lot of students. They are simply used to having something presented to them to work out. Normally we don't do that.
Johnson — You hit it on the head, you really did.
Wolfe — Second, many new employees do not have a basic knowledge of cash flow and how investments are handled. They seem to pick it up reasonably soon, but when they first come to work they're not thinking in that frame of reference. Fundamentals of economics can be covered very quickly — in school by maybe taking a 3-hour course.
Canfield — One of the problems there would be that the professors don't think that way.
Wolfe — But your students have got to operate that way immediately when they come out. Some engineers and some of all groups seem to have trouble. Some can speak well, some can write well, and some can't. I think it kind of cuts across the board. But I think it is more important than the students realize. Within the first year or two they are with the company, if one presents himself in such a way that he is classified as being an effective communicator, it goes a long way toward moving up rapidly. If a person comes to work and has trouble talking and writing, in time he is out of it. So I think an emphasis on your part or at least making the students aware that they need to be concise and literate is important.

Finally, some students don't realize the effort that we expect from them when they first come to work. We have had brilliant students who simply didn't put in the 120% effort that we expect. And we don't tell them this, but it is something that we watch. It is very important that these new employees hit the ground running with any company they go to work with. Some are aware of this expectation, but they just don't follow through. And I would like for you to tell them that when they leave school it is not a time to relax; it is just more of the same trauma and will continue for the rest of their lives.
Colver — I would like to speak to the question of communication. In our curriculum we do not require technical writing. And even if students did take a course in communication or technical writing, it still wouldn't prepare them exactly for their needed communicative skills. I have also thought about eliminating the two English courses in the freshman year and letting students take certain journalism courses where the primary objective is communication. When a graduate starts with a company, his ability to communicate in all forms is of foremost importance. Initial impressions upon managers are very difficult to forget, and if a new employee acquires an initial reputation of being inarticulate, it is very difficult to remove this even though the individual improves rapidly. Many times he may as well move on to another company rather than attempt overcoming a poor first impression.

Frank, you mentioned that your company expects a new employee to hit the ground running, yet you don't tell him this. It's like you are watching him out of the corner of your eye, but you don't inform him of the game rules. Perhaps the employees will look around and actually pattern their work habits after those in your organization with 20 years' experience, but who are marginal producers and have actually been in a state of retirement for 10 years. The new employee may even look up to these employees because they are the ones that are willing to talk to them. The real producers may not have time to talk to the new employee and get him on the right track.
Wolfe — I said we don't tell them, but that really isn't true. We do say, "We expect a lot out of you." We say all of the words, but I don't know whether they really believe what we are saying. They don't understand. When I talk about hitting the ground running, here I mean possessing a

willingness to do more than we expect of them on the job.
Johnson — That is what we call ambition.
Wolfe — Yes, ambition or whatever; it is sort of a state of mind. It is difficult to define what it is I am talking about except some new students seem to have it and some don't, and it is sort of independent of their technical skills.
Colver — Is it independent of where they went to school or of this type of exposure?
Orr — Yes, I think it is.
Colver — Is it? I am sorry you said that, Bill, because I would like to think that at OU we could instill something in our students that gives them the sort of exposure to produce the kind of ambition, motivation, drive or whatever that you are looking for.
Orr — I think you could, but schools don't; that's what I am saying. To be able to write well, one must do a lot of reading, and I am not talking about technical textbook reading. I am talking about general reading of works by good authors. Now, that is one thing that lawyers do which is different in their studies. English students do that also, and they are able to write in an easier manner. Frank Wolfe said something about engineering graduates having trouble writing well; some of the technical reports that I've looked at over the years presenting plans for us to enter some sort of new business contained a beautiful technical approach. Still, the engineer who wrote it missed the point completely. It had to be rewritten and redone in order to present it to the business people in a convincing way.
Wolfe — The main problem that we get into, particularly with new employees, is that when they come out of school they are used to developing technical material having all of the background and necessary assumptions which lead to a conclusion. Their report is a rather lengthy, directly written document similar to a thesis. That's their approach. In some parts of our business, say in research, that is what we require, but for most communications it's not satisfactory. We want him to say it all in either 10 minutes on his feet or write it on one page. You know this is where they really start having trouble. I think students should be asked on occasion to consolidate a hell of a lot in a few minutes' time.
Johnson — Gulf uses Harvard, Columbia, Yale, etc., for 12-week business courses. I think they may be more helpful in 12 weeks than some engineering schools could ever be in helping an individual going into the business world. Could you bring programs like this into a four-year course? For example, the case study method of working together with people. I know it was one of the greatest things that ever happened to me.
Locke — I think some things can be taught and handled in the curriculum, i.e., writing, being aware that when they go to work they should be prepared to work hard and give their best effort, and not having everything wiped clean at the end of the semester. Some of the things can't be taught, though, because they have got to be experienced. You can teach a little bit of the economics, but the judgements you are talking about are something that has to be experienced. That is the only way they are going to learn.
Orr — Well, I agree completely with that.
Canfield — This board, you know, is made up of very interesting people; it is a diverse combination. Bob Vaughan represents a point of view that I would be interested in knowing something about, since a significant number of our students go to graduate school.
Vaughan — You are caught between a rock and a hard spot right now in the academic environment. Chemical engineering in general has the most requirements of any degree program, at least at Cal Tech, and I assume it probably does here. We are fighting a number of problems, but I will give you a background on what Cal Tech thinks is important. The chemistry program at Cal Tech now is essentially a totally individualized program. There is only one required course that every student must take and that is a public speaking course, because not one student will take it if it isn't required. They will take the labs; they will take the other courses. It seems an individual either likes math and science or he likes people. If he is people-oriented he tends to go into law and he finds people that communicate. Have you ever tried to talk to a patent lawyer? Can you find one that can integrate? They're as bad in trying to do technical work as most engineers are in the humanities. And this is part of human nature; it means that you have got to work hard trying to develop it.

But the kind of thing that worries me a little bit too is the point no one has raised, which has to do with the knowledge of what is really going on in industry right now. How good is a man going to be 10 years from now? How good is the training that he is getting now? How well can he educate himself after he leaves here? And then, the actual knowledge he gets, does he know what a "accreditation groups are too interested in hardware"



venturi gate valve is when he gets there? Are you willing to take a man who does not know this but who can learn quickly, or would you rather have him with economics and less detailed technical matter? We have had industrial people in and they surprise me, because they would much rather have a guy with the basic science rather than a technical knowledge. For instance, we no longer have a unit operations laboratory. Our students work on problems that haven't been solved before. They work together on case studies; they have to organize them and evaluate their work when they get through — that is the important thing. In the unit ops lab, with old reports around, a student doesn't have to evaluate a thing. It is all cut and dried. If a student had to evaluate something that no one else had done, there was no way. So I think there is really an overall effort in trying to bring in the kind of problems that we have talked about.

And another thing, I think we have a problem within engineering with the accreditation groups which put limitations on what they think is needed for accreditation. Such groups are too interested in the hardware. The economic thing gets a little bit of interest. California has unemployed engineers; at the same time they have jobs where people are begging for engineers. But those unemployed are those who learned a "nuts and bolts" trade which has gone out to business. They weren't trained in general fundamentals and didn't learn to appreciate them as time went on. And I think we see it as a direct goal, not just for graduate students but for everybody — to teach fundamentals and to teach students how to keep themselves fairly broad as they go along.

But individuals in industry can have something to do with the accreditation that people in the academic environment can't have. The things I also think are important that I haven't heard mentioned yet are chemistry and mathematics. There is a tendency now to go towards professional engineering programs, where they want you to stretch a four-year general engineering course into a fifth year. Such a move is just going to kill the chemical engineer's chemistry background.

Canfield — Bob, let me ask you for a different point of view — and that is, how do you consider your undergraduate education at OU as preparation for graduate school?

Vaughan — Very well, with certain exceptions. I could have used a little bit more sophistication in math than I got here and a little bit more sophistication in chemistry. I would have been much better off had I had more chemical engineering, more chemistry, and probably more public speaking and more writing. I went into engineering because I really didn't like to do public speaking and writing. Now I find that I spend most of my time doing these kinds of things. I think that is a generally correct observation of an engineer. It is one of the first things you have got to somehow get across to students.

Perry — There has been a change in the last 20 years in the field of engineering in general. We keep harping on managerial abilities because we know the engineer is invariably going to end up managing other engineers and technicians. Twenty years ago this wasn't true; everyone worked in the lab or out in the plant.

To change our direction a little, I bet one thing each of you notices is the attitude of each new engineer you interview. If he comes in with the attitude: "What does the company have to offer me?," you write him off. If he comes in with the attitude: "What can I do for the good of the company?," that is the guy you will hire right on the spot if you possibly can. It is pretty distinct, there is not much in between.

Johnson — If he asks what the pension plan is, I send him out the door.

Canfield — Frank Wolfe pointed out they like people who can find problems and solve them. What we have been doing mostly in this discussion is identifying problems. We haven't moved too far in the direction of the solutions. One of our problems is that we don't know how to teach many of the things that should be taught because we don't know them ourselves. Professors by and large are not businessmen and most of them have never been in business. So most of us professors have little concept really of some of the things you businessmen would like for us to teach. I know when I went to the University of Arkansas for an undergraduate degree, I was profoundly disappointed with the experience. I went there from a high school that was a moderately poor high school. What I experienced my first year of college and the second, third and fourth was essentially what I had experienced in high school. I had anticipated and was ready for a more significant experience. I thought this would be different, but it wasn't. It was the same old stuff. I think students come to us ready for the kind of experience that you would like to see them have. If we knew how to do it or if we had a combination of people who knew how to do it, it could be done in four years without any difficulty whatever. Various ones of us have tried the project approach in teaching individual courses, that is, a student is given more or less an opening project which he works on to ultimately find a solution. Unfortunately, the times I have tried it I have ended up with a lot of Cs, Ds, Fs, and drops. Perhaps we hit them a little too late. They have become accustomed, like I did after my freshman year, to thinking "If this is all there is to it, I will do it, but I am not happy." My disappointment eventually waned and I became accustomed to that way of doing it. I think if we could somehow start out with a different experience for the student, at least in chemical engineering, we could do the sort of job you want.

Orr — I don't know if this can be applied to a freshman, but there is an awful lot of written material and one can really get himself involved in planning and programming bench marks of his professional progress. When I joined Lummus the profit center managers didn't understand management by objectives, but I installed that program. One of our best managers heard me out about what I was telling him to do. I said, "Now go, and within five objectives, no more, describe your job and what you want to achieve during this next year." He came back about three weeks later and said that was the hardest thing he had ever had to do in his life. And as you measure people in their progress, note that it takes about four or five years before they get very good at whatever they're doing. Maybe if we could start bringing that to our freshmen somehow, start getting the students to think about their lives and what they want to do, they just might do a lot more work in a lot less time.

Christensen — You can't do that, of course, if you say, "Okay, for four years you are going to be plugged into the sequence of courses we have got programmed for you." You know that is not how you teach somebody to manage his life.

Orr — There is a lot to that.

Canfield — We have thought about a 25-hour course in chemical engineering that just happens to begin at the freshman year, but there will be no individual courses involved as such. Although this would require a lot of money. We thought about a situation where the freshman enters the School of Chemical Engineering as a person would enter a new job. He comes in as a junior person in an organization which is set up simply to educate him, but it would be set up in a more formal way. It wouldn't be the classroom experience that he is accustomed to. We haven't planned this in any detail, of course, because

"think about your life, and what you want to do with it"

there is absolutely no way we can finance the operation. But these are the sort of things which could possibly give the student an experience which would do what we want.

Christensen — You talk about managing by objectives. The point is we don't teach by objectives. We lay out a course, we lay out a list of subjects that we are going to cover, and we don't describe what it is the student is really supposed to be able to do when he gets done with the course or that unit of experience. We plug the student in and grind for three hours a week.

Johnson — I think we are all talking about the same thing. You have got to have basic math and basic chemistry in chemical engineering; I think all of us agree that these are first and foremost. There is no doubt about that. Maybe you throw out unit ops and put something else in, but aren't we really getting down to the professor really taking the place of the parent? A kid goes to college when he is 17 or 18, and he moves into a whole new life style, a whole new world. He trades his parents and those experiences for the relationship with a professor.

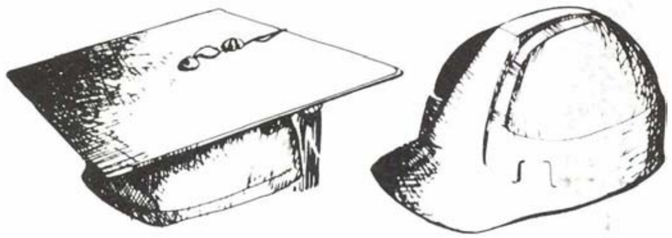
Christensen — But with the professor he doesn't get any kind of human relationship.

Canfield — No, particularly not to start with, because in the professional skills we have very little initial contact with the students.

Colver — To get back to something we discussed before: don't you have to have the engineer who thinks only in terms of "nuts and bolts"?

Orr — Sure you do.

Colver — They are the individuals that don't have any of these other things. But they can be managed by someone that can plan and see ahead. We are, however, interested in the student with the capacity or the potential to possess common-sense traits — not the individual you can hit over the head and he still doesn't have the capacity to understand or to start applying common-sense values. We all know certain individuals who are good slide rule mechanics or computer mechanics, but



$\int x^n dx = \frac{x^n + 1}{n + 1}$

What did he say?

they are never going to be good managers and they are never really going to be good engineers.

Vaughn — In any case, industry is not going to get the perfect man in four years. The questions are: What should we do that we can do best, what should we expect industry to do later on and, finally, how are we to operate on this basis? We have to decide whether it is good or bad to leave in old material or add new. And my feeling is that we are doing a pretty fair job right now. What I tend to do is emphasize the very basic fundamentals and the concepts of how you formulate and solve a problem. That is not consistent with either what the accreditation groups think or what certain faculty members believe.

Colver — Something someone said a minute ago reminded me of a battle we seem to be continually encountering, and that is: industry many times has not effectively utilized some of the tools that we now give our graduates. A good example is calculus. The new young engineer enters an organization and wants to apply calculus in solving a problem. Yet he must be extremely careful or he may have difficulty explaining his results to his boss. His boss doesn't remember any math beyond algebra and feels he has operated ably for 20 years and hasn't needed it yet. I think our recent graduates have many such tools but haven't been encouraged to use them.

Christensen — And he doesn't know how to explain what he is doing in an acceptable way either.

Colver — Yes, and in fact when he does apply such new methods he may be ridiculed.

Wolfe — I have not seen that kind of attitude nor that kind of problem.

Colver — You haven't?

Wolfe — No, I have not.

Canfield — I have. Not in Exxon, but then Exxon represents an unusual company in that respect.

Vaughan — But on the other hand, that is the battle the universities ought to be fighting. This is exactly where you ought to buck the industrial group, because obviously the company with better informed personnel will eventually have higher profits.

Canfield — Of course, we have never demonstrated that. That is another thing. I can remember a few years back when process control was going to be the salvation of the whole industry, but the industries that jumped right into it immediately lost a lot of money instead of making a lot of money. In many cases it is our fault not being able to demonstrate that these technologies are of any value. Certainly if a guy doesn't use calculus when he gets out, we have got to take some of the blame.

Perry — I think there are two sides to this. I think the use of calculus is good, but I think a student falls short when he gets into industry and takes a solution to his boss along with all the derivations. Ninety-nine times out of 100 his boss doesn't care how he got there — all he wants is that final figure. In other words, he has confidence in the man's ability, otherwise he shouldn't have him on the payroll. This gets back to report writing.

Colver — But don't you feel that when sound but untried, unproved methods are proposed there is a reluctance for management to take the chance?

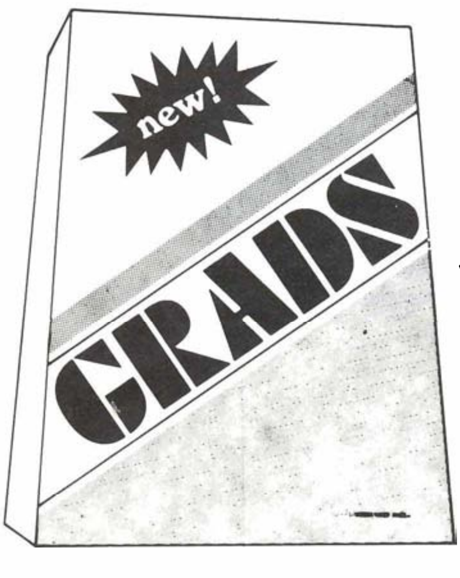
Johnson — If you have got a chance at 30% return, I will take a good risk. If it has got 12% return, I don't want to take the risk.

Canfield — Yes, but you can mention so many examples, not necessarily in the chemical industry but in other industries, where it is probably not a technical problem or money problem as much as it is a top management problem. It is a lack of understanding of the technical details. I can throw out the radial tires as an example. They started being developed in France long ago and produced in Europe long ago. The top executives in the companies made the decision that this is not the way it is going to go. Well, they were wrong. After all, they probably had pretty good input. I see this in a lot of U.S. industries. The automobile industry is one of the most staid industries around. The steel industry is a problem. I think the chemical industry is going to be the same sort of problem.

Wolfe — All of your industries by and large are concerned with the resistance to change, and fight against walls and barriers.

Johnson — Well, you take the top 30 industrial firms that make up the Dow. They grow at something like 6%, and that is the economy of the United States. That's not conservative, you know.

Wolfe — I think, in fact, the man who succeeds is the man who somehow, by force of personality or whatever, can convince people to change by making improvements. But making that happen is extremely difficult. And any engineer, when he comes to work, might as well get used to the idea that probably 80% of the things he proposes were already recommended. He has got to be able to live with that.
Perry — Yes, but Frank, when he gets older and looks back, he is going to be willing to discard a big number of those.
Orr — He will be a dead hero.
Wolfe — I want to touch on another point. Phil, you said that people were not using calculus on the job.
Colver — I am saying that there is a resisting force in management or in the companies they go to work for not to use it or at least if they use it keep it to themselves.
Canfield — I have heard managers brag that they have never used calculus in the 20 years that they have been out of school.
Colver — But they have used the results of it in their design.
Vaughan — Well, this is sort of getting off the topic. The question is not what's wrong, but what can a university do? And about all you can do is inform students along the way that this is a problem they are going to have, and try to instill enough confidence to know when they are right and when they are wrong.
Christensen — I think our problem again is we are looking at putting fixes on the 300-year-old process and what we ought to be doing is saying, "What is the purpose of education?" or "What are the objectives of engineering education?" and "Can these objectives be accomplished by the institution as it exists?" You know you have been spelling out some objectives here and the kinds of things I have heard really have more to do with personal development than with technical content. I am not sure you can accomplish that kind of personal development in the university as it is presently structured, because it is nothing but a glorified high school.



Packaged and Produced by The University

Vaughan — But on the other hand, there are few complaints about technical capabilities that come out of this kind of structure, so you have got to be careful. If you start to build a new system we have to somehow reincorporate those good things into the new system and it is not so easy.
Canfield — Yes, that is a good point.
Christensen — The point is that the university as it is presently structured cannot cause positive personality change. It is not structured to do that.
Kimmell — Why can't it?
Christensen — It can't because it is too large and too bureaucratic essentially and because it is nothing but a glorified high school, where you plug students into slots and slam them through.
Kimmell — I will hire a guy that is moral before I will one that has the technical background, because he can get the technical stuff but I haven't got the tools any more to train him morally. I can't discipline him enough to give him the moral training. And I think that if you start them out right in the universities that you provide this.
Colver — Granted there are certain things that we start with in each individual, but there is only so much one can do. How can we generate ambition, let's say, if that is desirable or instill motivation and the ability to want to achieve, to do a good job, to become disciplined and these sorts of things? You are suggesting that the university can do this?
Kimmell — Yes, I have seen the experiment run too many times, and I am a typical example of that experiment.
Vaughan — Could I also suggest that the school selects two or three kinds of people to go through this environment and it may have nothing to do with what the school does.
Colver — I have heard it facetiously stated that the goal of the university is to make its students as much *unlike* their parents as possible.
Kimmell — I think that is a mistake, because then you have to define the parents. Maybe you should make them different than some parents, but to say categorically that you are going to make them different than all the parents, I think that is wrong. You know, professionalism is difficult to define. What is a professional? I think a professional has polish, patience, a keen skill, and he is innovative.
Orr — And pride!
Kimmell — And some pride, you bet. Now this has to be put in the proper framework. The engineer has got to enjoy and delight in the things that he is succeeding in.

student spotlight

*This issue of the **Newsletter** is spotlighting three OU chemical engineering students. All three have extraordinary academic performance records and will surely be outstanding engineers. For your diligent work and professional dedication to engineering, we salute you, students!*

Craig Harvey, Michael Riddle and Joe Meng Wei Tsou

Craig Harvey

. . . will graduate in May 1974 with a B.S. in Chemical Engineering and a B.S. in Chemistry. His immediate plans include working in industry, and he will attend graduate school at a later date. Craig was an OU Merit Scholar. He participated in the Chemical Engineering Program of Excellence and the OU Model United Nations.

Michael Riddle

. . . also will graduate in May 1974 with a B.S. in Chemical Engineering. He received a research assistantship from the University of Wisconsin and will pursue a Ph.D. there with emphasis on rheological modeling of polymer systems. Michael has worked during the past two summers gaining industrial experience: in 1972 for Continental Oil, where he won the Special Project Report Award, and in 1973 for DuPont, working on rheological development of experimental fiber. During his academic career at OU, he was awarded scholarships by the Alumni Development Fund, the Harmon Foundation, the American Gas Association and the Dresser Foundation.

Joe Meng Wei Tsou

. . . is a recent graduate of the school (he received his B.S. in Chemical Engineering in December 1973) who is now working toward his M.S. in Chemical Engineering here. Originally from Taiwan, Joe immigrated to the United States in 1967. He lived with his family in Chickasha, Oklahoma, and went to high school there before coming to OU in 1970. Joe and his family, who now live in Moore, Oklahoma, have taken quite an interest in OU — Joe's father obtained his M.S. in Petroleum Engineering in 1967, his brother is studying pharmacy, and his sister plans to be a student here later this year. Joe would like to become a practicing chemical engineer and work for the chemical / oil industry.

NEWSLETTER NOTES

Al Clark, professor of chemical engineering, has another book coming out. It is titled *The Chemisorptive Bond: Basic Concepts* and will be published by Academic Press April 5, 1974.

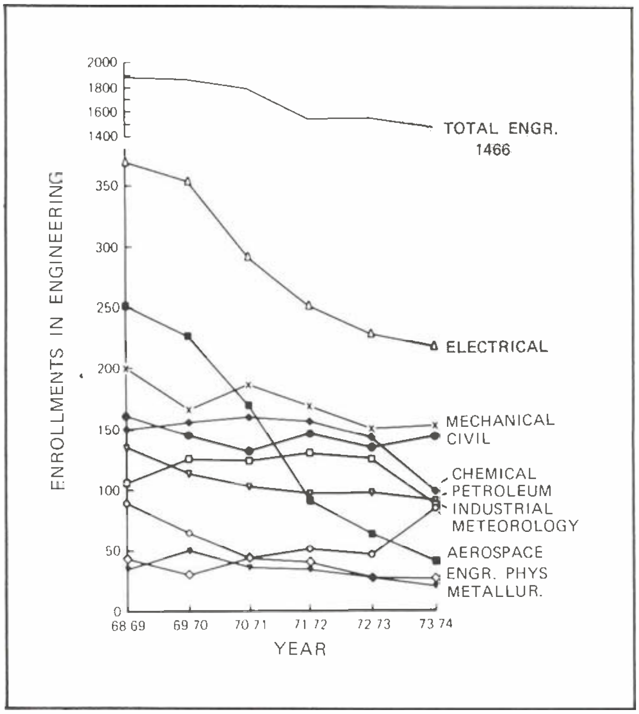
Kenneth E. Starling, also professor of chemical engineering, has written *Fluid Thermodynamic Properties for Light Petroleum Systems,* Gulf Publishing Company, 1973. Starling will spend the summer at the Electric Power Research Institute in Palo Alto, California, doing research on geothermal and alternate energy sources.

Phil Colver will be returning from sabbatical leave in June 1974 to continue his duties as director of the School of Chemical Engineering and Materials Science. Frank Canfield is serving as acting director during Colver's absence.

William P. Orr, president and chief executive officer of the Lummus Company, Bloomfield, New Jersey, has been named a group vice president of the firm's parent organization, Combustion Engineering, Inc. He also will head C-E's newly formed Engineering Group. (See "Globe-Trotting Engineer," page 4.)

On leave of absence during the coming academic year will be Art Aldag, associate professor of chemical engineering, and Frank Canfield, professor of chemical engineering. Aldag will be working for Phillips Petroleum Company in Bartlesville; Canfield will be working for ChemShare in Houston. As a result, there are two temporary positions in CEMS to be filled before September 1974. If you can recommend someone with industrial experience for either position, please let us know. It's a great opportunity to promote meaningful interaction with industry. (See "A Discussion," page 7.)

J. H. Christensen, associate professor of chemical engineering, will be on sabbatical leave from September 1974 to January 1975. He will use this period to further develop his interests in modular instruction, microcomputer applications in chemical engineering, and the individuation process.



Have you noticed the attractive new format of the *Alumni Newsletter?* Design and editorial assistance is now being provided by the University Publications Office, and the September issue of the *Newsletter* won a first-place award in the 1973 competition sponsored by the Oklahoma College Public Relations Association.

ENROLLMENT CURVES

Enrollment curves in the College of Engineering show that seven out of these ten departments showed a drop in enrollment. One major reason for this is the high number of undesignated engineering students; there was a significant increase in that number from 1972-73 to 1973-74. These students will filter into various majors such as chemical or metallurgical engineering as they learn to fill out enrollment slips correctly. So we have hope that the enrollment picture is not as dim as it looks now.

ALUMNI CORNER

We're vitally interested in knowing where you are and what you're doing, because one of the most important jobs of the *Newsletter* is to keep your friends informed of your activities. Please fill out one of the enclosed information cards and send it to us. Along with it, why not include a photograph? A "show and tell" letter from you would be great.

Richard G. Askew, M.S.'47, was transferred to Bartlesville, Oklahoma, January 15, 1974, by Phillips Petroleum Company as manager, chemical group world-wide planning and budgeting. Previously he was in Houston, Texas, as general manager of the plastics division of the Chemical Department. He is a 1972-73 member of OkChE.

Leo L. Baker, B.S.'38, was a recipient of the 1973 OU Alumni Hall of Fame Award. He is a 1972-73 member of OkChE.

James E. Berryman, B.S.'49, resides in Lewisville, Texas, and is self-employed. At present he is working full time on a contract for Mobil Oil de Venezuela, doing simulation studies. He received a Ph.D. in Chemical Engineering from the University of Texas in 1971 and is a 1972-73 Century Club member of OkChE.

Mark Buchheim, B.S.'63, is an operations manager with Gentry International, Inc., and resides in Sparta, New Jersey. After serving in the U.S. Army from 1963 to 1966, he received his M.B.A. degree in 1972 from Iona College. He is married to the former Diane Kirkus of Atlanta, Georgia.

Hugh R. Bumpas, Jr., B.S.'51, M.S.'71, is in Tsoying, Kaohsiung City, Taiwan, where he is a colonel in the U.S. Marine Corps. Since August 1973 he has been serving with the U.S. Military Assistance Advisory Group, China, as senior advisor, Chinese Marine Corps.

Kenneth R. Cantwell, B.S.'51, is employed by Phillips Petroleum Company in Bartlesville, Oklahoma, as director, chemical and mechanical engineering section, Computer Department. He is a 1972-73 member of OkChE.

Paul R. Chaney, B.S.'62, lives in Beaumont, Texas, where he is senior environmental control engineer for Mobil Chemical.

Henry H. Chao, Ph.D.'67, is a senior research engineer with Consolidated Paper, Inc., living in Wisconsin Rapids, Wisconsin.

James E. Cochran, B.S.'42, is products supervisor with Vickers Petroleum Company in Ardmore, Oklahoma.

John R. Cooper, B.S.'31, retired February 1, 1973, as supervisor after 41 years with Skelly Oil Company, including nearly five years in chemical warfare service during World War II. He lives in El Dorado, Kansas, and is a 1972-73 OkChE member.

Gilbert W. Denison, PhD.'62, is employed by Tremco Manufacturing Company and lives in Chagrin Falls, Ohio.

Richard A. Fitch, B.S.'56, is staff engineer for Amoco Production Company in New Orleans, Louisiana. He makes his home in Covington, Louisiana.

Walter M. Ford, B.S.'71, is an assistant plant engineer with Southern California Edison and lives in Bullhead City, Arizona.

Gerald L. Glahn, M.S.'56, is an engineering associate with Exxon Chemical Company, U.S.A., residing in Baton Rouge, Louisiana.

Larry E. Glasgow, B.S.'58, lives in Tyler, Texas, and is an engineer for Howe-Baker Engineers, Inc. He is also a reserve officer holding the rank of major and a 1972-73 member of OkChE.

Roger G. Harrison, B.S.'67, is a graduate student in the Chemical Engineering Department at the University of Wisconsin in Madison. He expects to obtain a Ph.D. degree in December 1974.

Michael Heymann, Ph.D.'65, is an associate professor in the Department of Applied Mathematics, Technion, Israel Institute of Technology, Haifa, Israel. He has been the chairman there since 1972.

Donald G. Howe, B.S.'64, resides in Oklahoma City, Oklahoma, with his wife Janet and their three children, Gregory, ReGina and Laura. He is a project engineer for Trend Construction Corporation.

William S. Hudson, B.S.'47, is vice president with Butler, Miller and Lents, Ltd., in Houston, Texas. He and his wife Mary Anna (Morton) live in Houston and have two children, Diana and Richard, who are both pursuing advanced degrees.

Khosrow Jatala, B.S.'71, is a research and development engineer for Dow Chemical Company in Freeport, Texas. He and his wife Peggy and their daughter Sara live in Lake Jackson, Texas.

John C. Jepsen, Ph.D.'64, is a manager with Shell Chemical Company, working in the Development Department of Project Polymus in Houston, Texas.

Bob LaFon, B.S.'60, dropped by the CEMS office on February 7, 1974, with an unrestricted grant of $3,000 from Celanese. He is process engineering superintendent for Celanese at the Pampa, Texas, plant.

Wilson Lee, M.S.'68, is employed by Hoffmann-LaRoche, Inc., Nutley, New Jersey, in research and development. He resides in Woodside, New York, and is a 1972-73 member of OkChE.

Gerald N. Livingston, B.S.'62, is an inorganics systems job leader for M. W. Kellogg. He and his wife Roma, who also attended OU, have three children, Nelson, 13, Don, 9, and Dana, 7. They live in Houston, Texas.

Robert M. Mead, B.S.'71, is a project engineer for Ingalls Shipbuilding Division-Litton Industries. He resides in Gautier, Mississippi.

Earl E. Patterson, M.S.'47, is a special assistant to the executive vice president of Reynolds Metals Company in Richmond, Virginia. He is a 1972-73 member of OkChE.

Omer A. Pipkin, Ph.D.'65, is a manager, technology, for Cities Service Company in New York. He lives in Convent Station, New Jersey.

Bernard L. Reymond, M.S.'64, is in Denver, Colorado, working for Stearns Roger as an environmental engineer. He expects to be a registered professional engineer there soon.

James H. Richards, B.S.'40, is working at McDonnell Douglas Astronautics Company as a branch chief, Strategic Defense Systems, in Huntington Beach, California. He has been with McDonnell Douglas since 1956.

Ken Sanders, Ph.D.'73, is employed by the U.S. Atomic Energy Commission as a process engineer in the Office of Regulation, Washington, D.C. In April he will move from Rockville to Gaithersburg, Maryland.

Max A. Turner, M.S.'49, is a senior engineer for Todd Shipyards, Research and Technical Division. He is a member of AIChE, AIAA and the Bay Area Chorus. He and his wife and their three children live in Houston, Texas.

Frank P. Williamson, B.S.'50, resides in Houston, Texas, where he is a project manager for Panhandle Eastern Pipeline Company. He is a 1972-73 member of OkChE.

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