Technology Transfer, the Resurgent U.S. Economy and America's
Love-Fear Relationship with Science
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I am delighted to join you today because what you do has always been of great interest to me. If I were graduating from college today, I would explore technology transfer as a career opportunity. It is at the nexus of universities and society and it is at the nexus of transforming new knowledge it into societal benefits. Technology transfer contributes to a higher standard of living and a better quality of life for the United States and the rest of the world. Your work is critically important to our society.

My remarks will attempt to create a cogent link among a wide range of topics in less than 20 minutes. So put on your seat belts!

- First, I would like to comment on the current economic expansion, the role of American universities in fostering this expansion, and the growing public recognition of this role, particularly in California.
- Second, I would like to compare today's political and economic climate with that of 25 years ago.
- Third, I would like to comment on the origins of the Bayh-Dole Act and the impetus that it gave to the transfer of technology from university and non-profit laboratory settings to the sector.
- Fourth, I would like to address America's love-fear relationship with science, as well the strength and fragility of public support for science.
- Lastly, I would like to make a few observations about the nature of your profession.

Most Americans who read newspapers or who invest in the stock market know that the U.S. economy is experiencing one of the longest economic expansions in its history.

Federal Reserve Chairman Alan Greenspan has commented on many occasions that this economic expansion is driven by one thing: productivity growth. Historically, the nation has had a 3.8 percent annual rate of productivity growth. In the past year it grew at an annualized rate of 4.3 percent. However, from the 1970s through the mid-1990s productivity growth fell from nearly 4 percent to approximately 2 percent.

What do these productivity growth rates mean for us as citizens? Why is it important? At a productivity growth rate of 4 percent, the standard of living in the U.S. will double approximately every 20 years. This means that in today's economy, most Americans will see the standard of living double three or four times during their lifetime. In contrast, at a 2 percent productivity growth rate, the standard of living will double every 40 years. Most Americans would be fortunate to experience a doubling of the standard of living during their lifetimes at this lower rate of productivity growth.

The difference between these two scenarios has enormous consequences for individual Americans and for our society.

Last year, the Council of Economic Advisors reported to President Clinton that 50 percent of the growth in the U.S. economy during the last 40 years is attributable to innovations resulting from basic research. This is a critically important finding. Where is most of this basic research being conducted? The answer is: in American research universities. So one can say, without exaggeration, that universities and the developments, products and processes resulting from university research have created much of the "economic miracle" that we are experiencing today. Universities are major contributors to our economic productivity.

I am not implying by these statements that the road ahead will be smooth for our economy. We may be experiencing a bubble in stocks listed on the NASDAQ. Technology stocks

may be overvalued. And we will certainly experience the rise and fall of business cycles and stock markets. But if productivity remains close to its historic norm – close to a 4 percent annual rate of growth – then our standard of living will continue to double every 20 years, regardless of what may be happening in the stock market in any given year. Please keep this point in mind.

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Judging from national polls, the American public understands the beneficial role of science. In 1995, a national poll asked a sample of Americans: "Do you agree that the federal government should support basic research even if it brings no immediate benefits?" Sixty-nine percent said yes. The same question was asked at the same time in California and 81 percent said yes. The public, particularly in California, understands that there is a connection between basic research and subsequent economic benefit. A related question was asked in the same poll: "Do you approve of federal government spending to sponsor

scientific research at universities?" The positive response nationwide jumped to 81 percent and in California it rose to 86 percent. Other polls show similar responses. People understand at a personal level that universities are performing the scientific research and educating the students that make this economic growth possible.

Nowhere is this economic growth more evident than in California. I recently chaired a study for the California Council on Science and Technology (CCST). The published report is considered to be the first comprehensive study of the role of science and technology in California. It examined the roles of universities, national laboratories, industry, venture capital, and public elementary and secondary education, among other forces driving science and technology in the state.

The study found, not surprisingly, that California is a disproportionately large producer of research and

development and is the nation's leading science and technology state. California has roughly 12 percent of the nation's population, jobs and gross domestic product, but California produces 20 percent of the nation's research and development. Furthermore, one-third of all American venture capital is invested in California companies, making California the nation's leading state in venture capital investments. Massachusetts is the second ranked state, and it receives only ten percent of the nation's venture capital.

Our study reported on another intriguing aspect of the role of California universities in driving this surge of science and technology. Every decade the National Research Council (NRC) reviews the quality of graduate programs in universities across the nation. California has more science and engineering programs ranked by the NRC as being in the top ten nationally than any other state. That might not surprise you, but the differential might surprise you. California has 78 such programs, largely at UC campuses but also at

Caltech, Stanford and USC. Again, for purposes of comparison, Massachusetts has 29 programs ranked in the top ten and New York has 23. They are the next highest ranked states after California.

Few people realize the extent to which the University of California is driving this knowledge growth. Stanford receives a tremendous amount of attention for its contributions, and deservedly so: the Silicon Valley is located immediately adjacent to it and Stanford is recognized for its role in the growth of the Valley. But data show that the University of California has played as significant a role as Stanford in generating the knowledge and the technologies that have made Silicon Valley an international phenomenon. Additionally, very few people know that UC had an early and important role in the capital formation that enabled venture capitalists to fund the Silicon Valley's research and technology enterprises.

Herb Gordon, the former treasurer of the University, was involved at an early stage in investing a portion of the University's retirement portfolio in venture capital firms. These firms, in turn, funded many of the start-up companies that are now thriving in the Silicon Valley, Los Angeles, San Diego and other areas of the state. Some of those companies have become international powerhouses. The University rarely communicates its role not only in technology development but also in the capital formation that made the Silicon Valley possible. I first learned about the University's role from Brooke Byers, a partner in the Kleiner, Perkins, Caufield and Byers venture capital firm. The venture capital community considers Herb Gordon a saint because his investments helped them secure the financial resources to produce the jobs and the economic miracle that we see today in California.

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Now let me contrast this current state of affairs with the period 25 years ago when I was working at the National

Science Foundation. President Nixon had just resigned and Gerald Ford had assumed the presidency. Inflation was high and rising further. There was high unemployment, and productivity growth rates were one-half what they are today. The country was in a desultory state. Richard Nixon had fired his science advisor because he opposed the President's position on the intercontinental ballistic missile, so there was no science advisor to the President. The National Science Foundation was being unfairly criticized for funding basic research that added little value to society and for funding science education that was undermining American values by teaching children concepts such as the theory of evolution. Some vocal members of Congress considered the peer review process a Good Old Boy Network. Peer review was seen as a way to funnel money to one scientist who, in turn, would funnel money to other colleagues by giving favorable peer reviews of their research proposals (even though the peer reviews were anonymous). Congress did

not yet understand the role of science in driving the economy.

At that time there was no biotechnology industry. There was no Internet. Mark Andreesen, the developer of the web browser popularized by Netscape, had not been born. Many of the developments that have become part of the fabric of our lives simply did not exist. The most innovative companies in the nation at that time were companies that are now considered stalwarts of the old economy. The world was very different indeed.

But in laboratories across the country—particularly at universities—pioneers were at work. Herbert Boyer was developing recombinant DNA technology at UC San Francisco together with Stanley Cohen at Stanford. Leonard Kleinrock was developing the forerunner of the Internet at UCLA. Irwin Jacobs, a professor at UC San Diego, was developing the digital wireless technology that led to the

creation of Qualcomm, which was last year's hottest NASDAQ stock. There are many other examples of similar pioneers.

At the time, there was little economic research showing the contribution of science to the economy. So the National Science Foundation began to fund researchers like Edwin Mansfield at the University of Pennsylvania, Zvi Grilliches at Harvard, and others who developed a body of economic research that demonstrated the relationship between scientific innovation and economic growth.

Back then, the federal government retained all rights to patents developed with federally funded research. As a result, technology transfer from federally-funded research was nonexistent. Scientific and technological advances rarely led to commercial application.

The National Science Foundation, led by its director, Richard Atkinson – UC's current president – and Charles Herz NSF's general counsel, participated in changing this situation. They had a significant role in a federal interagency task force that recommended changes to the federal patent policy. One major change gave university grantees the patent rights to inventions developed at their institutions from research funded by the federal government. The policy change enabled universities to license their innovations to companies that would commercialize the technologies. This interagency task force was the beginning of what evolved into the Bayh-Dole legislation that passed Congress several years later. The Bayh-Dole Act was a turning point in the history of technology transfer. The legislation accelerated the transfer of new knowledge, and it's application to societal benefit, in the form of new medications, medical devices, the Internet, wireless communications, and much more.

When I first arrived at UC San Diego in 1980, I was occasionally asked "Why don't you fire those communists on the faculty?" That was the perception of the campus by a small but vocal segment of the San Diego community. San Diego was a Navy town. Herbert Marcuse, the intellectual father of the student movement in the 1960s, had taught there, and Angela Davis had been a graduate student there. Both left a lasting impression on some San Diegans.

Today, the public perception is that UC San Diego is the engine that is driving the San Diego economy. The same view is held of Berkeley in the Bay Area, Irvine in Orange County, and UCSF in San Francisco. Why did the perception of UC San Diego in 1980 change to what it is today? Among other reasons, the Bayh-Dole Act accelerated the public's understanding of the role of universities in creating advances in knowledge and technology that create jobs, new companies and whole new industries. It enabled the public to see firsthand the role of science in driving the economy.

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Let me turn briefly to what I refer to as America's love-fear relationship with science. After World War II, the American public appreciated the value of science because radar technology helped the Allies win the air war over Great Britain. The Allied amphibious landings in North Africa, Europe and the Pacific Islands were coordinated from the Scripps Institution of Oceanography, which is now part of UC San Diego. Americans viewed the atomic bomb as having saved the world from axis oppression. As a result of these events, there was tremendous support for science.

Later, when recombinant DNA technology was developed by Herbert Boyer and Stanley Cohen, some very vocal opponents suggested that it would unleash on the public the biological equivalent of the atom bomb. The scientific community met at Pajaro Dunes and agreed to a self-imposed moratorium on recombinant DNA research until guidelines could be developed to guide researchers. P1, P2

and P3 laboratories were established to contain organisms with differing levels of potential threat to the public. And there was uncertainty, even fear, in some quarters. Some openly questioned whether public policymakers should permit such research to be conducted at all.

So the nation's views about science ebb and flow over time. On balance, Americans are decidedly optimistic and positive about the contributions of science. At the same time, there is a vocal segment of the population that views science with fear and trepidation. There is a fragility in the American support of science. Unless we get out and tell our story in an assertive manner – tell the good that has come from science and explain the benefits that can be derived from it – that fragility could manifest itself in a negative way.

This negativity could easily be expressed as lack of support for, and public challenges to, the role of universities and to the research that the federal government funds at American

universities. A key message that I would like to bring to this gathering is that we all have a tremendous responsibility to get out and tell the story about the contributions of science that have improved our daily lives.

Let me give you one example of how we did so in San Diego. We knew that UC San Diego had generated a lot of spin-off companies, but we had no good data on them. Winifred Cox, assistant vice chancellor for communications at UC San Diego, and I decided to gather this information in a systematic way. We distributed a questionnaire to the campus asking everyone to identify companies that were based on research conducted at UC San Diego. To verify our findings, we hired graduate students to contact those companies to ask them whether the companies had connections to UC San Diego and to describe the connections. We asked the companies to do something that we thought they might be reluctant to do. We asked them to tell us their revenues, their number of employees,

and the amount they paid in federal, state and local taxes. Within several months of initiating the project, we received an incredible outpouring of data. We learned that 199 companies had spun out of the campus and that the companies were proud of their connections to UC San Diego.

These 119 companies were generating $1.8 billion dollars in revenue and 15,000 jobs in San Diego alone. We used this information to show the people of San Diego exactly what kind of impact the University was having in their city. We produced a report and gave it to the media, to the San Diego Chamber of Commerce, to the Economic Development Corporation and to Rotary Clubs throughout the region. Public perception of the campus soon confirmed that UC San Diego was now seen as the engine of growth that was driving the San Diego economy.

Economic impact is much more than just an economic multiplier applied to university expenditures. Economic impact is also measured by the number of patents received, the technologies licensed, the companies founded, the jobs created, the products brought to market, the revenues generated, and the taxes paid. We should work together to gather this information to tell the UC story in its fullest dimension.

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I will conclude by saying that you are at the heart of this industry-university relationship. But, in my opinion, technology transfer at the University is far too focused on the licensing transaction and is not based enough on broadening and strengthening the relationships between universities and companies. Investment bankers and other professions were once solely focused on the transaction. But they soon realized that while the transaction provides the profits, the relationship provides the ongoing business. In your interactions with faculty and with companies,

confidence is built by respect, a successful track record of accomplishments, and positive relationships.

Unless you see yourself as a broker of relationships instead of solely as a negotiator of a single transaction, you will never fulfill the promise of what you can contribute to the University or to society at large. We should expand your portfolio to ask you to think of yourselves as broad-based representatives of the University. When you meet with a business, go ahead and speak about the particular technology that the company wants to license. But I would encourage you to explore as well whether the company might wish to hire graduate students during the summer or during the school year to work on company projects. Mention the opportunities that faculty consulting might bring to the company. Describe how the company might benefit from supporting graduate or undergraduate students who are involved in areas of research of interest to the company. Explain to the company the benefits it may receive from

funding research at the University. And, explore the opportunities for the company to support scholarships, fellowships and endowed chairs.

There is a broad opportunity for expanding your responsibilities. These additional responsibilities will make you more valuable to the University at present and far more essential to the University in the future. You have the potential to play a vital role in shaping the public's understanding about the value of science and the role that universities play in our economy. I hope that you will accept this challenge and pursue it with vigor.