



PRESIDENT CLINTON'S
ADDRESS TO CALTECH
ON SCIENCE AND TECHNOLOGY



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REMARKS BY THE PRESIDENT
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THE PRESIDENT: Thank you so much. Dr. Moore, President Baltimore; to the faculty and students at Caltech, and to people involved in NASA's JPL out here. I want to thank Representatives Dreier, Baca and Millender-McDonald for coming with me today, and for the work they do in your behalf back in Washington. I want to thank three members of our Science and Technology team for being here -- my Science Advisor Neal Lane; Dr. Rita Colwell, the NSF Director; and my good friend, the Secretary of Energy, Bill Richardson, who has done a great job with our national labs to keep them being innovators in fields from computational science to environmental technology.

One person who would have liked to have been here today and I can tell you thinks that he would be a better representative of our administration on this topic is the Vice President. When we took office together, the fact that I was challenged scientifically and technologically was standing joke. (Laughter.) And he wants all of you to know that he's campaigning all over the country with a Palm 7 on his hip. (Laughter.)

He wants you to know that he loves science and technology so much, he's not even angry that Caltech beat out Harvard for top spot in the U.S. News rankings this year. (Laughter.) I think it has something to do with the relative electoral votes of California and Massachusetts. (Laughter.)

But before I came out here I told Dr. Moore and Dr. Baltimore that it was a real thrill for me to meet Dr. Moore, that even I knew what Moore's Law was; and that before the Vice President became otherwise occupied, we used to have weekly lunches and I'd talked to him about politics and he'd give me lectures about climate change. (Laughter.)

But we once got into this hilarious conversation about the practical applications of Moore's Law, like it explains why every cable network can double the number of talk shows every year that no one wants to listen to. (Laughter.) And so it's a real thrill for me to be here. (Laughter.)

Actually, I come with some trepidation. An eight-year-old child met me at the airport, and she and her brother came with their father, who is a friend of mine, and she brought me a letter from her third grade class. And the letter had all these questions: What was your favorite book when you were in the third grade? What did you collect then? What do you collect now? And one of the questions was, are you ever nervous when you're speaking before large audiences.

And the answer -- and I was writing all these answers so we could type up a letter -- I said, not usually. But I mean, I'm sort of nervous here today. (Laughter.) And I told somebody I was nervous, one of the wags back at the White House with a sense of humor, and he said, well, you know the Einstein millennial story, don't you -- trying to help me get unnerved. (Laughter.) I said, so I said, no -- you always learn to be patient in the face of other people's jokes. It's one of the great social skills that an American can develop. (Laughter.)

So I said, no. And he said, well, God decides to give America a millennial gift, and the gift is to send Einstein back to Earth for a few days to talk to ordinary folks, because he was the greatest brain of the last millennium. And they have the first meeting in a nice little hall like this. And it's absolutely packed, and these three big, burly guys push their way to the front, shoving everyone else to the side. So Einstein politely takes them first and he says to the first guy, well, what's your IQ, young man? And he said 240. He said wonderful, let's talk about how I thought up the theory of relativity. And they have a terrific conversation.

The second guy, he says, what's your IQ? He said, 140. He said, let's talk about globalization and its impact on climate change. And they had a terrific conversation. And the third guy kind of hung his head, and he said, what's your IQ? And he said, 40. And Einstein said, oh, don't worry. You can always go into politics. (Laughter.)

I want you to know, though, in preparation for this day I've been spending a lot of time trying to get in touch with my inner nerd. (Laughter and applause.) And my wife helped me, because she's been having these Millennium Lectures at the White House to discuss big things. And the other night, she had Vince Cerf, who was one of the founders of the Internet, and Eric Lander, who's helped to develop many of the tools of modern genome research. And that really got me thinking, and I want to say some more serious things about that in a moment. And then my staff challenged me to actually order Christmas gifts over the Internet. And I did that. And while doing that, I learned that with just a click of a mouse, I could actually order -- and I did this, I'm embarrassed to say -- I ordered Arkansas smoked ham and sausage delivered to my door. (Laughter.) So I think the 21st century has more for me than I had originally thought. (Laughter.)

As all of you know, Albert Einstein spent a lot of time here at Caltech in the 1930s. And three weeks ago, Time Magazine crowned him the Person of the Century. The fact that he won this honor over people like Franklin Roosevelt and Mohandas Gandhi is not only an incredible testament to the quantum leaps in knowledge that he achieved for all humanity, but also for the 20th century's earth-shaking advances in science and technology.

Just as an aside, I'd like to say because we're here at Caltech, Einstein's contributions remind us of how greatly American science and technology and, therefore, American society have benefitted and continue to benefit from the extraordinary gifts of scientists and engineers who are born in other countries, and we should continue to welcome them to our shores. (Applause.)

But the reason so many of you live, work and study here is that there are so many more questions yet to be answered: How does the brain actually produce the phenomenon of consciousness? How do we translate insights from neuroscience into more productive learning

environments for all our children? Why do we age -- the question I ponder more and more these days. (Laughter.) I looked at a picture of myself when I was inaugurated the first time the other day, and it scared me to death. (Laughter.) And so I wonder, is this preprogrammed, or wear and tear? Are we alone in the universe? What causes gamma ray bursts? What makes up the missing mass of the universe? What's in those black holes, anyway? And maybe the biggest question of all: How in the wide world can you add \$3 billion in market capitalization simply by adding .com to the end of a name? (Laughter.)

You will find the answers to the serious questions I posed and to many others. It was this brilliant Caltech community that first located genes on chromosomes and unlocked the secrets of chemical bonds and quarks. You were the propulsive force behind jet flight and built America's first satellites. You made it possible for us to manufacture microchips of ever-increasing complexity and gave us our first guided tour on the surface of Mars. With your new gravitational wave observatory, you will open an entirely new window on the mysteries of the universe, observing the propagating ripples which Einstein predicted 84 years ago.

Today, I came here to thank you for all you're doing to advance the march of human knowledge and to announce what we intend to do to accelerate that march by greatly increasing our national investments in science and technology.

The budget I will submit to Congress in just a few days will include a \$2.8 billion increase in our 21st century research fund. This will support a \$1 billion increase in biomedical research for the National Institutes of Health; \$675 million, which is double the previous largest dollar increase for the National Science Foundation in its entire 50-year history; and major funding increases in areas from information technology to space exploration to the development of cleaner sources of energy.

This budget makes research at our nation's universities a top priority, with an increase in funding of more than \$1 billion. University-based research provides the kind of fundamental insights that are most important in any new technology or treatment. It helps to produce the next generation of scientists, engineers, entrepreneurs. And we intend to give university-based research a major lift.

The budget supports increases not only in biomedical research, but also in all scientific and engineering fields. As you know, advances in one field are often dependent on breakthroughs in other disciplines. For example, advances in computer science are helping us to develop drugs more rapidly, and to move from sequencing the human genome to better understanding the functions of individual genes.

My budget supports a major new national nanotechnology initiative worth \$500 million. Caltech is no stranger to the idea of nanotechnology, the ability to manipulate matter at the atomic and molecular level. Over 40 years ago, Caltech's own Richard Symonds asked, what would happen if we could arrange the atoms one by one the way we want them? Well, you can see one example of this in this sign behind me, that Dr. Lane furnished for Caltech to hang as the backdrop for this speech. It's the Western hemisphere in gold atoms. But I think you will find more enduring uses for nanotechnology.

Just imagine, materials with 10 times the strength of steel and only a fraction of the weight; shrinking all the information at the Library of Congress into a device the size of a sugar cube; detecting cancerous tumors that are only a few cells in size. Some of these research goals will take 20 or more years to achieve. But that is why -- precisely why -- as Dr. Baltimore said, there is such a critical role for the federal government.

As I announced yesterday, this budget also includes an historic initiative to make higher

education more affordable. I am well aware of the fact that I would not have become President of the United States without loans and grants and jobs that helped me get through college and law school; and that more and more, given the cost of higher education, a higher and higher percentage of our students need more of all those things. This has been a virtual obsession for me ever since I became President. I was determined to leave office saying we had opened the doors of college to all Americans.

We have come a long way, by changing the student loan program to make it less expensive and to give young people more options for paying off their loans, including as a percentage of their income when they leave school. We've increased the number of work-study grants from \$700,000 to \$1 million. We've dramatically increased the Pell Grant program, and the HOPE Scholarship tax credit and the Lifetime Learning tax credits we adopted in 1997 last year alone had almost 5 million beneficiaries in institutions of higher education in the United States. (Applause.)

Yesterday, I proposed that, for the first time, we make college tuition tax deductible, and that we do it in a way that would benefit even more people on more modest incomes so that they could get the same 28-percent benefit, even if they're in the 15-percent tax category. I think this is very important. (Applause.)

The budget contains another increase in Pell grants, special initiatives to help minority students get into science and engineering and graduate. (Applause.) Special efforts -- that is basically a test program for several thousand students now -- to try to do something about the extraordinarily high dropout rate from college.

Now, over two-thirds of the high school graduates are actually going to go into college this year. That's an increase of over 10 percent in the last seven years. That's quite a large increase in a short time. But the dropout rate has increased correspondingly. We want to know why. Is it for financial reasons? Is it because people weren't prepared? Could they all be just idiosyncratic personal reasons? And we intend to do everything we can with a very large test group to see what we can do to turn this situation around.

And, finally, we're going to double the size of our Gear-Up program to 1.4 million young people. That's the program where people in universities and college all across America mentor middle-school kids who are at risk to try to help them develop the skills and the belief that they can go to college, and simultaneously to tell them and their parents exactly what they can expect in the way of aid under current law if they do go, so they will know. Many people still don't know that the barriers to their going on to college have been removed. So I hope you will also support this part of our budget, because the young people of our country and their families need it. In addition to announcing our new research budget and our efforts to make colleges more affordable, I'd like to try to achieve one other mission here today. First, I want to take a step back to acknowledge that we have not done a good enough job in helping all Americans to understand why we need very, very large investment in science and technology.

Far too many of our citizens think science is something done by men and women who are in white lab coats behind closed doors that somehow leads to satellite TV and Dolly the sheep. And it's all a mystery. It is our responsibility to open the world of science to more of our fellow citizens; to help them understand the great questions science is seeking to answer and to help them see how those answers will actually affect their lives and their children's lives in profoundly important and positive ways.

First, we have to make sure Americans understand the contributions science and technology are making right now to the present level of economic growth, something Dr. Baltimore

referred to. For example, because of our early investments in the Internet, America now leads the world in information technology, an industry that now accounts for a third of our economic growth, although only 8 percent of our work force; that generates jobs that pay 80 percent more than the private sector average.

If you look at that -- what does that mean to ordinary people, and what does it mean to the nature of the economy we're living in? I have never told the American people that we had repealed the ordinary laws of supply and demand, or the business cycle. But we have stretched them quite a lot.

In February, next month, we will have the longest economic expansion in the history of the United States -- outstripping even those that required full mobilization for war. Now, part of that is because we have pursued, I believe, sound policies -- to get rid of the deficit; to start running surpluses, the first back-to-back surpluses in 42 years; to keep our markets open, with 270 trade agreements; to argue, as I have, that not only exports are benefited by open markets, we also benefit from the imports, because they're a powerful brake on inflation and allow us to continue to grow.

But the real reason this thing keeps going on and on and on is that -- all we did in the government was to set the conditions, and provide the tools, for the American people to succeed. The real reason is the exponential growth in information technology, and how it is rifling through every other sector of our economy and reinforcing the material science revolution, which preceded it by a few years, but which continues to the present day.

When I became President, there were only 50 sites on the Worldwide Web -- 50. When I became President -- that seemed like a long time ago to the students, but the rest of you will know -- (laughter) -- it's just like yesterday. There are now over 50 million. Think of it. In seven years, from 50 to over 50 million. It is changing everything about the way we work and live and relate to each other.

I was in Northern California a few weeks ago with a lot of really fascinating young people who work with E-bay -- a lot of you have probably bought things, maybe you've even sold things on E-bay. But for example, one of the things I learned is that in addition to the employees of E-bay, there are now 20,000 people whose primary source of income is buying and selling on E-bay. They do it for a living. And several of them -- not insubstantial number of them -- were on welfare before they found a way to bring their entrepreneurial skills to bare by trading on E-bay. It has changed everything.

So we have to say to people, if you like the fact that we have the lowest unemployment and welfare rolls in 30 years, the lowest minority unemployment rates ever recorded, the lowest female unemployment rate in 40 years, the lowest poverty rates in 20 years, the lowest single household poverty rate in 46 years, you have to understand that all that, at least in large part, is because of the ability of the discoveries of science and technology to rifle through our ordinary lives. And it is very, very important that all of us do a better job of that.

I have proposed in this budget a 36 percent increase in information technology research alone, so that researchers will be able to tackle a wide array of other challenges. How do we find, precisely, the piece of information we're looking for in an ever-larger ocean of raw data. How do we design computers that are usable by everyone including people with disabilities.

One of the most fascinating relationships I've developed -- we were talking on the plane ride out here about one of the great things about being President is nearly anybody will come to talk to you -- once, anyway. (Laughter.) And we were talking about all the people I had been privileged to meet in the last seven years. You know, I have developed quite a good personal

friendship with Steven Hawking, who, as all of you know, has lived longer with Lou Gehrig's disease, as far as we know, than any person who's ever lived -- partly, I am convinced, because of not only the size of his brain, but the size of his heart. But it is fascinating to see what technology has permitted this man to do.

Just a few years ago, he could have had the biggest brain in the world, and no one could have known it, because it could not have gotten out. There is no speaking capacity, almost no movement left. He can just move his thumb, and hold in his hand this remarkable little tracer that goes through a whole dictionary of words that he has, that he runs through with rapid speed. He picks the word he wants, puts the sentences together, and then an automated voice tells you what he just said.

How can we make it even easier for him? How can we make it even easier for other people? This will be a huge issue. Make no mistake about it, the liberation of Americans with disabilities is also in no small measure the product of the revolution in science and technology.

There are also other uses. I read the other day that manufacturers are soon going to introduce a refrigerator that can scan the bar codes of empty packages and expired goods -- (laughter) -- and order new groceries for you over the Internet. (Laughter.) Now, everybody who's ever poured out a carton of bad milk will love this. (Laughter.) You don't have to smell your bad milk anymore. It won't be long before the computer will refuse to order what's bad for you -- (laughter) -- and only pick items off Dean Ornish's diet. And then we'll all be in great shape. (Laughter.)

The second thing I think we have to do is let Americans know how investments in science and technology, broadly stated, will allow us to lead longer, healthier lives. Everybody knows now that you can put money into cancer research -- and thank God we've discovered two of the genes that are high predictors of breast cancer, for example, in the last couple of years -- but we need for more Americans to understand why we need a broad research agenda in science and technology, for the health of Americans. (Applause.)

In the 20th century, American life expectancy went from 47 years to almost 77 years, thanks to penicillin and vaccines for many childhood diseases. We were talking the other day about the impact -- I'm old enough to remember the first polio vaccine. And I remember how our mothers herded us in line and made us stand there waiting for our shot. And it was like they were all holding their breath, praying and hoping that we would get our shot before we got polio. It's something that young people today can hardly imagine, but it hung like a cloud over the families of my parents' generation. Now, we have this incredible life expectancy -- today, the average American who lives to be 65 has a life expectancy of 83 -- already. And we are clearly on the cusp of greater advances.

Later this year, researchers expect to finish the first complete sequencing of the genome -- all 3 billion letters and 80,000 genes that make up our DNA code. Since so many diseases have a genetic component, the completion of this project will clearly lead to a revolution in our ability to detect, treat and prevent many diseases. For example, patients with some forms of leukemia and breast cancer soon may receive sophisticated new drugs that elegantly actually target the precise cancer cells with little or no risk to healthy cells. That will change everything.

Our new trove of genomic data may even allow us to identify and cure most genetic diseases before a child is even born. Most people just take it as a given now that within the next few years, when young mothers bring their babies home from the hospital, they will bring along a genetic map of their children's makeup, what the problems are, what the challenges are, what the strengths are. It will be scary to some extent, but it also plainly will allow us to raise our

children in a way that will enhance the length and quality of their lives.

But it's important to recognize that we never could have had the revolution in the genome project without the revolution in computer science as well, that they intersected. Research at the intersection between biomedical research and engineering will also lead to amazing breakthroughs. Already, scientists are working on -- we've seen it on television now -- an artificial retina to treat certain kinds of blindness, and methods of directly stimulating the spinal cord to allow people who are paralyzed to work. Now, you think of that.

Last year, for the first time, to give you an idea of the impact of technology on traditional medical research, last year, for the first time, medical researchers transplanted nerves from the limbs to the spine of a laboratory animal that had its spine severed and achieved movement in the lower limbs for the first time. That had never happened before.

Now, because of advances in the intersection between science and engineering, we may not have to keep working on that. We may actually be able to program a chip that will stimulate the exact movements that were prevented by the severing or the injury of a spine. And all the people that we have seen hobbled by these terrible injuries might be able to get up and walk. Because there was medical research, yes, but there was also research on the engineering, nonbiological components of this endeavor. We have to do a better job of explaining that to the American people.

Third, advances in science and technology are helping us to preserve our environment in ways that preserve more sustainable and widespread economic growth. And that is very important.

Let me just give you an example. Not far from here in Southern California, a couple years ago the Department of Energy, working with the National Homebuilders and HUD, helped to construct a moderate- and low-income housing community, with glass in the windows that keeps out four or five times as much heat or cold, and lets in even more light. And that, coupled with the latest insulation technology and the latest lighting in the house, enabled the houses to be marketed to people of modest incomes, with the promise that their electric bills would average 40 percent below what they would in a home of that size built in the traditional manner. I can tell you that after two years, the power bills are averaging 65 percent less. And we can't build enough houses for the people that want them.

The Detroit Auto Show this year is showcasing cars that, I'm proud to say, were developed as part of our partnership for new generation vehicles that the Vice President headed up, and we started way back in '93. We brought in the auto workers and the auto companies and we said, look, instead of having a big fight about this, why don't we work together and figure out how to use technology to dramatically increase mileage. And a lot of you are probably familiar -- they're using fuel-injection engines, which cuts a lot of the greenhouse gas emissions; some using developed mixed-fuel cars that start on electricity, switch to fuel after you reach a certain stage, and then go back to electricity when you slow down back to that speed, because 70 percent of the greenhouse gas emissions are used in starting and stopping cars.

And there are all kinds of other things being developed. But this year the Detroit Auto Show has cars making 70, 80 miles a gallon, that are four-seater cars, that will be on the market in a couple of years. You can buy Japanese cars this year on the market that get about 70 miles to the gallon, but they're small two-seaters. Last year I went and saw cars that are 500 to 1,000 pounds lighter than traditional cars, and score at least as well on all the damage tests -- again because of the revolution in material science, with composite materials being used in the cars.

And the big thing that's coming up in this area is, before you know it, I believe we will crack

the chemical barriers to truly efficient production of biomass fuels. One of the reasons you see this whole debate -- in the presidential campaign, if you're following it, you know the big argument is, is it a waste of money to push ethanol or not, if it takes seven gallons of gasoline to make eight gallons of ethanol. But they're on the verge of a chemical breakthrough that is analogous to what was done when crude oil could be transferred efficiently into gasoline. And when that happens, you'll be able to make eight gallons of biomass -- not just from corn, but from weeds, from rice hulls, from anything -- for about one gallon of fuel. That will be the equivalent therefore, in environmental terms, of cars that get hundreds of miles a gallon. And the world, the environmental world, will be changed forever. And that's -- one-third of our greenhouse gas emissions are in transportation.

Now, I just want to kind of go off the script a little to hammer this home, because big ideas in science matter. And once you make a big breakthrough, then thousands and thousands of things follow that have immense practical significance. But you must also know and believe that being in the grip of a big idea that is wrong can be absolutely disastrous.

So today, in Washington and in much of the world, there is a debate that goes something like this: The overwhelming evidence of science is that the climate is warming at an unsustainable rate due to human activity. And then there's this old idea, which says, well, that's really too bad, but a country can't grow rich or stay rich and sustain a middle-class lifestyle, unless every year it puts more greenhouse gases into the atmosphere than it did the year before. And you certainly can't drastically cut them, and maintain your level of wealth.

Our administration spent hundreds of thousands of dollars last year complying with requests to appear before a House subcommittee that believes that our passion about climate change is some sort of subversive plot to wreck the American economy. (Laughter.) Either that or -- you know, I've been reading too many kooky books or something. (Laughter.) They think it's just crazy. Why? Because they can't face the fact that we would do anything to hurt the American economy, and they really believed it would. So I would argue to you that here is a place where we're in the grip of an idea that is wrong.

Our efforts to get India and China and other big countries that will soon surpass us in greenhouse gas emissions to cooperate with us, not in regulation, but in new technologies, to help them grow rich differently, always keep running up against the barrier of suspicious officials who believe somehow this is kind of an American plot to keep them poor. Why? Because they're in the grip of an idea that isn't right anymore. It is simply not true that to grow rich, you have to put more greenhouse gases in the atmosphere.

So again, I say we have to do a better job of explaining the contribution that science and technology can make to saving the planet and allowing us to still have prosperous lives -- and, I would argue, to allow us to have more prosperous lives and better lives that would otherwise be the case, certainly within 40 to 50 years, if we don't act and act now. This is profoundly important. (Applause.)

Finally, I think we have to do a better job of having an open debate about the responsibilities that all these advances and discoveries will clearly impose: The same genetic revolution that can offer new hope for millions of Americans could also be used to deny people health insurance; cloning human beings; information technology which helps to educate children and provide telemedicine to rural communities could also be used to create disturbingly detailed profiles of every move our citizens make on line.

The federal government, I think, has a role to play in meeting these challenges as well. That's why we've put forward strict rules and penalties to limit the use and release of medical records; why we've worked with Congress to ban the cloning of human beings, while

preserving our ability to use the morally and medically acceptable applications of cloning technology, which I believe are profoundly important; why we're working with the Internet industry to ensure that consumers -- consumers -- have control over how their personal information is used.

It's up to all of us to figure out how to use the new powers that science and technology give us in a responsible way. Just because we can do something doesn't mean we should. It is incumbent, therefore, upon both scientists and public servants to involve the public in a great debate to ensure that science serves humanity -- always -- and never the other way around.

On this campus nearly 70 years ago, Albert Einstein said, "Never forget this, in the midst of your diagrams and equations: concern for man himself and his fate must always form the chief interest of all technical endeavors." Today, at the dawn of this new millennium, we see for all of you, particularly the young people in this audience, an era of unparalleled promise and possibility. Our relentless quest to understand what we do not yet know, which has defined Americans from our beginnings, will have more advances in the 21st century than at any other time in history. We must be wise as we advance.

I told you earlier that the First Lady sponsored a Millennium Evening with Vince Cerf and Professor Lander. One of the most interesting things he said about his genomic research confirmed not other scientific research, but the teachings of almost every religion in the world. He said that, genetically, we are 99.9 percent the same. And, he said, furthermore, that the genetic differences among individuals within a given racial or ethnic group are greater than the differences between groups as a whole -- suggesting that we are not only our brothers' and sisters' keepers, but in fundamental genetic ways, we are our brothers and sisters.

And I leave you with this thought. I think the supreme irony of our time is that I can come here as President and have the high honor of discussing these unfathomable advances wrought by the human intellect, that have occurred and the even greater ones yet to occur, in a world where the biggest social problem is the oldest demon of human society -- we are still afraid of people who aren't like us. And fear leads to distrust, and distrust leads to dehumanization, and dehumanization leads to violence.

And it is really quite interesting that the end of the Cold War has marked an upsurge in ethnic and racial and tribal and religious hatred and conflict around the world; and that even in our own country we see countless examples of hate crimes from people who believe that others are different and, therefore, to be distrusted and feared and dehumanized.

You have the power to put science and technology at work advancing the human condition as never before. Always remember to keep your values at the core of what you do. And tell every one of your fellow citizens, and indeed people with whom you come in contact all across the world, that every single scientific advance confirms over and over again the most important facts of life -- our common humanity.

Thank you very much. (Applause.)

END 11:40 A.M. PST

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