

INTERVIEW FEATURE

Interview with Frank N. Kelley, Dean, College of Polymer Science and Polymer Engineering, and Professor of Polymer Science, June 1996

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Dr. Frank N. Kelley

BACKGROUND

The College of Polymer Science and Polymer Engineering at the University of Akron has been identified as one of the top polymer science academic programs in the United States and throughout the world. We had the honor of interviewing the dean of this prestigious program, Dr. Frank N. Kelley.

Dr. Kelley was born in Akron, Ohio, on January 19, 1935. He attended the University of Akron where he earned a BS in chemistry (1958), and an MS (1959) and PhD (1961) in polymer chemistry. After graduating, Dr. Kelley was employed by the Union Carbide Corporation until he entered active duty with the United States Air Force.

Assigned to the Air Force Rocket Propulsion Laboratory at Edwards AFB, California, as an Air Force officer, Dr. Kelley remained as a civilian at Edwards when he completed his military tour in July 1964. He conducted research and managed technical programs associated with solid propellant mechanical properties. In 1966, he became chief of propellant development and in 1970 was transferred to a staff assignment as chief of advanced plans. In 1971, Dr. Kelley was named chief scientist. In September of 1973, he transferred to the position of chief scientist of the Air Force Materials Laboratory at Wright Patterson AFB, Ohio. In June 1977, he was named director of the laboratory.

In September 1978, Dr. Kelley returned to his *alma mater* to serve as director of the Institute of Polymer Science. He was appointed as Dean when the college was formed in July 1988. He is an active researcher, teacher, and consultant. His publications have focused on the relationship of molecular structure to mechanical properties of polymeric materials.

Drs. DUBICK and NEWMAN: Frank, I want to thank you for the opportunity to conduct this interview. Could you please begin this discussion by providing a definition of a polymer? Many people, like myself, know very little about polymers.

Dr. KELLEY: *Polymer* is a word for a class of materials, just as the word *metals* is a word for a class of materials. Polymers get their name from the Greek words *poly* meaning "many," and *mer* meaning "unit." So *polymer* means "many units." And that describes this class of materials based on their smallest building blocks, the molecules that make them.

The nature of polymer molecules is that they are extremely long molecules consisting of many units, just like beads on a string. So *polymer* describes—for the people who think of things in terms of molecules—what this class of materials is made of. And the polymer materials that you would be most familiar with are rubbers and plastics.

Polymers are also the substance of life. In fact, most synthetic polymers are made from fossil fuels, such as petroleum or natural gas or coal. As we all know, these materials, these fossil fuels, originated as some form of life, either plant or animal life, that had been converted over eons below the surface of the earth into such materials as petroleum. There are many more naturally occurring polymers than synthetic polymers. The substance of the cells of wood or cotton is cellulose, a

polymer. Even the material which contains the genetic code in your body, such as DNA, is a polymer. The many components of your skin and muscle and connective tissue are polymers.

Drs. DUBICK and NEWMAN: You have been with the University of Akron a long time. What do you think the University of Akron's future is in polymers?

Dr. KELLEY: I have been a member of the faculty here for almost eighteen years. The future should be bright, in that the various uses of polymers will continue to grow. It is one of the most rapidly growing industries. It is in the top three industries in the nation. The continuous growth rate is at least twice that of competing materials like metals, and is sometimes two to three times that growth rate.

Drs. DUBICK and NEWMAN: Does the University of Akron's reputation of excellence assist you in recruiting outstanding students?

Dr. KELLEY: It is always extremely difficult to attract the very best students into a program in an institution which is not that well known and in a field which is multidisciplinary and in which there has not been many decades of recognition of the existence of such programs. So when a student thinks about going to graduate school, that student may think of the traditional types of departments: chemistry, chemical engineering, mechanical engineering, physics. Because there are still a relatively small number of polymer programs in this country, or even worldwide compared to the traditional programs, it usually is not the student's or faculty advisor's first option.

Drs. DUBICK and NEWMAN: I recently read an article in a local newspaper about a high school teacher who was listed as a polymer science teacher. Are there polymer programs in elementary and secondary schools?

Dr. KELLEY: There are programs in this area that have developed in elementary and secondary schools with a polymer focus. I think it is correct that we stimulated that interest perhaps ten or twelve years ago.

Wayne Mattice, one of our faculty members, has a Molecular Modeling Center that he manages which is a computer workstation-based simulation-type of research program for discovering new polymers and the ways they behave. The center is connected through the computer networks or through modems to three area high schools and is currently working on a fourth connection. It has trained science teachers here in the use of some software so they can, in their chemistry and physics and biology classes, use graphics and simulations to show students the principles of the chemical or physical behaviors of these materials. A variety of other examples is also accessible to these teachers for physics and chemistry.

Drs. DUBICK and NEWMAN: Does the sophisticated simulation software that you have made available to students integrating and combining physics, chemistry, biology, and so forth make learning more effective?

Dr. KELLEY: The key thing about the use of the compu-

ter and the use of some of this advanced software is that you can illustrate graphically. It is something that today's students are very used to doing: visually accessing information, whether it is from a television set or a computer screen. I think we can communicate some principles that were a little more difficult to communicate, and bring together the multidisciplinary aspects because we tend to think of polymers in particular in terms of the mechanics of the way the long molecules wiggle around and entangle. That particular visual picture of the way these materials are behaving can be grasped if you are seeing it. You can see so much more in such a shorter period of time than we could in the old days when we had to build, by hand, tinker-toy types of models.

Drs. DUBICK and NEWMAN: Is there a problem attracting American students to the study of science?

Dr. KELLEY: The number of high school graduates prepared for successful science and engineering collegiate episodes in their lives is a very small number. It is on the order of five percent. Then the question is what fraction of those who reach the baccalaureate level have either the interest or the aptitude to go to graduate school. Since, particularly in the engineering professions, there have been good jobs in general waiting for people at the four-year-degree or five-year-degree level, there is a tendency for most American students to want to go work and try to access the good life. If there is a good job waiting after school, why go to graduate school and prolong your start for buying that home, getting married, developing a family, getting that new car? That seems to be what motivates a lot of American students.

We have multiple impediments to our finding and attracting good US citizen graduates into our programs. We have absolutely no problem with noncitizen or international students. We have hundreds of applications for perhaps thirty positions a year. So we can be very, very selective, and often we get the very best from abroad. We feel also that there is a good secondary, let's say educational benefit, a fallout educational benefit, from the mixture of the cultures that occurs in a graduate school, and we experience it every day here. I enjoy it particularly. We have something that is the best in the world in this country, and that is graduate education. That is why international students flock to this country.

The question that often comes up in political or in corporate circles is, "Why are we training our competition from abroad?" That view fails to recognize two very important things. One is, according to our records, 88 percent of all of our graduates work in this country. Some of our graduates work abroad for companies based in this country. That is one thing. The other is that if we think in terms of our boundaries as being a limit in terms of any commodity that we deal with or any particular program that we deal with, we are making a serious mistake at this date in time. Having an international network of people who are trained, who can accomplish things, benefits the world economy. The question really is, how do we play in that world economy? So there are those two aspects. Most of our graduates go to work in this country. Those that don't are probably

still providing us some sort of general benefit.

Drs. DUBICK and NEWMAN: Please describe for us some of the things that the graduates of a polymer science program might do.

Dr. KELLEY: Remember I said that polymers and all of the polymer-related industry is among the top three industries in this country, about a 170 billion dollar industry annually. So there is hardly a machine, there is hardly any particular product maker or user or designer that does not involve polymers.

Polymers provide the interface between metal parts that have to undergo vibration so that they can dampen. Polymers provide flexibility. Polymers provide light weight and corrosion resistance and those sorts of things. There is hardly an industry which does not have a need for a polymer person. Certainly the transportation industry, the truck and automotive industries, have polymers all over.

The content of an automobile made of polymers is growing every year. We are now at about 400 pounds per vehicle. When you realize that 400 pounds of polymer is worth, let's say, 2000 pounds of steel or even in dealing with realistic trades, probably at least 500 pounds of steel, since the density of the two is different. But when you deal with a constant requirement to reduce energy consumption, both the manufactured products made of polymers and the use of polymers in fields that require moving objects from one place to another, you save enormous amounts of energy when you use polymers.

One thing that I think is inevitable, like death and taxes, is that energy is going to become more and more costly as time goes by.

Drs. DUBICK and NEWMAN: There is a movement in the school systems, at the Ohio Academy of Science and a variety of other places, that we give more recognition to multidisciplinary efforts, that one can no longer be successful as a scientist or an engineer working alone without working with other disciplines. Your program seems to epitomize multidisciplinary efforts.

Dr. KELLEY: One of the reasons our program was created was to cut across some of those lines. That is, our departments, one in science and one in engineering, each of those departments are multidisciplinary in character. There are chemists, physicists, and engineers in the science departments. There are a variety of different kinds of engineers in the engineering side of this college. So we were born out of a recognition that this multidisciplinary character is needed and is sometimes difficult to do in a traditional silo-like organizational structure.

Drs. DUBICK and NEWMAN: I have been told that the British scientists are very highly sought after by organizations and industry in this country because they come experienced in working as teams, they fit into networks and systems. Shouldn't we be concerned about this approach in our universities? Shouldn't we place value on efforts to develop teamwork?

Dr. KELLEY: Yes. I think that we have to value such

efforts, but we have to value them as supplemental, not as primary.

Drs. DUBICK and NEWMAN: Why not primary?

Dr. KELLEY: Because the process by which we have to develop an individual in a PhD program, is that a person be a self-starter, exercise independent judgment, and have creativity and innovative character.

Our students work in teams. They do from day one. Our average professor has fourteen graduate students working mostly on doctorates. They are a part of a major funded effort that tends to have a lot of interaction and synergism. They meet as a family—that is the word I will use rather than team—with the professor as the head of that family, with perhaps visiting scientists and post-doctorals who socialize together, who work on projects together.

The professor still has to discern whether each student is evolving not only as a good team member, team player, an integral part of the society, but as an independent contributor, independent in the sense of an independent thinker.

Drs. DUBICK and NEWMAN: If you had the power educationally speaking, how would you change the educational system to prepare scientists better, starting out with elementary school?

Dr. KELLEY: Starting with the elementary schools, I think it really relates to the kind of teachers we have, coaches if you will, in that environment. There has to be someone there who is experienced and has been excited by the subject to be able to transmit that excitement. Almost without exception, you find that a student goes into the sciences because the home environment was conducive to it. That is, science was an exciting thing at home, and it became an exciting thing at school.

I would somehow provide incentives and whole new structures for bringing the core of teachers in these fields into play that really have a personal excitement about the subject.

Drs. DUBICK and NEWMAN: I want to repeat what I thought I heard you say. That is, maybe the most important aspect in getting people prepared and involved with science is the motivation and attitude of the teachers.

Dr. KELLEY: Yes, and it is parents too.

Drs. DUBICK and NEWMAN: Would you please react and respond with your position in regard to the role of teaching *versus* research on the university campus?

Dr. KELLEY: Well, let's look at it as a clinical environment in which a master researcher is instructing an apprentice in how to do research. This is the most effective teaching that goes on. It is the most effective teaching that I do.

When I sit here with my graduate students, I spend a couple of hours with them going over not only what they have done and what their plans are but their way of thinking about these problems. You know that right there you are essentially molding a person into a very capable researcher. We teach the ethics of research. We teach the techniques of problem solving. We try to do

some mind expanding. We try to show how, if you have been beating your head against the wall, you can always find a way over or around or under it. So that particular type of teaching, I think, is the most genuine, effective type of teaching. And it happens to be that we are teaching a person how to deal with problem solving, creativity, and discovery. What could be a more valid type of teaching than that?

I have no concept of teaching *versus* research. I do no research in the context of pouring things from one test tube into another or whatever. The students do that. I do that through them. Sometimes I have to go and show them that I can actually do that, but that is just to prove to them that some of these manual skills have not left me. But the real skill happens to be to transmit into that brain and that pair of hands something about the art of discovery. So that is what goes on in our laboratories. I say there is not a single room in this building which is not dedicated to teaching. That's the view.

Drs. DUBICK and NEWMAN: I have a flippant question to ask you. It may be rhetorical, but I am just dying to ask it. Does it really take a rocket scientist to be the dean of the Polymer Science School?

Dr. KELLEY: Let me deal with that as though it was a serious question. Somehow the phrase *rocket scientist* has entered the lexicon of today as *nuclear physicist* used to be used in the atomic age. I guess that is the equivalent in the space age. I think I legitimately can claim to be a rocket scientist, having been the chief scientist of the Air Force Rocket Propulsion Laboratory, and I still consult widely in that field, I don't see it as compli-

cated as a lot of things. I see it as kind of ordinary and fun. So what is different about that?

I think the dean has to be a person who can interact with a whole variety of people, but particularly with his or her faculty in such a way that they have trust and feel like their best interests are being looked out for, and that there will always be a sympathetic ear, and they will always have access to information. Those are the things I practice.

I see my task as dean to try and make the environment as productive as possible for the faculty. I don't want to lose excellent faculty because they felt that this was either an oppressive or a losing operation. I think one thing you have to project always to any other of the groups you interact with, any of the audiences, is upward movement, if not in size, in quality, primarily in the quality of the program. That will bring in students. That will bring in faculty and will keep good faculty.

The two worst kinds of news I could get as the head of this program is that someone had hired one of our graduates and they said, "Boy, I hired one of your graduates and what a loser." That would probably cause me to crawl into a hole. I never want that to happen. Our students have to be our primary focus. The second type of bad news is for a faculty member to say, "I've got to get out of this place. I just can't get anything done here," or "I can't stand the environment." My task is to keep each one of those things on track and in a positive vein, not a negative vein. Everything else just falls into place after that. That's it. Not rocket science.

Drs. DUBICK and NEWMAN: Frank, thank you for your insight and your time.