“When the Jobs in the Nation Change, So Does the Job of the Scientist”

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Speech Transcript

I am delighted to be here and honored to be a speaker in this exciting lecture series at Rice. The focus on the Civic Scientist makes this a series for our times. It will be a place where scientists and the public can engage in dialogue about issues in science and technology that affect the welfare of citizens and the nation in the fast-paced global environment.

As the first speaker in the series, I suppose that I have the honored responsibility to shed light on the emergence of the Civic Scientist concept. I have titled my remarks: "When the Jobs in the Nation Change, So Does the Job of the Scientist". My use of the word scientist here and throughout my talk is a shorthand that includes scientists, engineers, and medical and technical professionals. The term Civic Scientist began with your respected colleague and old friend here at Rice, Dr. Neal Lane. At the time, Neal was serving as Director of the National Science Foundation.

I would first like to cast the concept in a brief historical perspective, especially for the younger generation of scientists and policy students in the audience today. There was growing discussion in the mid-1990s, which continues today, about the marked transformation in the economies of developed nations and the Asian tigers Korea, Taiwan and Singapore. These economies were increasingly propelled by science and technology. Today, we see this same trend broadening to include India and China. The United States has perhaps, the world's finest cadre of scientists and engineers, but there has been little dialogue between them and the larger public. That is how we have wound up with a public very interested in science and technology, but, nevertheless, knowing little about it.

In fact, a growing knowledge-chasm had developed between scientists and the rest of the population. Metaphorically, they live in separate worlds. This is not a case of placing blame but rather a matter of patterns carried over from the past. Despite this clearly contradictory situation, the march toward an increasingly sophisticated scientific and technical economy accelerated.

Now you might say, it's always been that way. But there is a difference between then and now. Today, a growing portion of the nation's jobs require some form of science and technology knowledge. We live in a different world today. How different? We need no more proof than a few stark statistics. Last year human beings produced more transistors, and at a lower cost, than they did grains of rice. In terms of consumer electronics in the world today: there are 2 billion mobile phones, 1.5 billion TV sets, 820 million PCs, and 190 million Game Boys. And by the year 2030, 24 years from now, world oil consumption is expected to rise 50% (IN magazine).

Let's look at our neighbors and how this plays out. Several years ago, a friend shared an anecdote with me that illustrates this dilemma.

He was meticulous about having his car serviced by the same master mechanic for years. When his oldest child got his driver's license he gave this honey of a car to his son. My friend and his wife bought what he called, "the total digital car." When one of the digital systems went awry, he immediately took it to his trusty master mechanic who promptly told him he knew nothing about the "new fangled" cars. A few years later, the mechanic went out of business.

Today many technologies have a lifecycle of just eighteen months.
The July 29th issue of the Economist magazine had an article titled "Technology Dinosaurs, Evolve or Die" in which they mention four giants in the computer industry that are losing ground. The article says, "Each had a bold vision of technology, but then failed to evolve as the very innovations they pioneered became commonplace."

This is the present trend and it will increasingly be the wave of the future. Several decades ago, the social philosopher Eric Hoffer wrote, "In times of change, learners will inherit the earth, while the learned will find themselves well equipped to deal with a world that no longer exists." His prophesy picks up speed every day. Remember the story about the master mechanic. His training was for a job that no longer existed. When he lifted the hood on a new car he was baffled.

Today, industries are hungry for science and technology workers and compete with each other for talent. This talent competition is even more intense among nations.

In the October 7 issue of the Economist magazine this situation was made crystal clear. It states, "The proportion of American workers doing jobs that call for complex skills has grown three times as fast as employment in general. As other economies move in the same direction, the global demand [for new skills] is rising quickly." As nations strive to rise from the position of developing to developed, they recognize that the lynchpin is always the human resource. Now, it is the education and training of your workforce that, in large part, determines how successful you will be as a nation.

The foundation for the power and wealth of economies has changed. Economic strength used to be rooted in land, physical labor, capital, and natural resources. The new formula is science and technology, highly trained workers, and lifelong learning to be able to participate in our changing economies. The world is going through a tectonic economic shift where more and more jobs require some understanding of science and technology. And, it turns out that when the nature of everyone else's job changes, so does the job of the scientist and engineer.

Researchers will always work at the frontiers of knowledge but as society becomes more technologically intense, the role and responsibilities for those highly trained in this realm will expand. Enter the transformation to the civic scientist. The word "civic" is an adjective that means, according to the dictionary, "of or affecting the community or the people." And this was exactly the emphasis of the new role and responsibilities of the "civic" in civic scientist. The concept of "civic scientist" was not intended to diminish the magnificent contributions of

scientists over centuries, and today, but rather to get scientists more broadly involved in the society that was built on their insight and intellect.

First, is to create a dialogue with the public about science and technology that is on the one hand a process of educating the public about what they want and need to know. The flip side of the dialogue is learning to listen to what the public thinks about the directions in which our science and technology are taking us.

And if you think that the job of a civic scientist is to do more talking than listening, think again. The scientist should be as much the listener and learner. In a science and technology driven society, the civic scientist is an integrator--one who knits together what is discovered, what are the opportunities and implications of the discovery, and what is the most necessary new knowledge. The civic scientist not only reaches out but also takes in the concerns and questions from the public.

More than a quarter century ago, the late social philosopher Lewis Mumford reflected on Western civilization's technological history. To paraphrase Mumford, Western society has not only accepted new technologies but unconditionally surrendered to them without respect to their human consequences. Since Mumford's commentary, the pattern has spread to global technology. We have reached a watershed in human history where we must develop the foresight to examine today's actions in terms of what they augur for sustaining our collective future.

And so, policymakers, scientists, and the public need to understand that economics, energy, and the environment must be considered as interdependent issues as we view the planet and its inhabitants. The civic scientist is a natural bridge in this transformation. The second role and direction for civic scientists is to help advance the knowledge-base of the nation's science and math teachers, and their students. Scientists can be particularly helpful by assisting with the design of hands-on learning experiences for students. Hands-on learning requires involvement and creativity, and has the magnetism to excite and inspire students, and perhaps prompt them to choose science and engineering careers.

You might question why I place such strong emphasis on hands-on-learning experiences for students. Why not stick to the way my generation was taught? Some of you here this evening remember the read, memorize, and drill exercises. Despite the rote methods, our generation turned out some stellar achievements. And we need to acknowledge that there will always be some things learned by rote.

Now, however, we know a lot more about how people learn, especially young people. The science of learning, in which the National Science Foundation has been a pioneer, is enlightening us on everything from how the brain processes information, to the physical environment for learning, to the knowledge that we all learn differently, to the importance of good nutrition for the developing brain, to diagnosing learning disorders quickly and providing assistance. It turns out that teaching students by the read-and-regurgitate method is often not the best way for them to learn. With hands-on-learning, the student, or team of students, is presented with a problem to solve. On the student's part, this automatically evokes a series of questions which call upon creativity, cumulative learning, and innovation.

Earlier this year, I had the opportunity to visit a classroom of fifth grade students involved in a hands-on, interactive program called "World of Wheels." It was supported by NSF, automaker BMW, the American Association of Automotive Engineers and the local school district. When asked before the program began what an engineer did, the students answered that he drove a train or took care of the school building. After being challenged by designing and building vehicles, complete with propulsion systems, and using recycled materials, they answered the same question very differently. An engineer then became a person who designs space craft and builds computers.

Considering global trends, this is precisely the kind of transformative experience that we need to duplicate in 15, 000 school districts across the nation. And, it will take the private sector and public institutions working with local school districts to make it happen. The up-and-coming workforce must have this knowledge and the concomitant skills. This naturally brings us to the teaching of science and math in our schools.

America may have the best scientists and engineers, but in comparison to many other countries we do not have the best educated students in science and math. It is true that we have a layer of the "crème-de-la-crème" at the top, but a major portion of students in science and math are getting mediocre or marginal training in these subjects.

This is a compound problem. First, all teachers are underpaid, and overworked with responsibilities that often have nothing to do with their teaching. We must commit to our teachers if we expect them to commit to our children. Second, many science and math teachers are inadequately trained for the classes assigned to them. Worse yet, there are teachers trained in everything from geography to gym who are thrown into a science or math classroom to teach.

I want to commend the Houston community for the work you started in 1991 with the Model Science Lab. You were way ahead of the curve on the concept of a Resident Teacher for one year at the Lanier Middle School Model Science Lab. This experience provides teachers with a wonderful opportunity to learn and practice new skills, to analyze, critique, and polish techniques, and to explore the latest knowledge on learning. It is my understanding that close to 100 science teachers in the Houston school district have gone through this Resident Teacher training. I would hope that similar programs could be instituted in other school districts and states. Perhaps the saddest and most common educational outcome we see in schools is that the youngest children, who are intensely curious by nature, are being short changed.

Children are born scientists, explorers, adventurers. That's why we think of toddlers as "getting into everything." They bring these innate powers to school, and, in the past, they have largely been taught by methods that have actually stifled these cooperative activities. Some tenacious young thinkers have historically defied these fences and walls. But too many students have emerged with their creativity blunted and much of their excitement for learning dulled, especially in science and math. This is a significant concern in terms of our current and future economy because the buzz word for the new global economy is "innovation." Some have even suggested that innovation is the Holy Grail of 21st century society.

We know that the wellspring of innovation is creativity. The last thing we want to do at any time, but especially now, is diminish curiosity and creativity in the process of teaching and learning.

Several years ago the Economist magazine did a study of innovation around the world. The study concluded that nations and companies that encouraged and rewarded risk-taking were more innovative. The survey indicated that nations with a combination of many immigrants and corporate policies of encouraging unorthodox thinking were the most innovative. A sidebar in the article said, "Risk takers break all the rules, trust them." Among other things, the Economist survey teaches us about two important ingredients in U.S. culture. It highlights the important role of immigration to a society, and also the habit of unorthodox thinking.

Some of you may ask why these are seen as advantageous. Let's look at immigration first. Immigrants are hard workers, driven to better their condition, not unlike the first immigrants who settled our nation, and the many who have come since then. Second, their diverse cultural backgrounds bring different perspectives on how to address issues and solve problems. Today, the immigrant population of the U.S. comprises 12 percent of our total population. And last month, the U.S. hit the 300 million population mark which makes us the third most populous nation in the world behind China and India. A nation of many cultures is like a rich stew where each ingredient helps to enhance the qualities of the others. A previous deputy director of NSF used to characterize our nation's diversity as our "Ace in the Hole."

And as for unorthodox thinking and risk-taking, that second part of innovation, the long history of America's frontier has bred a pioneering spirit into the fabric of our national character. These characteristics have given the U.S. an innovative edge throughout its history. History also teaches us that when nations become complacent, self assured of their position, and insular, they begin to fall behind. In the 21st century, the U.S. will need to sharpen its innovative edge in light of the increasing global competition. This is where the role of the civic scientist--a scientist "of or affecting the community or the people" comes into clearer view.

As many of you know, the National Science Foundation supports promising, transformative frontier research and researchers by grant awards for the most superlative research proposals. These proposals are judged by outside panels of scientists. In the late 1990s, the Foundation revised this Merit Review process so that grants were awarded based on two fundamental criteria, instead of one. The first criterion is the intellectual merit of the proposal to explore and advance the science. This first category has been the basis of the NSF Merit Review process since the Foundation's inception. The second is wider in scope and closely connected to the principles of civic science. We refer to it as the criteria for "broader impact" of the research or the researcher. In a sense, these are activities that have a ripple effect out in the larger populace. Criteria II helps scientists think more broadly about their work. The science is always critical and must be of the highest caliber. But Criterion II stretches the science and/or the scientist.

An example would be to integrate research activities (hands-on-learning) into the teaching of science, math, and engineering at all educational levels, from K -12, to higher education for science and non-science majors. A completely different example of a "broader impact" activity would be to give science and engineering presentations to the broader community such as in museums, libraries, on radio shows, and to groups like the League of Women Voters, rotary

clubs, and the like. It is important to understand that a response to the "broader impact" criteria is not optional; it is mandatory. Any proposal that arrives without a response to "broader impact" will be automatically returned. So this must be construed as an explicit policy direction. As you have probably already discerned, "broader impact" goes hand in glove with the philosophy underpinning the role of the civic scientist. It gives the researcher submitting the proposal the impetus to think beyond the science to the larger society. In order to encourage the most creative thinking about broader impact, we have specifically tried not to box it in, but rather to give the researcher free range of his or her imagination.

I know that all of you in the Houston area are familiar with Café Scientifique, the exciting new movement that has come to America from Europe. This is the perfect example of scientists engaging in dialogue with the public and to make science accountable to the populace. The National Science Foundation is sponsoring a Café Scientifique in Arlington, Virginia. We have been very fortunate to attract scientist/speakers who are not only articulate but also down-to-earth about relating their subject, they are good storytellers, and like being challenged. Having a sense of humor also goes a long way to being a crowd-pleaser.

I have been fortunate to have had a varied career in university teaching and administration, in industry as a researcher, research manager and corporate executive, and now as a civil servant. I must say that my experience in both academe and industry has been invaluable to my work in the Federal civil service. You learn a lot from the environment in which you work. You develop a perspective of the objectives, needs and problems unique to that sector. You develop an understanding of, and an ease with, the particular culture. When I have meetings with leaders from industry or higher education, I understand where they're coming from. It has helped me to resonate with the perspective, needs, and arguments of others. It puts everyone in the conversation on a more comfortable footing. It's good to remember that there's a lot of social engagement in dialogue of any kind.

I brought these skills and understandings to my work over the last several years as a civil servant. I served as the Director of the National Institute of Standards and Technology, and currently, as you already know, I am Director of the National Science Foundation. These last two positions have given me the opportunity to: help shape science and technology policy, to talk to scientists and engineers about their changing role in society, and to discuss with industry, governors, and teachers about partnering to create a better prepared science and technology workforce for the nation.

In addition, I have regularly had the opportunity and the responsibility to testify before Congress. I also speak individually with policy makers about the changes that are taking place in science and technology, and in the global economy, that could require new emphasis, initiative, and action. Keeping in mind that members of Congress are the "public's" chosen representatives, I hope you will construe my role as partly civic scientist. I believe that this work is important to U.S. competitiveness and prosperity for the 21st century.

On another dimension, I know that there are students in the audience this evening in the natural or social sciences or engineering, and perhaps in the arts or humanities, who are interested in a possible career in public policy as a way to make a difference in the world. I am reminded of the

wisdom of Dr. Jonas Salk who said, "Our greatest responsibility is to be good ancestors." He wanted each of us to think about how we could leave the planet and its inhabitants in better condition than we found it. To me, this does not mean that any single individual must solve some gigantic world problem but rather that each one of us should choose a small piece of a big problem and make a difference. You may wish to find that piece in sub-Saharan Africa but you can just as easily find it in Houston or Boston or rural Maine or New Mexico.

Sometimes, if you change a direction or policy in one community, like Houston's Model Science Lab, it becomes a model for other places, and soon it spreads like a vine and you know where it began. And never be afraid of trying something for fear it might not work out the way you planned.

Remember what I said earlier about thinking creatively and taking risks and how this has helped make America great. The risk-takers transport us to whole new ideas and places. Find a problem and tackle it on a small scale first. Think of Muhammad Yunus (Eunice), the Bangladeshi economist who just won the Nobel Peace Prize for fighting poverty. He established a system of microcredit to the poorest Bangladeshis, mostly women. A loan of the smallest amount of money allowed these women to start small businesses. These women had close to 100 percent payback rate. Yunus has also suggested that China establish a similar practice. This small-scale effort could someday radically change the economy in the developing world. In the longer view, it is my belief that civic scientists, however you may choose to define the term, can bring us closer to that goal.

Thank you.