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448th Convocation Address: "Scientific Literacy and Liberal Education in a Technological Age,"

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"Scientific Literacy and Liberal Education in a Technological Age"
by Melvyn J. Shochet

It is a great pleasure to welcome all of you, especially the 1997 graduates. I am honored to address you at this exciting moment of transition in your lives.Today I want to focus on the importance of a liberal education and of scientific literacy to our success, both individually and as a nation, in an era that is characterized by rapid technological change. The challenges we face are increasingly difficult because we must comprehend complex technical issues. Even if these were considered dispassionately, they would be difficult to address. But we have added burdens. The issues and their factual bases are distorted and manipulated, sometimes inadvertently, but often deliberately, for political, social, or economic gain.

It is easy to focus on the increasing complexity and accelerating change in our technological society. However, it must be remembered that society has been driven for a very long time by technology, which most often originated in basic scientific research. Although the scientists were motivated by their desire to better understand the universe, there was substantial, tangible benefit from their work. It was the study of electricity and magnetism in the late eighteenth and early nineteenth centuries, culminating in the work on induction by Faraday and Henry, that led to electric lights that transformed our cities and electric motors with their impact on industry in the late nineteenth century, as well as the first modern means of communication, the telegraph. The synthesis of electricity and magnetism into the electromagnetism of Maxwell in 1865 led to radio in the 1920s and television in the 1940s. The enigmatic quantum mechanics, developed in the first third of this century to address a few problems in the otherwise very successful theories of classical physics, was crucial for the invention of the transistor, the enabling technology of the computer age.

Such historic leaps in our understanding of nature, and the societal changes that have resulted, are of course not restricted to physics. The merging of the tools of biology and chemistry in recent decades has greatly increased our ability to understand how living organisms function. In the past few months, for example, the popular press reported on the structural biology of the AIDS virus, how it uses a protein harpoon to attack the human immune system.

That scientific advances have dramatically altered modern society is irrefutable. So, I am afraid, are the problems they bring to a democratic society. For democracy to work, to populace must understand the major problems facing it, perhaps not with sufficient depth to write legislation, but at least broadly enough to wisely elect those who will set policy. Unfortunately, the highly technical scientific and engineering underpinnings of many critical issues before us are not understood at all by much of the electorate. Examples abound - from the physics needed to set reasonable energy policy, to the modern biology for finding a sensible balance between funding and short-term expectations for medical research, to the chemistry and basic tenets of experimental science needed to cut through the hyperbole on both sides of such environmental issues as the depletion of the ozone layer.

These problems were brought home to me a few years ago when I served on a jury, an experience that shook my trust in our judicial system. The case was simple enough. Late at night, after a light snow had fallen, a suburban police officer observed a car screech to a halt at a red light and go into a skid. After being stopped, the driver failed a breathalyzer test and was charged with driving under the influence of alcohol. In the trial, the defense lawyer argued that his client's blood alcohol level of 0.2 percent - double the legal limit - was not proven by the breathalyzer test, because a technician testified that the instrument has an accuracy of only 2 percent. Thus, the lawyer argued, his client's alcohol level could have been anywhere from 2.2 percent down to -1.8 percent. This misunderstanding of what 2-percent accuracy means (that the reading was ten times more accurate than needed to prove intoxication) was not challenged by the state's attorney and certainly not by anyone else on the jury. They did not understand the argument (it was too scientific and mathematical), so they accepted the defendant's claim. Anyone is an authority, even someone with no understanding of the issue, if the argument is technical.

The populace has become numbed by technical issues. The average citizen now assumes that all such matters are extremely complex. As a result, there is no attempt to analyze them. An example comes from Washington politics last summer. There was a furor over the 12-cent-per-gallon rise in the price of gasoline. Congressmen on both sides of the aisle were suggesting that legislation was needed to correct this severe distortion of the marketplace. No one pointed out that the price of gasoline, even after the increase, was the same in real terms as it had been 30 years earlier when we were paying 27 cents per gallon. That perhaps required some technical understanding of the consumer price index. However, there was a much simpler, junior-high-school calculation that everyone could have made, but no one mentioned. Part of the rhetoric at the time was that the increase in the gasoline price would force American public to cancel their summer vacations, because they could no longer afford to travel. What should have been noted is that for a family

trip of 1000 miles in an automobile getting 25 miles per gallon, the increase in the cost of the vacation would be five dollars! The fear of technical issues and mathematics prevents people from doing such simple calculations and thereby debunking fallacious arguments.

The lack of scientific literacy makes distortion and manipulation of the facts much too easy. Of course there is a long history of usurping the language of science for personal gain. The snake-oil salesmen of the old west peddled their own version of medical advances. The phrenologists of the nineteenth century, the apologists for slavery and Nazi persecution, and the tobacco companies all argued that their positions were supported by scientific evidence. The populace either couldn't or didn't want to address the validity of the arguments. Most of the distortion of science today is not nearly so pernicious, but it is important nonetheless. Many in the media and in public office don't appreciate that the essence of the scientific method is experimental observation, that experimental results always have inherent uncertainty, and consequently that independent confirmation is essential. A few weeks ago, there was a report in the newspaper of the extraordinary discovery of a directionality to the universe. A few days later, what was essentially a retraction appeared, noting that the data might have been misinterpreted. Last year, the popular science press reported that my experiment at Fermilab had discovered that quarks are not the elementary building blocks of nature, even though in the paper we published, we explicitly noted that such an interpretation was unwarranted. Avoiding a probing analysis of the data leads to similar distortion of public issues, such as the safety of nuclear reactors or the amount of global warming that is due to human pollutants.

The solution to this problem is an educated populace. But educated how? Education is not merely learning factual information, for with rapidly changing science and technology, the knowledge base is constantly and rapidly expanding. What is needed is the ability for critical, systematic, and analytic reasoning, the essential ingredients of the liberal education Chicago has always valued so highly. Such analysis must be broadly applied, not only to the humanistic and social problems many are comfortable thinking about, but also to the scientific and technological issues that are seemingly so difficult to comprehend and resolve. We need a populace that is not afraid to address a problem with an open mind, to analyze each possible solution and weigh the evidence pro and con. This requires an education that fosters comfort with quantitative reasoning rather than the fear of it, and the understanding that education is never complete. It is a lifelong process of critically addressing important issues in the face of an expanding and changing database of knowledge.

As you embark on the next stages of your careers, you will almost certainly face problems with a large mathematical, scientific, or technological component. Much of academic research beyond the scientific disciplines has become increasingly quantitative. Legal issues now include property rights with emerging forms of communication like the World Wide Web and the relationship between the rights of a patient and the obligations of a medical provider with regard to new, very expensive treatment, whose long-term efficacy is not yet certain. Setting public-health policy requires cost-benefit, ethical, and medical analysis of new technological tools. Those who will work in the private sector may have to evaluate new scientific discoveries or technological inventions and make economic decisions about their utilization. You and the public at large will also have to address a critical issue affecting the future strength of our economy. Basic research has been essential to its growth. A recent study showed that in the United States 73 percent of the scientific papers cited in industrial patents came from publicly supported research. Yet federal support for basic research has significantly declined during the past fifteen years. Will we reverse that trend, greatly increase private sector support for basic research, or accept the possibility of economic stagnation? Such questions must be resolved in the next decade.

This, then, is your challenge, and indeed the challenge for all of us. We must carefully and rigorously analyze the problems we face as a society in an era when there are rapid technological and scientific advances, and when the trappings of science can and are used to distort the truth. The skill you acquired here will serve you well as you assume positions of leadership in academia, the professions, business, the arts, and in public service. Your accomplishments give us hope and confidence for the future, and fill us - your teachers, families, and friends - with pride at this your graduation and commencement. Congratulations!

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