Hanna continued . . .

factories to name a few, must recognize the impact of these facilities on the total environment and be able to defend their projects. For example, when I was director for Ohio State's water resources center, one of our major projects dealt with coal mining methods in Appalachia. The coal in that area has a high sulfur content compared to western coals. We found that when the strata was exposed, the sulfur would oxidize forming sulfuric acid, which emptied into the region's waterways. Our research efforts led to changes in mining procedures and operations to effect cleanups. Another project dealt specifically with the interrelationships between the economic system of Toledo and the effects of pollution on Lake Erie. As engineers, we have a responsibility to respect the environment.

Q: How do you impart that responsibility to your students?

A: We stress the importance of the engineer's role in society and give the students a solid foundation in technology and specific modes of problem solving. We emphasize the importance of acquiring good communication skills, both written and verbal, in order to relate to the public in solving complex societal problems. We also try to take advantage of what we have learned from past mistakes and be sure that in the future we consider the long term effects of whatever we do.

Q: Can you give an example of a project in which future consequences were not considered?

A: When I was with Standard Oil in Venezuela, we were drilling oil on Lake Maricaibo—which is about the size of Lake Erie. The oil was to be transported by large tankers through the channel that connected the lake to the sea. However, a shallow bar in the channel had to be dredged to permit the tankers to enter. This dredging was done without consideration of possible consequences. Gradually the sea water began to intrude more and more into the lake until it totally changed the lake's characteristic, resulting in adverse affects on the area's large fishing industry.

Q: Have there been many changes in engineering since you first entered the field?

A: Decidedly so. There have been tremendous advances and an explosion of information that has required more and more technological knowledge to handle it. The most recent trends include concern for the environment, the computer age, value engineering, risk analysis, and more sophisticated approaches to overall problems in the field. Also communications have been revolutionized through the development of television, laser technology and placing satellites in space. Another relatively new major issue is our concern for greater efficiency in energy conversion systems.

Q: Do we need more engineers?

A: Yes. We always will because our technology is increasing all of the time. There are so many problems that we are going to have to solve. We will need to develop new energy sources and industries to support our ever-growing population. We will need to build new cities and find better ways to maintain existing cities. For example, the streets in New York City are literally going to pieces. Sewers and water lines in many of our major cities are 150–200 years old and they need to be replaced. All of these needs will require more engineers in the work-force.

Q: What advice would you give students who are considering a career in engineering?

A: Get a good sound background in mathematics and physical science because engineering is based primarily on these two broad areas. I tell students that if they like problem solving they will like engineering. Also, grades are very important because your record follows you wherever you go. Develop good study habits early and keep up with your reading. During the first two years you are acquiring the math and science background necessary to handle the engineering science and design courses you will encounter in the upper division. It is also important to develop a professional attitude, and become involved in student chapters of professional societies.

> **"It is important to develop a professional attitude, and become involved in student chapters of professional societies."**

Q: What makes the CSU, Fresno engineering program unique?

A: The engineering program stresses a good mixture of theory and application. We have laboratories in most of the major areas of study, enabling us to turn out practicing engineers. Also the senior professors are teaching at the undergraduate level, where guidance and development are so vital.